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The Westray Story

A Predictable Path to Disaster

Report of the Westray Mine Public Inquiry

Justice K. Peter Richard, Commissioner

Volume One

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Cover: Sketch of Westray mine by Elizabeth Owen

“The most important thing to come out of a mine is the miner.”

Frédéric Le Play (1806–1882)
French sociologist and inspector general of mines of France

At 5:20 am on 9 May 1992
the Westray mine exploded taking the
lives of the following 26 miners.

John Thomas Bates, *56*

Larry Arthur Bell, *25*

Bennie Joseph Benoit, *42*

Wayne Michael Conway, *38*

Ferris Todd Dewan, *35*

Adonis J. Dollimont, *36*

Robert Steven Doyle, *22*

Remi Joseph Drolet, *38*

Roy Edward Feltmate, *33*

Charles Robert Fraser, *29*

Myles Daniel Gillis, *32*

John Philip Halloran, *33*

Randolph Brian House, *27*

Trevor Martin Jahn, *36*

Laurence Elwyn James, *34*

Eugene W. Johnson, *33*

Stephen Paul Lilley, *40*

Michael Frederick MacKay, *38*

Angus Joseph MacNeil, *39*

Glenn David Martin, *35*

Harry A. McCallum, *41*

Eric Earl McIsaac, *38*

George S. James Munroe, *38*

Danny James Poplar, *39*

Romeo Andrew Short, *35*

Peter Francis Vickers, *38*

This Report is dedicated to their memory.

In the early morning of 9 May 1992 a violent explosion rocked the tiny community of Plymouth, just east of Stellarton, in Pictou County, Nova Scotia. The explosion occurred in the depths of the Westray coal mine, instantly killing the 26 miners working there at the time. On 15 May 1992, I was appointed by Order in Council to inquire into and report on this disaster.

During the formative days of this Inquiry, as my understanding of the underground coal mining industry developed, I was struck by two notions that have persisted throughout. The industry is very close-knit with an interdependence, camaraderie, and fellowship that may be unique in modern-day business. And people in the industry, at all levels, regard what occurred at Westray as a personal matter affecting them as if it had happened in their own backyard. It is for them a family tragedy. I suspect that these attitudes have deep historic roots. There are few industries in which one's safety, indeed one's very survival, is so inextricably linked to the attitudes, practices, concerns, and behaviour of fellow workers. Truly, in the underground coal mining environment, you are "your brother's keeper." The miner who sneaks a smoke while underground is risking the lives of his fellow miners. On 7 December 1992, the flick of a cigarette lighter underground caused the death of eight miners at the Southmountain Coal Company in Virginia.

The Westray tragedy is regarded in the industry as a black mark against coal mining in general rather than as a merely localized event. As a result, I received a remarkable degree of cooperation from the industry, which, while being most encouraging, underscored the solemn responsibility I had assumed. The coal industry – miners, managers, operators, and regulators – is most anxious to determine what can be learned as a result of this tragedy and what can be done to prevent another.

The 1981 Report of the Joint Federal-Provincial Inquiry Commission into Safety in Mines and Mining Plants in Ontario (the Burkett Report) is aptly entitled *Towards Safe Production.* As its title suggests, the entire thrust of the report is to increase and to promote safe practices in mines. The only completely safe mine is a closed mine. By the same token, the

only completely safe aircraft is on the ground with the engines off. The only truly safe automobile is the one parked in the garage. Once a mine is open, there begins the constant process of trade-off between production and safety. From the chief executive officer to the miner at the working face, the objective must be to operate the mine in a manner that ensures the personal safety of the worker over the economic imperatives of increased production. The two seemingly competing concepts – safety and production – must be so harmonized that they can co-exist without doing harm to each other. It is here that the regulator must assume the role of monitor and aggressively ensure that the balance is understood and maintained. In this sense, the function of the regulator is both instructive and supervisory. As one provincial mine inspector in Ontario told me, "Ideally, if we perform our duties properly we will eventually work ourselves out of a job." As I read *Towards Safe Production*, I was impressed with the clarity and wisdom of this regulatory role.

The Order in Council that established this Inquiry gives me power to "inquire into . . . whether the occurrence was or was not preventable." Of course it was. For this Report we have chosen the title *The Westray Story: A Predictable Path to Disaster* to convey that message. The message is that the Westray tragedy was predictable and, therefore, preventable. The Report contains recommendations and suggestions aimed at avoiding a similar occurrence in the future.

Anyone who hopes to find in this Report a simple and conclusive answer as to how this tragedy happened will be disappointed. Anyone who expects that this Report will single out one or two persons and assess total blame for the tragedy will be similarly disappointed. The *Westray Story* is a complex mosaic of actions, omissions, mistakes, incompetence, apathy, cynicism, stupidity, and neglect. Some well-intentioned but misguided blunders were also added to the mix. It was clear from the outset that the loss of 26 lives at Plymouth, Pictou County, in the early morning hours of 9 May 1992 was not the result of a single definable event or misstep. Only the serenely uninformed (the wilfully blind) or the cynically self-serving could be satisfied with such an explanation.

This Report has been written with the benefit of hindsight, which, as the saying goes, provides 20/20 vision. Many of the incidents that now appear to fit into the mosaic might at the time, and of themselves, have seemed trivial. Viewed in context, these seemingly isolated incidents constitute a mind-set or operating philosophy that appears to favour expediency over intelligent planning and that trivializes safety concerns. Indeed, management at Westray displayed a certain disdain for safety and appeared to regard safety-conscious workers as the wimps in the organization. To its discredit, the management at Westray, through either incompetence or ignorance, lost sight of the basic tenet of coal mining: that safe mining is good business. As one mining executive remarked to me in June 1996 during a mine visit to Alabama, "We could not afford to operate an unsafe mine, due to the high cost of accidents and downtime." Certainly, the validity of this concept was never more obvious than in the horrible aftermath of Westray.

The tale that unfolds in the ensuing narrative is the *Westray Story*. It is a story of incompetence, of mismanagement, of bureaucratic bungling, of deceit, of ruthlessness, of cover-up, of apathy, of expediency, and of cynical indifference. It is a tragic story, with the inevitable moments of pathos and heroism. The *Westray Story* concerns an event that, in all good common sense, ought not to have occurred. It did occur – and that is our unfortunate legacy.

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November 1997

To His Honour
The Lieutenant Governor

By Order in Council dated 15 May 1992, I was appointed a Commissioner under the *Public Inquiries Act* and a Special Examiner under the *Coal Mines Regulation Act* to inquire into, report, and make recommendations respecting the tragic Westray mine explosion, which occurred on 9 May 1992.

I am pleased to report that I have now completed my mandate as set out in the Order in Council and, as directed, I hereby submit my report to you and to the people of Nova Scotia.

Respectfully submitted,

K. Peter Richard, Justice
COMMISSIONER

Preface

From the very outset of this Inquiry, the massive amount of documentary and testimonial evidence created logistical as well as evidentiary problems. The determination of which of the evidence was the most relevant and which was not essential to the completion of the Inquiry mandate was a formidable but necessary undertaking. This approach was necessary in order to keep the Report a reasonable size without sacrificing content. Each chapter of the Report was directed, as closely as possible, to specific directions in the Terms of Reference. The reader will note that each chapter begins with a marginal note indicating the particular term or terms of the Order in Council most germane to the discussion to follow. This focus enabled us to concentrate on the evidence most pertinent to each aspect of the mandate of the Inquiry.

The Terms of Reference

One of the most difficult decisions faced by members of the Inquiry research staff and myself was when to say "enough." During each phase of our investigation and research, we had to make a conscious decision to discontinue those efforts and direct our attention towards the preparation of this Report. There was always the lure of the unread research paper or the bit of testimony that might have placed a slightly different slant on something. The determining factor was always the Inquiry Terms of Reference and whether additional effort would help to fulfil my mandate as set out there.

One such example may be illustrative of this problem. In the Terms of Reference, I was empowered to "*inquire into . . . whether any neglect caused or contributed to the occurrence.*" Following the 9 May 1992 explosion, there were the inevitable finger-pointing and accusations in the media and elsewhere. Allegations of political interference or intervention during the planning stages of the Westray mine were common. Suggestions were made that Premier John Buchanan and his successor, Premier Donald Cameron, might have exerted influence that resulted in decisions not consistent with good business practice. Nova Scotia Labour Minister Leroy Legere was criticized for the conduct of his department during the weeks following the disaster. There were subtle suggestions that these ministers of the crown must accept some responsibility for the lack of vigilance and planning that might have contributed to the accumulation of circumstances leading to this disaster. In my view, it is evident that the nature and the extent of a cabinet minister's responsibility was widely misunderstood. Rooted as it is in the British parliamentary system, ministerial responsibility has a long and complex history. It has been the subject of much learned writing over the years, both in the United

Kingdom and in Canada. I felt that the issue ought to be canvassed in this Report, at least to the extent of placing the actions of the various ministers in the proper constitutional context. With the assistance of Dr Peter Clancy, professor of political science at St Francis Xavier University, I have included a brief analysis of this concept and how it applies in the context of Westray. It is not dispositive of the subject, but it may give the reader some insight into the concept of ministerial responsibility and its implications in a particular set of circumstances.

In much the same way as decisions were made respecting the investigation and research aspect of this Inquiry, we also had to draw the line on how much revising, editing, and refining of text were to be done. This is especially difficult when preparing a report on very technical and somewhat arcane subject matters and attempting to have the text accessible to the average reader. This Report cannot be seen as a technical paper on coal mine operation and safety. My aim from the outset has been to prepare a report that addresses the questions either expressed or implied in the Terms of Reference as set out in the Order in Council, and to do so in as readable and non-technical a manner as the subject matter allows.

The Process and the Report

After some deliberation about the most effective way to present the results of the Inquiry, we decided to divide the discussion into four parts, contained in two volumes. A Reference volume and an Executive Summary complete the package. In Part One, Prelude to the Tragedy, I look at Westray from the point of view of how the mine came to be and how it functioned. In Part Two, The Explosion, I analyse what happened on 9 May 1992 and examine the various technical problems involved in mining coal in Pictou County, as well as how Westray handled them. In Part Three, The Regulators, I examine provincial responsibilities, and in Part Four, The Aftermath, I relate what happened after the explosion.

I have tried to keep the Report free of all but a minimum of technical language or jargon. That has been done only to the extent that it would not distort the meaning. The Glossary of Coal Mining Terminology, located in the Reference volume, is meant to assist where the use of technical language was essential.

The Reference volume of the Report also contains many of the photographs referred to in the text, as well as a number of mine plans and associated material. This volume is spiral-bound for convenience. It permits the reader to consult a photograph or plan while reading the text relating to it.

We have made a conscious effort throughout this Report to provide authority for any statements or conclusions. This is to ensure that there is a sound basis for them, whether it be in the testimony of witnesses or the findings of experts, or our many exhibits. This documentation may also be useful to the reader wishing to pursue any particular aspect of the Report. During the course of this Inquiry, we have amassed a considerable library

of materials relating to coal mining and to industrial safety, both in coal mines and elsewhere. A bibliography has been prepared and is included in the Reference volume.

In the interest of economy of space, I may not refer to each piece of testimony or every document in support of a particular finding or conclusion. If 20 witnesses have testified to excessive amounts of coal dust in the mine, I may refer to only two or three such witnesses as representative of the evidence on which I have based my findings or conclusions. This is consistent with our practice during the investigative stage of the Inquiry and at the hearings. For instance, although 120 Westray miners and draegermen were interviewed, only 30 were actually called to the hearings, simply to avoid needless repetition. Inquiry Exhibit 74, Interview Abstracts – Post-Explosion Conditions, is a summary of extracts from post-explosion interviews; it is included in this Report as Appendix J. This summary was prepared by Inquiry staff to help determine which of the 120 miners would be asked to give testimony at the hearings. It provides a convenient, though cryptic, source of information respecting many post-explosion observations. The circled numbers on map 1 in the Reference volume are keyed to this appendix.

For those who wish access to Inquiry documents, including transcripts, exhibits, research materials, and copies of this Report, all are at the library of St Francis Xavier University, Antigonish, Nova Scotia. A complete set of exhibits and transcripts, along with the Report, is also on file at the Nova Scotia provincial archives in Halifax.

I have relied on much more than the documents, exhibits, and hearing testimony in formulating the opinions and conclusions contained in this Report. I gained useful insights during visits to several underground coal mines in Canada and the United States. These visits are more fully described in Chapter 16, The Inquiry. In addition, I have met informally with mine operators and executives, and with mining inspection personnel in British Columbia, Alberta, Ontario, and Washington, DC. I have talked to Labour Canada mine inspectors and visited the CANMET equipment certification laboratory at Bells Corners, Ontario, and the Cape Breton Coal Research Laboratory at Sydney, Nova Scotia. As well as studying Canadian federal legislation and provincial legislation for British Columbia, Alberta, and Ontario, Inquiry staff have studied legislation from jurisdictions including South Africa, the United Kingdom, Australia, the United States, and the states of Utah and West Virginia. Many of the more progressive measures from those jurisdictions have been included in the legislative recommendations incorporated into this Report. I am of the view that legislative changes respecting workplace safety ought not be disaster driven, although the sad fact is that they usually are.

The legislative recommendations are set out throughout the Report in the related subject areas. These recommendations do not constitute a complete legislative regime but rather are suggestive of a regulatory direction. As will become apparent in the Report, I favour the highly detailed approach to regulations as exemplified by Title 30 of the *Code of*

Federal Regulations (CFR) in the United States. What approach is finally adopted in Nova Scotia will depend on the further deliberations of experts and the outcome of federal-provincial negotiations respecting a cooperative approach to mine safety regulation. Also, the choice of the appropriate legislative regime will determine whether many of the recommendations will be adopted or be subject to modification to fit the regime so selected.

As a matter of style, and for reader convenience, the Report is structured so that all findings and recommendations are set out as they are made, relevant to the matters being discussed. The findings and recommendations are also set out in their entirety in a concluding section of this Report as well as in the Executive Summary. Also, for reader convenience, there is some duplication throughout the Report. For example, I have attempted to make Chapter 6, The Explosion, as complete as possible to avoid the inconvenience for readers of flipping back and forth to other sections or chapters in order to pick up the thread of continuity. Since many of the elements of the explosion are matters relating to mine ventilation, Chapter 7, Ventilation, further discusses these elements.

Throughout this Report I have attempted, so much as possible, to keep the narrative free of comment. In most cases the narrative speaks for itself, but at times comments, which I have generally placed in footnotes, seem appropriate.

Acknowledgements

It would not have been possible to complete this Report without the assistance and cooperation of many people. I was continually amazed by the sincerity, goodwill, and genuine interest demonstrated by everyone in the international mining community with whom I had contact. Whether I reached them by phone, letter, or personal visit, the response of each was immediate and generous. I realized early in my study that the members of the mining community form a close-knit group, with a genuine interest and empathy for others in the community. They were always eager to assist in any way – especially where safety is concerned. In particular, I wish to acknowledge the assistance of the following persons:

Kevin Burkett, Ontario labour arbitrator, who chaired the Ontario mining inquiry and who authored the report *Towards Safe Production*. Burkett built upon the concept of "internal responsibility" first articulated by James M. Ham in the 1976 Report of the Royal Commission on the Health and Safety of Workers in Mines. This concept has gained recognition in other parts of Canada.

Glen Zumwalt, Skyline mine, Helper, Utah, for arranging my first visit to an underground coal mine. *Craig Hilton*, vice-president operations, who gave me my first briefing in underground coal mine safety and acted as my guide through the Skyline mine. *Ben Bringhurst*, safety director for Skyline, who impressed upon me the singular importance of safety in the mine; I was especially struck by Ben's thoughtful and "no nonsense" approach to mine safety.

Bob Cooper, vice-president, finance, Devco, for consultations and for providing materials on training. *Reg McIntyre*, vice-president operations, Devco, for arranging a tour of the Phalen colliery and providing much assistance by way of interviews and conferences. Reg also provided valuable insights into the Westray rescue operation, of which he was a valued participant.

Bruce Campbell, now retired executive director of the Ontario Mining Association, and his successor, *Michael Green*, both of whom provided valuable insights into the mining industry. Bruce also provided a valuable perspective into the practical application of Ontario mining legislation.

Mary Tate, director of the Occupational Health and Safety Branch of the Ontario Ministry of Labour, for arranging meetings with Ontario mine inspectors and providing an overview of the Ontario mine safety administration.

Ian Plummer, recently retired provincial coordinator of mining, Occupational Health and Safety Branch, Ontario Ministry of Labour, for

his continued assistance and advice on matters of mine safety and the administration of safety legislation. Ian also provided assistance in the formulation of the section on internal responsibility and its administration in Ontario.

Charles Byrer, project manager, Coalbed Methane, U.S. Department of Energy, who provided advice and literature on many aspects of underground mining, as well as much of the research material used to prepare the section on coal mine degasification.

Hall Chamberlin, formerly of the British Columbia Mining Association, for sharing his expertise and insights into various aspects of the Canadian underground coal mining industry. I also acknowledge the assistance of *Gary Livingstone*, president of the association.

Dr William Hustrulid, strata control engineer, formerly of the Colorado School of Mining, for direction and assistance in ground control matters. Dr Hustrulid also produced and edited the valuable text on underground coal mining *Underground Mining Methods Handbook*, which has been an important research tool for the Inquiry.

Barbara Dygert, of the Society for Mining, Metallurgy, and Exploration, Inc., Littleton, Colorado, who secured several research volumes for the Inquiry and kindly consented to the use of charts and diagrams in this Report.

Dave Forrester, director of the Sydney Coal Laboratory (CANMET), for a very informative day of instruction at the laboratory there. I am also indebted to *Gary Bonnell*, methane specialist, and *Dave Young*, who came to Stellarton and provided a most graphic demonstration of the explosive properties of methane and coal dust. I also acknowledge the assistance of *Dan Kennedy*, research scientist, and *George Klinowski*, ventilation specialist.

Dr John Udd, director of CANMET, Bells Corners, Ontario, for his cooperation and assistance in arranging and conducting a tour of the CANMET facilities at Bells Corners, and for providing insights into technical assistance available to the mining industry in Canada. Dr Udd arranged for my visit to the Sydney Coal Laboratory.

Davitt McAteer, assistant secretary of the U.S. Department of Labor, *Ed Hugler*, counsel, and *Madison McCulloch* and *Bob Elam*, deputy directors of MSHA, Washington, DC, for cooperation and hospitality in arranging a tour of their facility at Arlington, Virginia. (Bob Elam was on site during the days following the Westray disaster to assist on behalf of MSHA.) I am particularly indebted to *Glenn Tinney*, then manager of safety services, for arranging an intensive and informative tour of the various safety offices within the agency and to *Cheryl McGill*, mining inspector, for her "hands on" review of mine safety practices and enforcement.

Tom Kessler, superintendent, *Don Farley*, assistant superintendent, and instructors *Dave Friley*, *Dennis Hartsog*, *Cliff Lindsay*, all of the National Mine Health and Safety Academy at Beckley, West Virginia, who freely gave of their time and expertise. I have relied on their interest and cooperation on several occasions during the course of this Inquiry. While at Beckley, I had the privilege of spending some time with *Jim Rutherford*, now retired assistant director at MSHA, as well as with *William "Bolts" Willis*, director of mine safety, West Virginia Department of Mines.

Bill Carr, president of Jim Walter Resources, Inc., of Brookwood, Alabama, for giving so freely of his time and resources to make my visit to JWR as productive as possible. *Charles Dixon*, senior vice-president, engineering, JWR, for arranging a tour of the training facility and one of the underground coal mines. I am thankful for the continuing support and assistance that Mr Dixon has provided. *G. Willis Coates*, recently retired JWR general manager of safety and training, and training supervisor, *Dale Byram*, his successor, along with *Ralph Ausborn*, safety instructor, *Wyatt Andrews*, safety supervisor, and *Reggie Lamons*, underground manager, provided safety instruction and guided me through an underground mine at Brookwood.

Local manager *Bill Whitefield* of *MSA Canada Inc*., who kindly loaned various pieces of mine safety equipment to the Inquiry for instructional and display purposes during the hearings.

Bob Bone, PEng, mining engineer and inspector with the British Columbia Ministry of Energy, Mines and Petroleum Resources, and inspector of the underground coal mine at Campbell River – a room-and-pillar operation quite similar to Westray – who has been particularly helpful during the course of the Inquiry. *Tom Carter*, manager, mechanical and electrical engineering, Mine Health and Safety Branch, who, along with Bob Bone, provided a very instructive day in the operation of the BC mining inspectorate.

Greg P. Isenor, of Sydney, Nova Scotia, who, in the very early stages of the Inquiry provided valuable insights into the history of methane exploitation testing at the Pictou coalfield. Mr Isenor had been a consultant in the Algas project.

Trudie Richards, freelance writer and journalist, who provided the Inquiry with an insightful commentary on the interrelationship among the media, rescuers, and families during the time following the disaster.

George Vooro, president and chief executive officer of Quinsam Coal Corporation, Campbell River, British Columbia, who supplied the Inquiry with detailed and current mine and ventilation plans for the Quinsam mine. This material provided valuable comparative data on room-and-pillar mine layout and planning.

John Chisholm, president of Nova Construction of Antigonish, Nova Scotia, and developer of the open-pit mine in Stellarton/Westville, who

invited me to tour the open-pit mine. Through this visit I was able to get some first-hand appreciation of the geological configuration of the Foord seam.

Members of the judiciary were also forthcoming and eager to offer advice on the conduct of public inquiries and other matters. Justices *Horace Krever*, *Sam Grange*, and *Lloyd Houlden*, commissioners of inquiries in Ontario, were always available to provide valuable assistance and support concerning inquiry procedures and practices.

Finally, although my appreciation to Inquiry counsel and staff is expressed in Chapter 16, I would now like to thank all those who devoted their talents to the work of the Inquiry. I am grateful to each of them for their contribution.

PART ONE

Prelude to the Tragedy

History, Development, and Operation

1 History of Coal in Pictou County

The Westray mine at Plymouth was the only operating underground coal mine in Pictou County at the time it exploded on 9 May 1992. This belies the fact that much of the social and economic fabric of Pictou County was woven around the coal mining industry and the Pictou coalfield. I was surprised at how much of the history of coal mining in Pictou County has been recorded. Libraries at St Francis Xavier University in Antigonish, the Town of New Glasgow, and the Nova Scotia Museum of Industry in Stellarton have sections devoted to the Pictou coalfield. As I reviewed this material, the name of James M. Cameron kept appearing. I was impressed by the prodigious research he carried out into almost all phases of the history of industrial Pictou County. His detailed history, *The Pictonian Colliers*, is the seminal work on the Pictou coal mining industry.[1] The bibliography to this Report includes a number of historical materials, compiled for the most part by Judith Hoegg Ryan, another student of Pictou County coal mining.[2]

Historians think the first settlers of what became Pictou County must have known of the presence of coal as early as 1767 because the local Indians knew of the escaping methane gas. They told of fires caused by lightning striking trees and the burning trees then igniting the outcropping of coal in what is now the Stellarton area.[3] The historian the Reverend George Patterson, in discussing the origin of the county's name, wrote that "there can be little doubt that . . . [the name Pictou] is formed from the Indian name . . . Pictook." He went on to write that Silas Rand (compiler of the first dictionary of Micmac) "ascribes the word to the Indian word 'Pict' meaning any explosion of gas and suggests the name is descriptive of the escape of gas (methane) from coal lying beneath the surface around the East River."[4] The history of the "industrial" part of Pictou County is largely the history of coal mining. Early coal mining was labour intensive, and the population of the county grew as employees and service industries were attracted to the area. That growth continued as other businesses and industries, drawn by the proximity of a good source of fuel, settled in the communities of industrial Pictou County.

I decided that a sketch of the history of coal mining in Pictou County would be a fitting introduction to this Report. By this means, I hope to give the reader some insight into the historical, social, and economic

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1 James M. Cameron, *The Pictonian Colliers* (Halifax: Nova Scotia Museum, Province of Nova Scotia, 1974).

2 Much of what follows is the work of Judith Hoegg Ryan, who has an abiding interest in, and a long family association with, the Pictou County coal industry. She was retained at the early stages of the Inquiry as its historian.

3 Cameron, *Pictonian Colliers*, 16.

4 George Patterson, *A History of Pictou County*, 2nd ed. (Belleville, Ont.: Mika Studio, 1972), 22.

significance of coal mining in this area. The roots of Westray extend back to the first attempts to mine the Pictou coalfields, and elements of the disaster rest in the nature of those coalfields with their "thick, gassy seams," which were "prone to spontaneous combustion and explosion."[5] This sketch begins with a description of the Pictou coalfield and then outlines briefly the history of mining in the county from its rudimentary beginnings to World War II and the postwar mechanized era. This history is marked by fire, explosion, and death.

The Pictou Coalfield

The Pictou coalfield lies within a land area measuring roughly 18 km from east to west and 6 km from north to south, and encompasses approximately 25 seams of bituminous coal. These coal seams lie beneath each other, separated by rock strata. All the seams outcrop in a half-moon fashion east and west, and all slope downwards, or pitch, towards the north. The farther west, the steeper the pitch of the seams becomes. At the west outcrop, the pitch is approximately 26 degrees. Moving east, it flattens to approximately 18 degrees, as at the Westray mine. These seams of the Pictou coalfield exist in six coal members of the Stellarton group, which are distinct from each other according to when they were deposited, and which are divided by faults. The three members with minable seams are, from youngest to eldest, the Thorburn, the Albion, and the Westville members. Figure 1.1 shows the coalfield and the locations of some of the mines mentioned below.

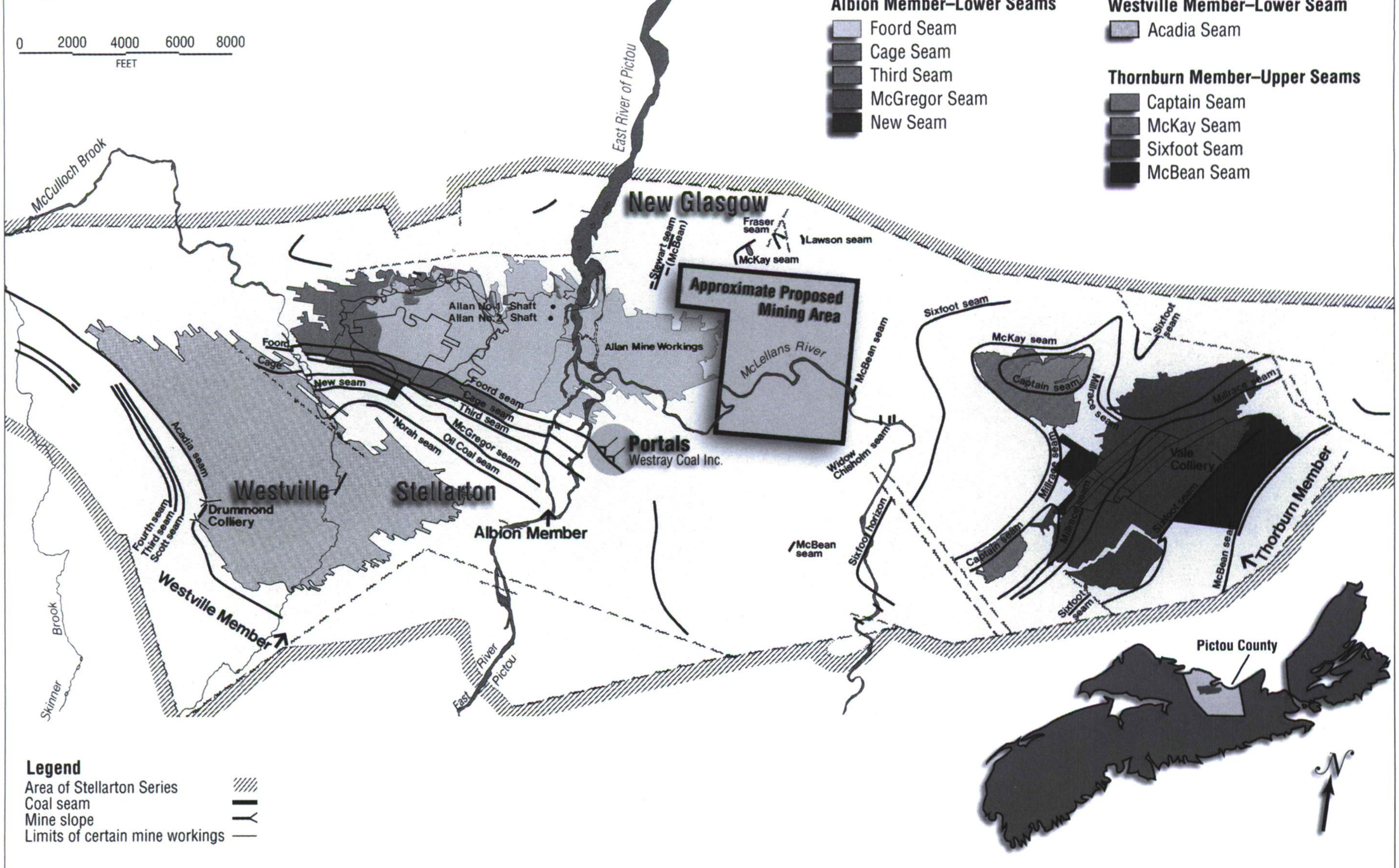
The Thorburn member contains five workable seams of coal, four of which have been mined. The fifth, averaging less than 1 m thick, has not been mined. The Albion member, containing 16 seams, is separated from the Thorburn by masses of shale. A former Nova Scotian coal mine supervisor, Francis Gray, has described the Albion: "At its maximum the deposit consists of some 1500 feet of strata containing sixteen coal-seams aggregating in total thickness 270 feet."[6] At least seven of these seams have been worked. One thousand feet (305 m) of strata are estimated to lie between the Albion and the Westville members. The top seams of the Westville – the Acadia and the Scott – have been mined; the two lower ones were considered too inferior to develop.

Of the three members, the Albion contains the richest seams and has been the most heavily exploited, despite its very complicated geology. Gray wrote that "no other coal-field in North America has the drift origin characteristics possessed by the Albion-Stellarton coal-seams." Because the coal accumulated in deep hollows, the seams here evidence "quick lateral variations in thickness and quality. The Foord seam, for example, changes within a short distance from over 30 feet of clean coal to a thickness of over 50 feet of intermingled sheets of coal and shale, finally

5 Hugh A. Halliday and Judith Hoegg Ryan, "Mining Disasters," *The 1996 Canadian Encyclopedia Plus*, CD-ROM (Toronto: McClelland and Stewart, 1995).

6 F.W. Gray, "The Saga of a Coalfield," *Dalhousie Review* 24, no. 1 (1944): 51–59.

Figure 1.1 The Pictou Coalfield



Source: Exhibit 4, Figure 2.3.

splitting up and fingering out into barren strata." Gray also described the whole stratigraphic column as "carbonaceous, gaseous, and prone to spontaneous combustion." Most mining has been in the Foord seam, which is the closest significant seam to the surface. Over 14 m at its thickest, the Foord was once considered to be the thickest seam of bituminous coal to be mined in the world. Over time, the Foord has hosted at least eight mines, the most productive being the Allan from 1904 to 1951.

Underlying the Foord seam is the Cage seam, approximately 11 m at its thickest. The Cage pit operated from 1853 to 1880, and later the Cage seam was mined through the Allan, Acadia No. 7, and particularly the Albion mines. Next is the Third seam, where the Albion slope (or inclined roadway) was sunk. Following, in descending order, are the Purvis seam (unmined), the Fleming seam, and the McGregor seam, with a small band of stone separating the last two. The McGregor slope was sunk in the McGregor seam (thickness, 6 m), and the Fleming seam (thickness, 2 m) was also worked from the McGregor mine. Underlying the McGregor is the Acadia No. 1 (or New) seam, and a slope by the same name was sunk in it in the mid-1910s and closed in the mid-1920s. The seam was worked afterwards from tunnels in the McGregor mine. Below the Acadia No. 1 lies the Norah seam. A slope was sunk part-way down this seam but was not developed owing to the poor quality of coal, and seams below this have not been considered worth mining. Figure 1.2 presents a basic stratigraphic section of the area.

Stellarton took its name from a small seam of oil coal known as "Stellarite" because it seemed to throw off stars when it was burned. Coal from this seam was mined from 1863 to 1867 and sold in the United States until its oil coal was supplanted by cheap Pennsylvania oil. In 1937, George Rice, a consulting engineer and internationally recognized expert on coal mining, reported on the Stellarton coal seams: "The most striking features of the coal seams and enclosing strata are the irregular folds and numerous faults in different directions which together with the rapid variation in thickness makes the most difficult mining conditions your investigator has observed in any of the coalfields of North America or in Europe."[7] The history that follows bears out Rice's findings.

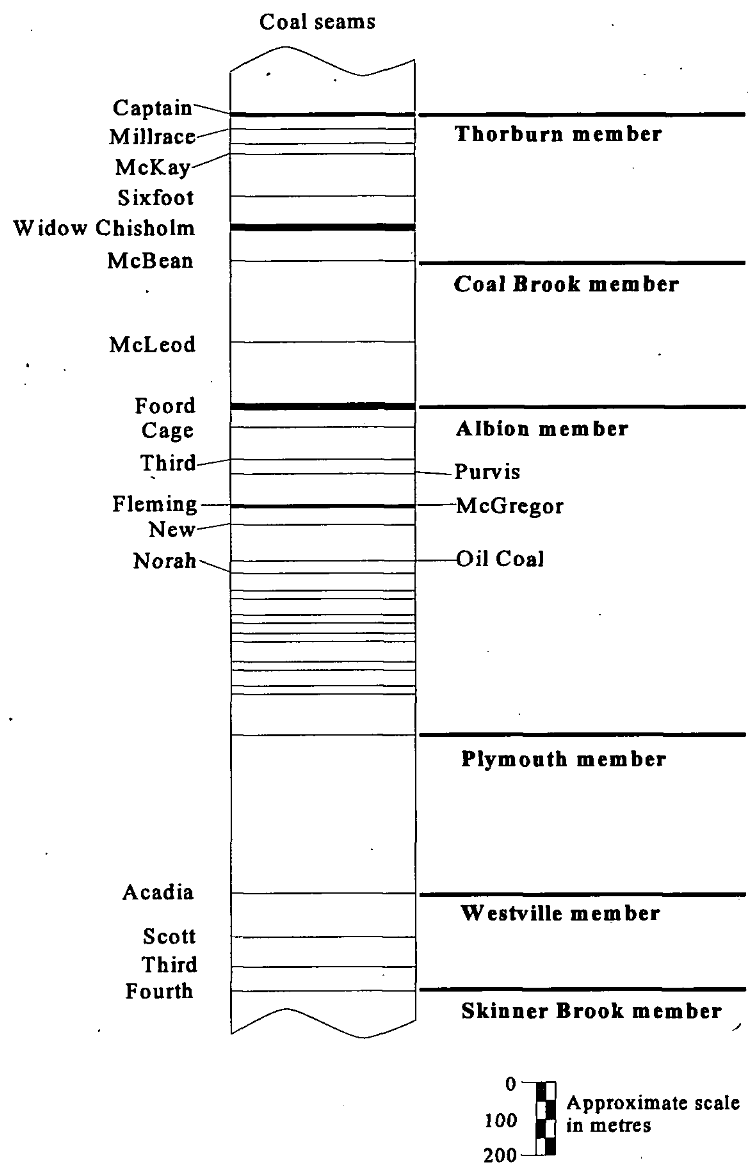
Mining in Pictou County to World War II

Mining began in Pictou County around 1800. Early small mines sold coal to the surrounding population and even shipped to Halifax, and despite financial hardship and difficult mining conditions yearly production came to average about 2500 chaldrons.[8] The coal was raised by horsepower and sold mostly at the mouth of the mines, which were located on the west side

7 George S. Rice, "Report on Pictou Coal Field," prepared for the Royal Commission on Acadia Coal Company Limited (1937), pp. 1–2.

8 A chaldron, equal to about 1.2 m^3, was a unit of dry measure formerly used in England for measuring coal. Twenty-five hundred chaldrons would equal about 2,200 tonnes of bituminous coal.

Figure 1.2 Coal Seams of the Pictou Coalfield



Source: Exhibit 10.1, figure 1.8.

of the East River. These first pits were rudimentary, their owners lacking technical skill and money for modern equipment.

The General Mining Association

In 1826, the General Mining Association (GMA) of England came into possession of all the mineral rights in the province, and its surveyor recommended mining coal at what are today Stellarton and Sydney Mines. The well-capitalized GMA arrived in the province armed with knowledge of the latest advances in coal mining in England, political clout, and access to the most up-to-date machinery. In June 1827 the *Margaret Pilkington*,

carrying machinery and collier families from England, sailed into Pictou harbour, and Albion Mines (now Stellarton) was founded on the west bank of the East River.

Within three months of sinking the Storr pits 240 feet to the Foord seam, the GMA was producing coal. By December 1827, it had erected the first steam engine in the province, displacing horse gins for pumping water and hoisting. To support its industry it constructed coke ovens, brickworks, offices, a store, employee housing, and the first steamship in Nova Scotia, its engine coming from the GMA's own foundry. At first, coal was transported along a one-and-a-half-mile horse tramway downriver, where it was loaded into small boats for carriage to cargo ships. In 1839, the company opened the Albion Railroad to carry coal to piers at Abercrombie. This railway's English-made locomotives were the first to run on iron rails in Canada.

Joseph Howe reported in 1830 that the GMA employed 80 men and 14 horses on the surface, while 50 men with seven horses were producing coal underground in a room-and-pillar system.[9] In 1832, these Storr pits caught fire, killing 14 horses. The pit mouths had to be sealed and later flooded to extinguish the fire, which investigation proved had been arson. After almost a year, the mine reopened, producing until 1834, when it exploded. Recovered, it exploded again in 1836. The last explosion in 1839 was so severe that the workings were permanently deserted.

The Bye pits were then sunk in the Foord seam, 200 yards west of the Storr pits. A powerful steam-pumping engine allowed the GMA to go deeper than previously, while two 25-horsepower winding engines, made in the Albion foundry, hoisted the coal. The mine was ventilated by a furnace. In 1842, the Bye pit workings were described "in as perfect a state as I suppose to be possible. There is ample provision for drainage, for ventilation, and for clearing off the gas."[10] However perfect, within a year of opening, a fire broke out in the new mine. Fire and small explosions continued to plague the operation, until an explosion in 1861 took three lives. The next six years brought another fire, another explosion, and in 1867, an inferno so severe that the pit had to be abandoned.

Between 1850 and 1869, the GMA sank three more mines in the Foord seam – the Dalhousie, the Foster, and the Foord. The Cage pit was sunk to the Cage seam in 1852. By 1880, all these mines (by then owned by the Halifax Company) had been permanently closed by fire and explosion, which were believed caused by accidental flaming of methane. The sparks that ignited the gas probably resulted from careless use of open-flame lamps, from leaky safety lamps, from blasting coal in places where gas was present, or from spontaneous combustion. The exception was the Foster pit, which caught fire from burning hay that ignited as it was being brought down the shaft to feed horses. Compounding the problem was the

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9 *Nova Scotian* (Halifax), 21 July 1830.

10 Public Archives of Nova Scotia (PANS), RG1, vol. 463, doc. 44 (Early Government Records 1815–93).

GMA's practice of connecting the pits below ground, so that a fire or an explosion in one mine usually affected another.

Of particular interest in this era is the Foord pit, started by the GMA in 1866. This landmark new mine employed the most up-to-date technology, including a Cornish pumping system, which allowed it to mine deeper than previously (the Foord's 1,000-foot (305 m) shafts were the deepest of their time on this continent). The large steam-driven exhaust fan provided the first fan ventilation in a Nova Scotia mine. The most powerful winding engines in the province easily could raise a double-decked cage holding more than 2 tons of coal.[11] When in full working order, the mine could produce 1,000 tons of coal per day. After a methane-fired explosion in 1869, only safety lamps were used, and no blasting was allowed until a new fan was installed and found to be totally effective. Instead of blasting, the coal was torn out by a new system consisting of a series of wedges driven into the coal by hydraulic pressure. Inaccurate surveying was probably to blame for Foord pit miners twice breaking into old workings in the fall of 1880. The flooding that ensued killed nine horses in the first instance, and six men in the second. In November, the pit exploded, killing 44 men in the east side of the mine. Miners from the west side managed to escape through the interconnected Cage pit. Subsequently there were two more explosions, which spread to the Cage, and both mines had to be flooded and closed. Attempts to reopen the Foord over the following years were foiled by fire, and the pit was permanently given up in 1897.

Other Early Mining Operations

In spite of all this misfortune, Pictou County was for a number of years the greatest coal producer in British North America, according to Patterson.[12] The GMA monopoly over Nova Scotia's mineral wealth was subject to extensive lobbying, and was finally revoked in 1858. Thus its competitors also made numerous attempts to mine coal in Pictou County. Over the next few decades the unsuccessful pulled up stakes, while others consolidated. The GMA sold its Pictou County properties to the Halifax Company in 1872. The Halifax amalgamated with the Acadia and the Thorburn-oriented Vale companies in 1886, to form the new Acadia Coal Company, and, in 1891, Acadia Coal took over the Black Diamond mines in Westville. Henceforth, Acadia Coal was synonymous with the coal industry in Pictou County, although throughout the years others were also in business.

The most successful of these others was the Intercolonial Coal Company, which began the Drummond mine in Westville's Acadia seam in 1867. After only four years, annual production reached 102,000 tons.

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11 Because of the historical nature of this chapter, references to the weight of coal will be in tons, as reported in the literature. Most references are probably to the long ton, which is similar in weight to the metric ton (tonne).

12 Patterson, *History*, 398.

In 1873, the first recorded mine disaster in the new Dominion of Canada occurred when a fire followed by a gas explosion destroyed the Drummond, killing 60 men. The mine was recovered within a year and was mostly prosperous until after World War I. Intercolonial sold out to a private operator in 1954. Smaller companies ran mines, such as the Marsh and the Greenwood, in the Thorburn area at different times.

Acadia Coal operated the Acadia mine in Westville from 1867 to 1914. In Stellarton, it sank the Albion slope in the Third seam and the McGregor slope in the McGregor seam in 1880. Served by the same bankhead, these side-by-side mines produced until the mid-1950s. Both the Cage and Foord seams were also worked from the Albion, but the Third seam was the major producer. The Fleming and the Acadia No. 1 seams were connected underground by stone tunnels and worked from the McGregor mine. Nearby, the Acadia No. 7 mined the Cage and Third seams from 1936 until it was closed by fire in 1947.

In Thorburn, the Sixfoot mine, originally sunk by the Vale Company and renamed Acadia No. 3 after the amalgamation, operated from 1872 until 1914 and from 1918 until 1938.

Acadia Coal was bought by the Nova Scotia Steel and Coal Company (NSSC) in 1919, which in turn was taken over by the British Empire Steel Corporation in 1921. The British Empire Steel Corporation reorganized in 1928 as the Dominion Steel and Coal Corporation (DOSCO). As well as Acadia Coal, DOSCO owned most of the mines in Springhill and on Cape Breton Island.

Mining and Miners

By 1900, the coal industry's significant advances were reflected in Pictou County mines. The capacity of hoisting, pumping, and ventilation systems had kept pace with deeper and more extensive mine development; machines for undermining the coal were supplanting picks; dynamite-derived explosives were replacing gunpowder for blasting; and compressed air–driven engines were augmenting ballast and haulage by horse underground. Safety lamps that both tested for methane and provided light without open flame were the only lights used in the Stellarton and Westville mines by 1890, although open lights continued to be used in the Thorburn mines (which produced less methane).

In 1911, Acadia Coal acquired breathing apparatus that would permit rescue workers to enter gas-filled mines after explosions to free trapped men and also to save the colliery. The company recruited and trained first-class miners to serve on the Acadia Rescue Corps, an elite squad that over the years earned an international reputation for skill and courage.

Through the efforts of the Provincial Workmen's Association, the quality of life underground slowly improved. By 1873, mining legislation provided for inspection of mines by a government inspector. Legislation in 1881 required certification for miners and officials, making night school and examinations essential for promotion. The 1900 *Coal Mines*

Regulation Act set some additional standards for safety in underground mining operations.

Over the first 75 or so years of the industry, emigrants from the British Isles, Europe, Newfoundland, and elsewhere in the Maritimes moved to Pictou County to work underground. They brought up their families in company-owned housing near the pits. Paternalism by the coal companies was well rewarded, as these mining ghettos brought forth generation after generation of boys to work their mines. A young man started underground on "boy's work," such as driving a horse, trapping (opening and closing ventilation doors to permit transportation of coal), or helping the track layer. Although some went on to work for a daily wage as "company hands," operating haulage, brushing roadways, or timbering, for example, most boys were anxious to get on the coal. After a year underground, a young man could go before the Examining Board for his second-class miner's papers. This certificate allowed him to produce coal at the face under the direction of a first-class miner. A year there qualified him to be tested by the Examining Board for his first-class certificate. He could then take charge of a working coal face, and be paid according to the boxes of coal he could put out.

Although technically his tutelage started his first day underground, a boy's apprenticeship actually started the day he was born in a company house in a mining community. Listening to his father talk pit with his buddies, he came to know that he would follow in his father's pitboots, and learn the craft of mining by his side at the coal face. Coal mining was more than just a job in Stellarton, Westville, and Thorburn; it was a way of life.

The Allan Mine

In 1904, Acadia Coal turned the sod for a new mine in the Foord seam. These were industrial boom times in Pictou County, and the new Allan mine symbolized an optimistic future of coal-fuelled prosperity. Like its predecessor, the Foord pit, the Allan was in the vanguard of engineering and technology, and is still considered to have been a superb piece of planning and engineering. It was designed to produce 1,000 tons of coal a day, with close attention being paid to every facet of its operation. On site was a thermal plant, which generated electricity from Allan coal. Both mine and plant were located on North Foord Street, where in 1997 Sobeys, a major locally based corporation, had offices.

The shafts of the Allan mine struck the Foord coal at 1,204 feet. However, at 476 feet and 962 feet from the surface, "stone drifts" were driven from the shaft through rock until they struck the Foord seam. Levels were driven east and west and the Foord seam was worked off these passages. At "the 1,200," levels were driven horizontally east and west. A long slope was driven down off the 1,200-foot level; off that slope was driven the 1,500-foot level. The slope, now called the Foord East sinking, continued down to the 1,750 level, which was considered to be

very close to the basin of the Foord seam. Not much development was done or coal extracted from this 1,750 section because of ground control problems and unsuitable coal. Tunnels driven south off the 1,200 levels connected at the Cage seam and also at the Third seam. All three seams yielded coal in the Allan, with the Foord seam being the most productive.

In the late 1920s, headings were driven breaking into the east side of the old Foord workings. Some of the bodies lost in the explosion of 1880 were then recovered, and in 1941 the rest of those bodies were recovered when a further entry was made into the Foord. The advancement of the southeast 1,200 in the Allan Mine was discontinued in the late 1930s owing to hazardous conditions.

Mining in the Allan was almost exclusively by room-and-pillar panels, so sections could be quickly closed off when fire broke out, as it frequently did. As the face retreats, the roof caves in behind, and this area of waste coal and rock is known as the gob or crush. In the 1930s, because of crushing that closed off rooms before they could be mined and for economic reasons, retreating longwalls were tried in the Allan between the southeast 1,500 and 1,200 levels.[13] Blasting was prohibited on these retreating longwalls because the mine's suction ventilation fan would pull the gas from the gob, increasing the risk of fire. The coal was mined with air-driven coal-cutting machines and mechanical air-driven hand tools.

All hauling engines, fans, and other machines were operated by compressed air. In the workings, the tools were air-driven radial coal cutters and pneumatic picks. Coal was transported by horse and compressed air–driven main-and-tail rope haulage. Electric-powered equipment was considered too dangerous. Electricity was used for lighting at the bottom of the shaft. Water was pumped from the 1,750 level by stages using compressed air–operated duplex pumps to an electric master pump at the 962. Located at about 400 feet in the 1,200 southeast level, at the Foord sinking landing, was an electrically operated engine for lifting coal from the 1,750 and the 1,500 to the 1,200. This was as far as electricity went in the mine. This use of compressed air–driven equipment applied to all Stellarton and Westville mines. Apart from a few lights at the slope bottom, no electricity at all was used in the Albion mine. All the water from the Albion drained down to the McGregor mine, and at the McGregor slope bottom an electric pump discharged all the water from both mines.

Death and Destruction in the Pictou Coalfield

Death was a fact of life in the Pictou coalfield, particularly in the Albion seams. In the early decades, records were not kept, but historian James Cameron has calculated that 576 deaths occurred between 1866 and 1972,

[13] Modern retreat longwall is now the most productive and the safest form of mining. See the section on mining methods in Chapter 10, Ground Control, for descriptions of different coal mining methods. See also the section on mine visits in Chapter 16, The Inquiry, for my personal observations of these various methods.

and has estimated that 625 to 650 died "from colliery misadventure in Pictou County" since the industry's debut.[14] The 1992 Westray explosion adds 26 more names to that roster.

Most single lives were lost by falls of rock or coal from the roof or high coal faces. Accidents involving machinery, particularly coal trips (coal-transporting equipment), took a large toll. Methane inhalation and blasting also took lives. Poor lighting contributed to many accidents until the 1920s, when battery-operated cap lamps began to be used. Flooding of the sort that drowned six men in the Foord pit was infrequent. However, in the McGregor mine in 1955, water broke out from behind an old brick stopping and rushed down the slope. It gathered momentum, accumulating debris as it ripped out tracks, and wrecked an ascending riding rake, or man carrier. Eventually the debris compacted, plugging up the slope and trapping more than 75 men below at the same time as it stopped their ventilation. The men were rescued in the nick of time through a cross-cut from an adjoining slope.

The greatest dangers were explosion and fire. The disasters that took most lives were the explosions, and all but one were underground. Cameron has calculated that the Pictou field suffered 48 major fires.[15] That number would not include the frequent "fire smells" that required an area to be walled off. The fear was that fire would ignite methane – the gas given off naturally during coal mining. Pure methane will not burn, but an air mixture containing 5 to 15 per cent of this "firedamp" is explosive, with 9.5 per cent its most volatile point.

By 1927, Nova Scotia mining laws dictated that, when methane at a concentration of 2.5 per cent or more was detected in a working place, the men had to be withdrawn, and a notice board indicating the danger put up not less than 100 feet from where the gas was detected. No one was allowed to enter the area until sufficient air was applied to dilute and sweep away the gas. Air with as little as 0.5 per cent concentration of methane was removed from a working section by increased ventilation. No coal could be blasted if *any* methane was found. A flame safety lamp was used to test for methane, and areas were thoroughly inspected for methane before blasting was permitted. Every measure possible was taken to prevent a spark that might ignite a fire. Electricity was limited to the shaft or slope, and all equipment was operated by compressed air. Once a week miners were searched; if matches were found in their clothing, the men were sent to the surface and fined. Nevertheless, the fires in the Stellarton mines have almost always been deemed to have started as spontaneous combustion of coal in the crush.

In the early years, many mines had to be flooded to put out fires. The severe 1913 fire in the Albion was started by the friction of rope rubbing on a wooden bullwheel. That fire burned for 16 days before being extinguished by draegermen and miners using water. However, fires in the

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14 Cameron, *Pictonian Colliers*, 187.

15 Cameron, *Pictonian Colliers*, 170.

crush were usually both prevented and fought by walling off the affected area with airtight stoppings. By the mid-1920s, these stoppings were being constructed of wood blocks mortared together like bricks. Test pipes were installed in fire stoppings during their construction, so that gas samples could be taken later. A sample can be taken from behind a sealed stopping only when the barometer is low and atmospheric pressure is at its lowest, because that is when a mine produces the most gas. Conversely, when the barometer is high, the atmospheric pressure would cause these pipes to draw in rather than push out. When oxygen was found in a sample, it meant that air was leaking in, threatening spontaneous combustion. Carbon monoxide indicated the presence of fire. When these stoppings were tight, the only gas behind them was methane and there was no danger of fire. When a sample was bad, grout (liquid portland cement) was pumped into the cracks around the stoppings to make them as airtight as possible. It has been said that grouting saved the mines in Pictou County in their last 20 or 25 years, because of the mines moving so much – bumping and creeping – particularly at night when cooler, denser air raises the atmospheric pressure.

Sometimes emergency stoppings were put in behind the mining as it advanced. These stoppings had openings only large enough for coal boxes to go through. In the event of fire the affected area could then be closed off quickly, without losing the coal in interconnecting rooms. After a section was worked, the doorways were filled in and the stoppings made airtight and permanent. This system was common in the Stellarton mines.

When methane explodes in a coal mine, coal dust fuels the explosion as it rips through the mine towards the main air intake. The most effective method of preventing explosions from travelling throughout the mine proved to be limestone dusting, called stonedusting, which was introduced in the late 1920s. Stonedust is non-combustible, and so in the event of an explosion it acts to choke the flames, preventing the explosion from spreading. The *Coal Mines Regulation Act* came to state that the roof at all working coal faces had to be supported within four feet, and stonedusting had to be within 15 feet of a working coal face. Throughout the mines, stonedust shelves were built close to the roof. The force of any explosion would blow the staging down, causing the stonedust to fall into the fire. Dust samples were taken regularly to ensure a minimum of 65 per cent incombustible content.

George Rice reported in 1937 that stonedusting in Stellarton:

> is a vital precaution in these mines which produce an unusual amount of very fine particle sized coal dust from a naturally friable coal. The dust dribbles from the roof and faces and comes from cars in haulage. The hazard is shown by the many serious explosions in this district in the past, before rock dusting was understood. Although these explosions chiefly emanated from gas ignition caused by fires or other flames, undoubtedly they were rendered violent and far-spreading by coal dust.[16]

16 Rice, "Report," p. 14.

Almost all the mines in Stellarton were closed by fire or explosion. On an idle workday in 1888, the Albion mine exploded so violently that the blast travelled up the main slope and burned several surface facilities. Although the cause was never proven, the explosion is believed to have originated as spontaneous combustion in old Cage seam workings. Most Albion fires were in the Cage seam, the second thickest seam, and include fires in 1910, 1920, 1945, 1947, and 1951. In 1917, a fire in a walled-off section emerged through a stopping in the Albion's Third seam workings, necessitating that the pit be sealed at the surface for six months. Reports in the Devco papers mention that seven fires in the Albion between 1925 and 1936 resulted in closed sections.[17] Consequently, all that potential coal was lost.

Three separate fires in the Acadia No. 7 Mine in 1944 hastened its closure in 1947. The most serious result of fire in the McGregor mine was the 1952 explosion. Draegermen built temporary stoppings over a hot and smoky fire, which had started spontaneously. Then miners were engaged to build permanent stoppings. An explosion occurred, killing these 19 men. As a result of the inquiry into this disaster, mining legislation was changed to require that men be taken out for 24 hours after temporary stoppings are built. Safe air samples must then be obtained before permanent stoppings can be erected.

The Westville mines also had an unenviable record of fires and explosions. The Drummond explosion of 1873 originated with a shot fired in an area unsafe for blasting because of methane. In 1893, lightning struck the headframe of the Scott pit and travelled down the steel hoisting ropes to ignite the gas underground, which exploded and started a fire. The Drummond mine was threatened by three crush fires in the winter of 1913, one of which required 51 stoppings to be built "by 100 men working round the clock for three months." There was a small gas explosion in the Drummond in November 1915. There were several more fires between 1913 and 1941, while fires in the 1950s required the closing of two levels.[18]

The Thorburn field experienced fewer fires; its seams were thin and could be mined from stone to stone.[19] The 1885 Vale and 1930 Greenwood mine explosions were both deemed to have been caused by an open lamp meeting a pocket of methane.

Fire and Explosions in the Allan Mine

The Allan produced coal for more than 40 years. "Experts considered the Allan Shaft the most dangerous mine in the world" because of the nature

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[17] Beaton Institute, University College of Cape Breton, Sydney, Devco Papers, MG 14, 13, 8B (q), box 137 #2.

[18] Cameron, *Pictonian Colliers*, 176–84.

[19] Being able to mine a seam leaving no coal, only solid rock, at the roof and at the floor creates fewer sources for methane emission.

of the coal.[20] Over its lifespan, the Allan experienced eight methane explosions, at least six of which were believed caused by spontaneous combustion in the crush. The Allan's first explosion occurred in 1914, on a Sunday morning when no men were working. However, two men who rashly went down to investigate were killed by carbon monoxide. That explosion was deemed to have been caused by spontaneous fire in sealed Foord seam workings. The second explosion, on 23 January 1918, was the worst in Pictou County's history. Eighty-eight men were killed; all the men in the mine died, except nine who escaped from the 500 section before the carbon monoxide wafted up from the deeper workings. At this time, Canada was at war and sabotage was alleged, but not proven. The jury in the coroner's inquest agreed with the suggestion that the explosion was probably started by a shot that flamed and ignited gas.

In 1924, an explosion occurred in the west 962 workings of the Foord seam and travelled through the Third seam section before blowing itself out. Four of 11 men trapped behind a fall suffocated; seven stayed alive by sucking air from a broken compressed air pipe, and the workforce in other sections of the mine escaped. The origin of the explosion could not be ascertained but was believed to have been spontaneous combustion.[21] Severe explosions occurred in both 1929 and 1932, but, fortunately, both occurred on holidays when the mine was idle. The pits were sealed at the surface. In 1929, instead of the fires burning out, they caused a second explosion, while in 1932 the water gauge indicated that five minor explosions occurred within five hours of the mine being sealed. The 1929 explosion was the most destructive of all, but even so, had the mine not been completely stonedusted, the damage would have been worse. The mine was cleaned up over two years and gradually returned to production.

The *Coal Mines Regulation Act* required that all coal faces be undermined before blasting. In 1935 a shotfirer in the southeast 1,500 fired a shot in the coalface without prior undermining. The shot flamed, igniting gas hanging at the roof line, and the subsequent explosion blew in 300 feet of the level. This rockfall and the heavy stonedusting of the section helped to localize this explosion and, except for seven men killed in the explosion area, all 200 men in the mine escaped.

In 1941 or 1942, an explosion occurred behind a line of stoppings in a crush area of the southeast 1,200. The area was badly shaken, but no lives were lost. The mine was sealed for a short period of time. On 28 April 1950, in the southeast 1,200 section, a gas explosion occurred after

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20 Halliday and Ryan, "Mining Disasters."

21 James Cameron (*Pictonian Colliers*, 239–40) writes that in the affected area "only two shots had been fired that day . . . but the men were positive fire had not been started by the shots, and equally positive gas was not in the place." The special examiner was unable to ascertain the cause of this explosion. "The Nova Scotia Department of Mines reported: 'The general opinion was and is that the explosion was the result of fire resulting from the two shots fired in the 962 workings that afternoon, but the evidence was so strong that the places were thoroughly examined after the shots were fired that the actual cause must remain unproven.'" Judith Hoegg Ryan told me that over the years everybody she has questioned about this, including someone who was an overman at the Allan in 1924, has attributed this explosion to spontaneous combustion.

spontaneous combustion. Thanks to heavy stonedusting it did not travel too far, nor was it severe in the area where men were employed. Seven men were rescued from the explosive area, some badly burned. Shortly after the shaft was sealed, a change in the water gauge at the fan drift indicated that another explosion had taken place. After three months, the Allan was reopened. The following March, three spontaneous fires occurred in three different locations in the mine. The pit was again sealed and it was decided to close the mine permanently.

These explosions proved the mettle of the Acadia Rescue Corps. Encumbered by heavy breathing gear, draegermen laboured in front of hot, smoky, and threatening fires, building stoppings to extinguish the burning that could otherwise destroy their workplace. After explosions, the rescue men struggled through wrecked mines in gas and volatile atmospheres searching for their comrades. When a seal was taken off a pit mouth, they were the first down, investigating conditions in air that was 98 per cent methane, with only a nose clip and mouthpiece separating them from eternity. The contribution of the Acadia Rescue Corps to their community and the industry was invaluable.

The Post-World War II Era

After the grim years of the 1930s Depression, World War II revitalized the industry, as coal was desperately needed for the war effort. The war boom created a feeling of optimism for the future of the industry, and mechanization was thought to be the key. In 1945, DOSCO contracted with Paul Weir, an American mining engineer, to "report upon the economic possibility, if any, of increased mechanization of the mines, whether by increasing investment in machines of any of the present standard types, or by the development of special designs applicable to the conditions of the Nova Scotia field, as one means of reducing that disparity (in production per man-day between Nova Scotia and the competitive fields in the USA)." Weir's findings were tersely negative regarding the Acadia collieries: "We have no recommendations to make. The lack of a reasonable amount of virgin coal with proven uniform conditions of occurrence, in our judgement, precludes any mechanization except that of a minor and piecemeal nature."[22]

Weir's opinion is not surprising, in light of George Rice's conclusions about the Stellarton mines eight years earlier. "The difficulties in natural conditions have made the orderly laying out of workings an almost unsolvable problem for obtaining low or even moderate cost of production of the coal. This even more than the difficulty of support of a weak roof of soft friable coal ribs, is the principal reason for the lower rate of production per man-shift of all workers than in any coal fields known to the writer, and a higher cost of production."[23] Expanding on these adverse conditions, Rice blamed the irregularity of the coal beds, the thickness of

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22 Beaton Institute, Devco Papers, MG 14, 13, 8B (q), box 10 #21.

23 Rice, "Report," Introductory Statement.

the coal, the irregularity of coal thickness, and the ash content. Further, the soft and friable character of most of the coal and the roof strata made roof support difficult and caused the ribs to squeeze in. Rice believed that, although "the amount of fire damp . . . is not unusual on the basis of tons of coal produced . . . owing to the irregularities of the workings, ventilation is a more difficult problem than is found in most mines either of the Province or of other coal fields of North America, and it necessitates great care in the matter of preventing sources of ignition." The "liability to spontaneous combustion . . . produces a particular difficulty . . . in combatting fire, where fire-walls have to be erected to great heights to reach up into compact roof above the coal. Some fire-walls as high as fifty feet have been erected and 'cementation' has had to be employed . . ." He continued: "[T]he combination of all the factors mentioned above makes the planning of the mine developments the most difficult the writer has ever seen."[24]

Acadia Coal's Stellarton workforce persevered, producing coal by outdated and inefficient methods, regularly losing time and coal to fire. Meanwhile, DOSCO's Cape Breton mines were equipping for the future with mining and loading machines, locomotive haulage, and electrically operated tools to make mining easier and more cost efficient. Stellarton's mines could not keep up in an increasingly competitive industry. The Allan was producing its capacity of 1,000 tons a day, but more tonnage was needed to meet increased costs. When three fires broke out at once in 1951, the mine was sealed, and the "million dollar mine" of 1904 was not reopened. The Albion mine closed in 1955; it had been worked out. Two years later, a spontaneous fire in the McGregor could not be contained, and the mine was sealed at the surface and never worked again. Mining was finished in Stellarton, the town that had been dependent on coal since 1827.

Unemployed miners, and their sons after them, were given preference in hiring at Acadia's remaining mine – the McBean, in Thorburn – which reopened in 1946 after being closed by fire in 1889. The McBean was the first and only mechanized underground mine in Pictou County until Westray opened in Plymouth in 1991. The conditions that precluded mechanization in Stellarton did not apply in the Thorburn mine. The erratic Stellarton geology described by Weir and Rice was not characteristic of the McBean seam, a thin vein of coal averaging four and a half feet in thickness, with strong, hard stone strata overlying and underlying the seam. The regularity of the coal seam within hard strata meant that the coal could be extracted from stone to stone. In the McBean, all coal cutting machines and haulage equipment were run electrically. This mechanization was a relief for Pictou County miners, freeing them from much heavy labour. Instead of being paid by the tonnage produced, they received daily rates for different jobs. Average daily output was 900 tons.

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24 Rice, "Report," p. 6.

When DOSCO pulled out of coal mining in 1968, the McBean continued operating under the Pictou County Research and Development Commission (PICORD), but was run by the Cape Breton Development Corporation (Devco). Over the years, the mine had been heavily subsidized by the federal government, but in 1972 that financial support was stopped and the mine closed, leaving 174 miners without work. Meanwhile, the small, privately owned Drummond mine in Westville continued producing coal from the Scott pit seam. Mining was room and pillar, extracting pillars from rooms mined earlier and taking some untouched coal near the surface. The coal was hand cut, shot, and loaded into mine cars that were hauled by small air-driven engines until they were picked up by the main surface hoist. In 1984, an unfightable fire closed the mine, putting about 40 men out of work. Although a strip mine was operating in Westville, there was no underground coal mining in Pictou County after the Drummond closed until the Westray mine began producing coal in 1991.

2 Development of Westray

To inquire into . . .

(g) all other matters related to the establishment and operation of the Mine which the Commissioner considers relevant to the occurrence

The Westray project was controversial from the outset. Although various companies had been interested in the area, it was Curragh Resources Inc. (Curragh) that eventually put together the pieces, incorporated Westray Coal in November 1987, and began underground development. The proposed mine developed amid firm opposition from the bureaucracy and unwavering support from the provincial government. As development proceeded, it was the subject of continual debate and criticism in the legislature and in the media. It also proceeded with an uncompromising and abusive Curragh negotiator at the helm.[1] For these reasons, it is not surprising that the negotiations for financial assistance between Curragh and the federal and provincial governments proved to be arduous and taxing. In the end, the strong and single-minded political backing for the project overpowered the opposition, and Westray received tremendous financial support from the public sector. Curragh officials managed to secure a federal loan guarantee of approximately $85 million, a direct contribution against interest, a $12 million provincial loan, an $8 million interim loan, and a generous provincial take-or-pay agreement.[2]

The Pictou Coalfield: The Feasibility Studies

The Pictou coalfield has been the focus of considerable interest and research over the years from both private companies and the Department of Natural Resources.[3] Various studies have explored the feasibility of mining the Foord and the surrounding seams and, although it is not necessary to the Terms of Reference of this Inquiry to set out in detail the earlier historical interest in the seam as a resource, we will give some consideration to the studies conducted during the 1980s because the 1988 and 1989 Kilborn studies submitted by Westray to the provincial government as its planning documents relied on much of this data and analysis.

Brinco Mining Limited (Brinco) expressed an interest in Nova Scotia coal deposits in early 1980. In July of that year, Brinco obtained a lease option from the Department of Mines and Energy to explore the pertinent ground – 6,500 acres (2,630 ha) in Pictou County at Westville, which

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1 **Comment** It seems that Curragh chief executive officer Clifford Frame's sense of committed provincial government support encouraged him to adopt an intractable and abrasive stance – as will become evident later.

2 "Take or pay" is a means of reducing financial risk for the supplier of a commodity. For example, where an energy supplier (e.g., a coal producer) is required to invest substantial money to satisfy the demands of a customer (e.g., a power company), the supplier will get a take-or-pay agreement from the customer to ensure a reasonable return. The meaning in the Westray context will become clear in this chapter.

3 See Chapter 1, History of Coal in Pictou County, and Chapter 11, Department of Natural Resources, for a review of the geological background.

included the Acadia and the Scott seams – and the company completed a preliminary feasibility study of the area.[4] Brinco, being fully committed to other development projects at the time, sought a partner for a joint venture, and Suncor Inc. (Suncor) began its involvement in the project. In 1981, Brinco and Suncor were jointly granted a special licence to search and prospect for coal lying deeper than 400 feet (120 m) in the Acadia and Scott seams. Their rights in accordance with the special licence were later expanded to include the Third and the Fourth seams.[5] Their interest focused on the deep coal under the town of Stellarton and the extension from the Westville coal seams.

In August 1982, Brinco stopped contributing funds, and Suncor acquired the majority interest in the exploration project. At the time, the Department of Mines and Energy was reviewing an appraisal conducted for Suncor by Associated Mining Consultants Limited (AMCL) that indicated a need for further geological and exploratory work. Accordingly, Suncor requested and received an extension of its exploration licence to collect further geological data.

In May 1986, Suncor obtained Special Licence 2/86, which was essentially a renewal and extension of three previous licences held by Suncor. Special Licence 2/86 authorized Suncor to search and prospect for coal lying deeper than 400 feet below the surface in all seams in an area of approximately 14,640 acres (5,925 ha). The licence extended to the eastern limit of the Pictou coalfield and covered all potentially significant deep exploration points. It was for a term of one year, and was renewable for four additional one-year terms by application to the Governor in Council.[6]

Suncor commissioned a series of research and feasibility studies in the area during the mid-1980s. During this period, greater emphasis was placed on the mineability of the Foord seam. Between 1984 and 1986, Golder Associates completed various reports for Suncor, including a review of geotechnical aspects, rock mechanics, and access slope development. Dr Miklos Salamon, the Inquiry's geotechnical expert, concluded that Golder's reviews were the last substantive geotechnical

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4 Brinco Mining Limited, Acadia Coal Project, Project Status Report, March 1981 (Inquiry file, NSDNR 1). "Inquiry files" refer to material available to the Inquiry but not entered into evidence. For future reference, readers are directed to the Nova Scotia government archives.

5 See Special Licence 5/81 (Inquiry file, NSDNR 38). Special Licence 5/81 appears to have dropped the requirement that the coal lie deeper than 400 feet vertical. In a memorandum dated 20 November 1981 (NSDNR 38), Ed Bain, manager of coal development for the provincial government, explained to Wynne Potter, assistant deputy minister, the result of having removed such a clause: companies could access coal between the outcrop and 400 feet in order to bring access slopes to surface; and all coal, including surface coal, was open to the companies. Bain recommended that the wording be changed, so that the companies would not have the right automatically to any potential surface coal reserves on those seams. In May 1982, Special Licence 5/81 was renewed. This version specified that the licence related to coal lying deeper than 400 feet, with reasonable access to coal below 400 feet and extraction of coal above 400 feet that was incidental to the development of the access.

6 Norwest Resource Consultants Ltd., "Suncor Inc. Pictou County Coal Project Feasibility Study, volume 2: Mining and Processing" (Calgary 1986) (Exhibit 8, s. 1.6.2).

studies to be done.[7] Dames & Moore carried out a number of reviews for Suncor in 1986. These reviews outlined potential problems with using a single-entry longwall face, which apparently was the production method being considered by Suncor at the time.

In 1985, Norwest Resource Consultants Ltd (Norwest) completed the "Acadia Coal Project Preliminary Comprehensive Feasibility Study," supplemented in 1986 by the "Pictou County Coal Project Feasibility Study." Adrian Golbey, a mine development expert for the Inquiry, reviewed and commented on the 1986 study. He testified that this report was indeed at the level of a feasibility study: it contained an element of marketing, a review of geotechnical matters, an underground mine layout, ventilation calculations, production levels, support mechanisms, and a mining method.[8] Although Norwest incorporated the work of other consultants in its report, it in effect conducted the final analysis. The report concluded that a mine in the area would be technically feasible, and it recommended a combined mining method: shortwall panels using longwall equipment and room-and-pillar mining.

Meanwhile, declining world oil prices and losses incurred in the development of its tar sands project caused Suncor to close its entire coal department. Suncor began to seek potential buyers for the project, which included the various studies conducted to date, the provincial exploration licence for the area, and the potential for a contract with Nova Scotia Power Corporation (NS Power).[9]

In February 1987, Suncor entered into an option agreement with Placer Development Limited (Placer), which commissioned a further study to be conducted by AMCL.[10] This study was in effect a review of the information gathered by various consultants to date. Golbey believed that it was at the feasibility study level, although it "may not have all the chapters in it."[11] It recommended the establishment of two rock tunnels and a room-and-pillar mine, with partial pillar extraction (depillaring) as the main technique of coal extraction. Such an approach was flexible and could accommodate geological disturbances.[12] AMCL concluded that a properly planned and executed ventilation system could cope with expected volumes of methane.[13] According to Golbey, AMCL's review was similar to the Norwest plan, except it called for room-and-pillar mining throughout.[14]

7 Hearing transcript, vol. 14, p. 2373.

8 Hearing transcript, vol. 3, pp. 501–02.

9 See the following section for a review of the evolution of NS Power's involvement.

10 Placer Development Limited, "Pictou Project Feasibility Study" (Vancouver, 1987) (Exhibits 10, 11).

11 Hearing transcript, vol. 3, p. 515.

12 Exhibit 10.2, pp. 1–2.

13 Exhibit 10.1, p. 139.

14 Hearing transcript, vol. 3, pp. 519–20.

Salamon thought that the Placer report was overly optimistic in some respects. Although it assumed that an overall extraction of 36 per cent of the coal could be achieved, the physical conditions of the potential mine and the planning parameters – great mining depth, excessive working height, a weak and friable (easily crumbled) roof, wide entries, a steep seam, and faulted ground – were, in fact, quite adverse. Salamon concluded that "it is more than likely that the room-and-pillar method as proposed will not be workable under some of the more demanding conditions at Westray."[15] Placer concluded that the project was viable, and decided to proceed with it.

Shortly after completing this study, Placer amalgamated with Dome, and the board of directors of the new company decided not to go ahead with the Pictou project. Having lost Placer as a potential successor, Suncor again sought a buyer for the project. There is no evidence of any further planning or study having been conducted between Placer's 1987 feasibility study and the Kilborn study commissioned by Westray Coal in 1988.[16] In fact, as Salamon pointed out to the Inquiry, the Kilborn study largely adopted the conclusions and layout of the Placer report.[17] In short, all the studies commissioned on the project assumed that, while it was technically feasible to mine the seam, the steepness and thickness of the seam, the weak roof strata, and the number of faults would pose particular problems for safe mining.

Although several studies had been made, Salamon expressed some reservation about their definitive nature. He questioned whether there was any continuity of thinking from one study to the next, since a number of different consultants had been involved in the process. He questioned whether consultants proposing changes from the work of previous reports had considered or reviewed the rationale behind such approaches.[18] Salamon's comments are telling. The mere fact that a number of feasibility studies into the mineability of the area had been conducted did not mean that sufficient mine study and planning had been completed.[19] Presumably, a prudent mine operator and a prudent mine regulator would ensure that adequate mine planning was both a focus and a priority during the early stages of development.[20] Unfortunately, Westray management was focusing its energy on immediate financial areas: finalizing a contract with NS Power for the sale of Westray coal and negotiating a financial assistance package with both the federal and the provincial governments.

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15 Exhibit 58.2, s. 7.4.

16 Kilborn Limited, "Technical and Cost Review of the Pictou County Coal Project" (1988).

17 Hearing transcript, vol. 14, pp. 2380–81. See Chapter 11, Department of Natural Resources, for a more detailed discussion of the Kilborn study.

18 Hearing transcript, vol. 14, p. 2378.

19 See comments on the adequacy of mine planning in Chapter 10, Ground Control.

20 See Chapter 11, Department of Natural Resources, for a review of the department's responsibility in this regard.

Nova Scotia Power Corporation

The contract finalized between NS Power and Westray for the supply of coal to the Trenton power generating stations had been developing before Westray's involvement in the project. It is clear that, by the 1980s, there was a growing concern in Nova Scotia about the volume of sulphur dioxide emissions in the province.[21] In fact, during the mid-1980s, Premier John Buchanan attended the New England Governors/Atlantic Premiers Conferences and discussed the environmental effects of, and concerns about, the emission of sulphur dioxide in the mid-western United States – emissions that eventually made their way to Nova Scotia. As a result, the premier signed an agreement with the New England governors and the other Atlantic premiers that set a limit on the volume of sulphur dioxide emissions. Then the Canadian government, with the support of all the provinces, signed an agreement with the government of the United States, again agreeing to set limits on permissible sulphur emissions.[22]

These agreements clearly tailored the options available to NS Power, which was planning a new power plant at Trenton. NS Power faced the problem of burning high-sulphur coal from Devco. Foord seam coal, in contrast, had a lower sulphur content, and this attribute was undoubtedly attractive to the power corporation as a means to meet the province's limit on sulphur emissions. At the Inquiry, Senator Buchanan recalled a study indicating that NS Power would either have to use Pictou coal or bring in coal from elsewhere. He testified that, as premier of the province at the time, he could not have contemplated importing coal when the province was rich in the resource.[23] NS Power's only real alternative was to install scrubbers at its plants to reduce sulphur emissions – an expensive proposition.

Evidence suggests that, as early as 1982, NS Power was interested in the Pictou County coal project. In a Department of Mines and Energy memorandum to deputy minister John Laffin dated 15 June 1982, Wynne Potter, assistant deputy minister, reported:

> It appears that, like everyone else, Brinco is experiencing severe cash flow problems and Suncor think that Brinco may very well sell their interest in this project. Staff of this department as well as Environment, Development, Nova Scotia Power Corporation and Nova Scotia Resources Limited have had initial discussions with Suncor regarding the ongoing exploration activities and it appears that Suncor intend to proceed with the second phase.[24]

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21 Former premier Donald Cameron testified at the Inquiry that Pictou County coal had long been seen as a potential solution to the growing problem of pollution (Hearing transcript, vol. 66, pp. 14399–402). He suggested that eliminating the necessity of scrubbers at the Trenton power plants could mean a saving of some $125 million in initial construction costs and $16 million per year in operating costs.

22 Hearing transcript, vol. 68, pp. 14953–55.

23 Hearing transcript, vol. 68, p. 14956.

24 Inquiry file, NSDNR 38.

That potential market provided much of the impetus for Suncor's exploration in the area. By November 1985, Suncor considered NS Power a possible customer and had held an introductory meeting with its representatives.[25] By early 1986, Suncor and NS Power were formulating a letter of intent. In notes of a meeting held on 16 January 1986, P.J. Whalen, Suncor's manager of coal marketing for the Pictou County Coal Project, described the power corporation as interested, eager, and ready to facilitate a joint task force to evaluate the project's development potential:

> The Power Corp. is interested in the Pictou County Project and recognizes the opportunity for a mutually beneficial development. Discussions even touched on joint fuel stockpiling and waste disposal. Clearly, there is a willingness to consider a capital expenditure in new NSPC [NS Power] facilities which might surpass the mine development costs . . . Mr Lethbridge [NSPC] suggested that an expedient evaluation of the development potential could be facilitated by a joint task force.[26]

In a draft marketing report dated 6 March 1986, Suncor stated that NS Power had "provided a letter of intent which has formed the basis of continuing contract discussions."[27]

When Suncor put the project on the market, NS Power and Suncor were close to completing a coal contract to supply the Trenton power plant. In the mid-1980s, Pat Phelan was director of mining engineering in the Department of Mines and Energy. He told the Inquiry that Suncor relied, in part, on the potential contract as a means of marketing the Pictou project and increasing the viability of the mine.[28] Similarly, the power corporation was beginning to rely on a potential mine in the area as a source of low-sulphur coal for the new Trenton power generating plant.[29]

By August 1987, Suncor was actively pursuing potential buyers for the property before its agreement with NS Power was due to expire. Phelan reported the following activity for August 1987:

> Suncor have advised us that there are several other companies potentially interested in taking over the property. NSPC have extended their agreement to purchase coal from the mine until the end of this year. Suncor are actively working to have someone take over the property before the NSPC extension expires.[30]

The evidence suggests that there were communications between interested purchasers and NS Power to confirm that the power corporation was a

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25 Marketing Plan, Pictou County Coal Project, 1 November 1985; Marketing Progress Report to 30 November 1985 (Inquiry file, West Room28 52).

26 Inquiry file, West Room28 52.

27 Inquiry file, West Room28 52.

28 Hearing transcript, vol. 51, p. 11105.

29 Hearing transcript, vol. 51, pp. 11108–09. The quality of the coal to be used in a power plant is important information for its design. NS Power needed confirmation of a source of coal for the new plant at Trenton in order to design the appropriate features.

30 Exhibit 35c.0006.

potential buyer. As well, NS Power approved the initial selection of candidates as acceptable potential developers of the project.[31]

On 9 September 1988, Westray finalized a deal for Suncor's coal rights.[32] On that same day, an agreement was also signed between Westray and NS Power, the latter agreeing to purchase 700,000 tonnes of Westray coal annually for the Trenton 5 and 6 coal-burning units.[33] The contract outlined qualities of coal, pricing mechanisms, and production schedules. Clause 2.02 provided as follows:

> Trenton Unit 6 is scheduled for commercial operation in November of 1991 and its coal requirements for the First Delivery Year will be reduced to the required stockpile build and about five (5) months of operation. This Contract Year would also represent initial production from the Mine. Accordingly, the guaranteed quantities referred to in Section 2.01 hereof are not appropriate for the First Delivery Year. *The Mine is scheduled to commence production on or about July 1, 1991, and it shall meet the requirements of Trenton Unit 5 from on or about July 1, 1991 and Trenton Unit 6 from the commencement of the Mine production to the end for the First Delivery Year. . . .* Buyer and Seller acknowledge that numerous factors can alter the start-up date for the Mine and Trenton Unit 6. It is the intent of the parties hereto to keep each other advised as to the progress of construction and revised completion dates so as to minimize the effect of any delays in the completion of either of the projects. [Emphasis added.]

Westray failed to meet these anticipated production dates. This failure was due, in part, to the suspension of tunnel development from approximately July 1989 to the fall of 1990 pending the securing of government funding.

In January 1990, NS Power wrote to Westray expressing concern over the long delay in the tunnel excavation and its impact on coal delivery dates. NS Power explained that, in the event of a delay, it would have to extend its contract with Devco to ensure continuity of supply.[34] In a letter dated 5 June 1990, NS Power advised Westray that it was "making inquiries which could result in deliveries regarding alternative coal supplies for Trenton 5 and 6 units, until such time as your company can demonstrate it can supply coal in fulfilment of the terms and conditions of the Agreement."[35] In a memo to the Curragh head office dated 7 June 1990, Westray general manager Gerald Phillips explained that the main reason for concern on the part of NS Power and the province was that federal funding had been approved in May 1990 and tunnel development had yet to resume. Phillips wrote: "From a schedule standpoint, the tunnel development must start as soon as possible to ensure no further delays occur in our start up schedule of mid-1991."[36]

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31 Exhibit 141.11, p. 2.

32 Exhibit 51.21. See the following section for a review of Curragh's involvement in the bidding process.

33 Exhibit 35a.0105–33.

34 Exhibit 64.10.001.

35 Exhibit 64.10.002.

36 Exhibit 64.10.004.

There is little doubt that the delay in financing and tunnel development led to a subsequent emphasis on production by Westray. Both Donald Cameron, then minister of the provincial Department of Industry, Trade, and Technology, and his deputy minister, Tom Merriam, commented on whether they felt Westray was under any pressure to produce. Cameron told the Inquiry:

> I think it's only normal the company wanted to fulfil that contract. . . . I would feel pressure if I had a contract and if, you know, if you don't supply it, you don't have money. . . . I'd be surprised if they didn't feel pressure . . . I think they felt the pressure to go into the Southwest section to produce coal because of that delay. I mean, I'm convinced that's the reason. The only reason. They may not tell you that, but I'm convinced that's the reason.[37]

Merriam testified that he was not aware of any discussion in which Westray was told that it would be in serious trouble if it did not produce.[38] He said, "[T]hey had a coal delivery date that had some significance so that would be the pressure point, if you will, that I assume was foremost in the minds of the company."[39]

There is no question about this pressure. The delay in construction due to protracted negotiations with both levels of government created a sense of urgency for Westray. The company's focal point, more than ever, became the production of coal and the satisfaction of the NS Power contract. Westray's push for production militated against adequate mine planning and mine safety.[40]

The Arrival of Curragh

By the fall of 1987, Curragh Resources Inc. (Curragh) was well acquainted with the Pictou County coal project. It is somewhat unclear how Curragh first became interested in the project. The evidence suggests that Curragh's involvement in the bidding process for the Suncor project was tardy. Curragh made a formal offer dated 27 November 1987 to Suncor to buy its interest in the project. Clifford Frame, Curragh's chief executive officer, offered to purchase the project for $7.5 million subject to the satisfaction of three conditions:

> 1. negotiation and execution of an agreement of purchase and sale including standard representations and warranties;
> 2. obtaining by us of an agreement with the Nova Scotia Power Corporation regarding the sale of coal to such corporation; and
> 3. the granting of a mining licence from the government of Nova Scotia.[41]

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37 Hearing transcript, vol. 66, pp. 14651–52.

38 Hearing transcript, vol. 72, p. 15747.

39 Hearing transcript, vol. 72, pp. 15746–47.

40 These topics are addressed in detail in Chapter 11, Department of Natural Resources, and Chapter 5, Working Underground at Westray, respectively.

41 Exhibit 51.1.

Suncor accepted the offer, and Curragh gained the rights to the Pictou County coal project.

This offer was preceded by earlier contacts between Suncor and Curragh. The documentation and evidence are equivocal. On 15 July 1990, Nancy Ripley-Hood, solicitor for the Department of Mines and Energy, sent a hand-written memorandum to Laffin briefing him on the proposed take-or-pay contract.[42] Ripley-Hood recorded information she recalled being told several years earlier by Merriam:

> In early September 1988 [*sic*], DC [Don Cameron] approached by CF [Clifford Frame] to undertake the Project. DC was and is convinced this is a good deal – even tho' TM [Tom Merriam] and the rest of staff are dubious at best. *There is some question whether DC was told to approach CF (*[by] *Elmer MacKay/B Mulroney Mr. Buchanan).*[43]

Senator John Buchanan, who was premier of Nova Scotia at the time, had no recollection or knowledge of such an event. He denied suggesting that Cameron contact Frame or anyone else associated with Curragh.[44] According to Buchanan, he had first met Frame in the fall of 1987 in Ottawa when he was attending a federal-provincial conference. He recalled that Kilborn president Jack Mitchell introduced him to Frame at a lunch meeting. Buchanan said that during lunch he was told that Curragh was negotiating with Suncor for the Pictou County project – something Buchanan testified he already knew. He recalled advising Frame to contact the Department of Mines and Energy, which Frame said he had already done.[45] Buchanan told the Inquiry that he met Frame a second time in late spring 1989 at a reception in Pictou County where the project was discussed by the mayors, wardens, and local Members of the Legislative Assembly (MLAs), and possibly by officials from the Department of Mines and Energy. He did not see Frame again until after the explosion of the Westray mine. Buchanan said that he had no knowledge of Curragh's dealings with Suncor or how the company came to be involved in bidding for the property: "No, I haven't any idea. I suspect in the mining world that companies involved in mining throughout this country, I think they pretty well know what everybody else is doing in the mining business."[46]

Cameron, as a Pictou County MLA on the government side, had been contacted by Suncor as early as 13 December 1985 about its interest in developing a mine.[47] Cameron denied making the initial contact with

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42 For a thorough discussion of this contract, see the take-or-pay agreement section later in this chapter.

43 Exhibit 141.03.067. Emphasis added.

44 Hearing transcript, vol. 68, p. 14924.

45 Hearing transcript, vol. 68, pp. 14926–27.

46 Hearing transcript, vol. 68, pp. 14927–29.

47 Letter from Suncor's project manager to Cameron outlining some discussion points from a meeting they had had that day (Exhibit 141.03.004–05).

Curragh, but was somewhat less explicit in his denial. He testified as follows:

Q. . . . There had been allegations that you were instructed to get ahold of Mr. Frame or that Mr. Frame was referred to you by various other parties.
A. . . . Why would I be getting ahold of Mr. Frame when I wasn't even in Cabinet and wasn't even going to run again?
Q. Do I understand you then to be giving evidence that as of the end of 1987, certainly into the early part of '88, you would have had no involvement with Curragh in relation to its proposal to Westray?
A. I can't recall.
Q. When do you recall the first connection between yourself and Curragh as a proponent of the project?
A. Well, clearly around, you know, the first part of '88 and then I became Minister. Clearly . . . as the Member in the area, I'd be informed what was going on. I mean, by the first part of '88, it was clear the company made an agreement. It was in the paper. They were going to buy the project and proceed. So – but no real formal issues until I became Minister. And then it was ongoing.
Q. Can you give me the first incident or point in time that you can recall being connected with Curragh or knowing of the Curragh project?
A. No, I don't want to speculate.

. . .

Q. . . . I'm taking it from your evidence that you did not know of Curragh or Curragh's involvement in the project until probably after Curragh had made its offer to Suncor. Is that fair?
A. I don't want – you know, I took an oath this morning, and I'm not going to lie, but I'm not going to just answer questions just to satisfy you either. I can tell you I wasn't involved in any way until after I became Minister. I might have been as a Member informed about things. I might have met Gerald Phillips in the meantime. I would think it might be likely. Clearly, the papers would have something about Curragh buying the project. I don't know. I didn't review that. If you have some documents, I'll review them and explain them to you.
Q. When do you recall first meeting Mr. Frame?
A. My recollection is after the project was well on the way.
Q. And can you identify that for me? What are you talking about in terms of timeframe.
A. Well, I would say that maybe the first time I talked to him – the Premier told me to come in his office and they had him on a speaker phone, and there was some other people there. And I think that's – I said, "Hello," that's about it. I didn't know him.
Q. Can you place that in point of time?
A. I really can't, sir.
Q. Would it have been after you went into Cabinet?
A. I wouldn't even want to – I wouldn't even want to make that claim.

. . .

Q. [quoting from Ripley-Hood's memo to the deputy minister in Exhibit 141.03.067] . . . "There is question whether D.C. was told to approach C.F."
A. Well, I can tell you it's not true.
Q. All right, in whatever year.

A. In whatever year. I didn't approach Cliff Frame.
Q. All right, and by the time you know of Frame, he was in the deal?
A. Absolutely.[48]

Cameron stated that he had no information confirming or denying that anyone from the provincial government had approached Suncor to discuss Curragh's involvement in the bidding process.[49]

In a 9 October 1987 internal Curragh memorandum to Frame and other Curragh officials about Suncor's Pictou project, the unidentified author comments on the "political front":

> Bob Coates [minister of the federal Department of Regional Industrial Expansion] called John Buchanan. He had talked to Thompson, the Chairman of Suncor but didn't get much response – the bidding process has started and it is hard to change.
>
> Buchanan was to call me for another chat but has not done so. Bob says he is very busy but I suspect he doesn't quite know how to handle Suncor.[50]

The inference is that Frame or another Curragh official was seeking the assistance of the premier to intervene or at least support Curragh's efforts to be involved in the bidding process. Buchanan refuted the suggestion that he ever spoke with the chairman of Suncor about the bidding process. Cameron testified that he, too, was unaware of any such event, though he said he would not be alarmed to learn that Curragh had sought the assistance of someone in Nova Scotia to facilitate becoming involved in the bidding process.[51]

Elmer MacKay, federal minister of public works and MP for Central Nova at the time, also testified before the Inquiry. MacKay commented on the suggestions that Buchanan had asked Coates if he was aware of anyone who would be interested in developing a mine in Pictou County and that the Curragh connection was passed from Coates to Buchanan: "I have also heard this. It sounds plausible to me because Bob Coates was acquainted with Steve Roman. . . . And Cliff Frame was a key associate of Stephen. And . . . it's entirely possible that Mr. Coates was the connector, if you will."[52]

Phelan said he did not know of anyone's contacting Suncor to request that Curragh be allowed to submit a bid for the project late in the process. Phelan further testified that he was not privy to discussions between Curragh and Suncor and did not believe he had known anything about how they arrived at their agreement.[53]

On 23 September 1987, Phelan wrote a memorandum to Laffin in which he provided an update on the Suncor Pictou coal project. John Shillabeer, Suncor's project manager, had advised Phelan that six

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48 Hearing transcript, vol. 66, pp. 14444–49.

49 Hearing transcript, vol. 66, p. 14454.

50 Exhibit 141.03.001.

51 Hearing transcript, vol. 66, p. 14455.

52 Hearing transcript, vol. 65, pp. 14258–59. Roman was a mining executive and a Conservative party candidate in several elections.

53 Hearing transcript, vol. 51, p. 11118.

companies had already signed a secrecy agreement with Suncor and had received the Placer feasibility study. Phelan went on to say that three or four more companies were expected to sign in the next few days. He explained that Suncor had requested that the companies reply by mid-October with an expression of interest and an approximate range of what they would pay for the property. Suncor would deal with two or three of the companies and expect them to provide a firm offer by 15 December. Suncor would then make a final decision by 31 December. Phelan went on to say:

> John Shillabeer was aware that Clifford Frame approached Tom Thompson, the President of Suncor, regarding the project. Mr. Shillabeer was later contacted by Price Waterhouse who are representing Westray Resources, a subsidiary of Curragh Resources. Suncor are now waiting to receive a signed copy of the secrecy agreement and will be forwarding a copy of the Placer Feasibility Study to Price Waterhouse. Shillabeer indicated that there may have been some delay in getting the information package to the Curragh interests because of their requirement to have a secrecy agreement signed, but they are treating this inquiry in the same way as the other 10 companies who are interested in the project.[54]

Phelan could not explain having singled out Frame for special attention in his memorandum to the deputy minister.[55]

There is little evidence on the identity of the other interested companies or the reasons why they may have been disqualified as potential buyers. Cameron said he was aware of two other companies who vied for the rights to the project – Esso and Coalcor. It was his understanding that Esso had been turned down as a potential developer because it intended to tie up the leases while bringing in its own coal from a low-sulphur coal mine in South America. Cameron's information on Coalcor was also limited. He testified that the company was very upset about the situation because "they felt they didn't get a fair shake." He went on to question how Coalcor was intending to develop such a project without any source of revenue.[56]

It is clear that Curragh had set its sights on the Pictou project and was intending to develop it with government funds. On 25 November 1987, two days before its formal offer to Suncor, Curragh had already applied to the federal government for financial assistance under the Atlantic Enterprise Program.[57] While both the federal and the provincial financial assistance packages sought by Curragh are discussed at length later in this chapter, it is significant to note that the *first* formal action taken by Curragh in pursuing the project was to seek financial support from the public sector. There is no evidence of any technical evaluation, feasibility study, or review of existing studies by Curragh officials before the

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54 Exhibit 137.03.17.

55 Hearing transcript, vol. 51, p. 11119.

56 Hearing transcript, vol. 66, pp. 14450–52.

57 Exhibit 35d.0011–12.

submission of their offer. The approach of Curragh, compared with that of Suncor or other interested mining companies, is telling. Deputy minister Tom Merriam told the Inquiry that it is not uncommon for companies to attempt both to minimize their risk and investment in a project and to lever funds, public or otherwise. Although Curragh may have been more aggressive in levering those other sources, its approach to the project, in that sense, was not unusual. Merriam went on to say:

> A. But certainly at the end of the day, Curragh's attitude was that they were very aggressive in minimizing their cash investment, if you will, in the project or their investment of whatever form.
> *And that troubled me in the sense that I was concerned about what might happen down the road if, in fact, there were difficulties that had to be addressed. If they were starting out with that approach, I'm not sure where that would have left us a little later on in the process.*
>
> Q. Is that something that we should learn from this, that we should be careful to ensure that the proposer, the developer, while he may want government funds, and that's understandable, is really in it for the project as opposed to in it because they can do it for almost nothing?
>
> A. Yes, and I would say the simplest measure of that over time has always been the level of equity investment.[58]

That was the reality of Curragh's involvement.

Finding

It seems that Curragh was interested in the Pictou coal project only if it was able to secure significant government support; Curragh seemed less interested in the merits of the project itself. And it was this mind-set that set the tone for the negotiations and developments to follow.

Federal Financing

The negotiations between Curragh and the federal government for financing the Westray project were long and trying: Curragh made application to the federal government on 25 November 1987, and an agreement was not finalized until 27 June 1990.[59] There was significant opposition to the proposed Westray mine, particularly at the bureaucratic level. As a result, many issues required resolution before a deal could be reached. The opposition to the project was evoked by the level of federal financing requested by Curragh, the effect such a project would have on the Devco operation, and environmental concerns. The resultant delay in resolving these issues was due, in part, to Curragh's intransigence. Curragh's stance, as directed by Frame, reflected confidence in the solid political support for the project, backing that prompted the company to play hardball with the federal officials.

58 Hearing transcript, vol. 72, p. 15691. Emphasis added.

59 Harry Rogers, deputy minister of the Department of Regional Industrial Expansion, testified to this date of signing when he discussed the final documents (Exhibit 64) that were sent to the company for signing (Hearing transcript, vol. 61, p. 13465).

The Negotiators

Before reviewing the negotiations between Curragh and the federal government, it is important to gain some appreciation of the personalities integral to the process. Harry Rogers was deputy minister of the Department of Regional Industrial Expansion (DRIE) from 1987 to 1992.[60] He became the lead representative of the federal government in the negotiations for a financial assistance package. Elmer MacKay commented on Rogers's involvement. He felt that Rogers tried to reach the best possible deal for the government, and described Rogers as a "reluctant convert" who thought that "it may be all right, provided it's a clean deal and . . . there are as many safeguards put in there . . . as a deputy minister can put in."[61] Rogers agreed with MacKay's description that he started out quite negative about the project, but eventually came around and tried to get the best deal he could for the federal government.[62] Rogers perceived his own role in the negotiations as follows:

> I could not reveal to my own staff or to anybody else that I was favourably disposed or unfavourably disposed. Because to do so would disqualify me in terms of . . . the project leadership role that I had been asked to assume. So I simply maintained an optimistic view with respect to the proponents and . . . at the same time I was challenging them, and would undertake the discussions with Minister MacKay or Minister Cameron in as even-handed a fashion as I possibly could, because to do otherwise would destroy my own credibility and, therefore, my effective leadership of the case that I had been asked to assume.[63]

In commenting on his negotiations with Curragh, Rogers testified that "[t]hey were tough, hard-nosed negotiators, and we were equally tough-minded with respect to the expenditure of taxpayers' money."[64] Rogers went on to comment on Curragh's chief executive officer, chairman, and lead negotiator – Clifford Frame:

> I did say they were tough negotiators. He [Frame] was personally abrasive and abusive, and a very difficult and unattractive person to do business with. Probably the most offensive person I have met in business or in government.[65]

MacKay supported the project, which was in his constituency. Rogers testified that MacKay had played an appropriate role in the development of the Westray project:

> Well, certainly, he acted as any Member of Parliament would in actively and aggressively, proactively promoting a case for his constituents. And he's no different in that respect than anybody else, so there's nothing

60 Hearing transcript, vol. 61, p. 13317. The department has been renamed the Department of Industry, Science, and Technology, and is often referred to as Industry Canada.

61 Inquiry interview, 28 March 1996 (Exhibit 135, p. 83).

62 Hearing transcript, vol. 61, p. 13355.

63 Hearing transcript, vol. 61, p. 13354.

64 Hearing transcript, vol. 61, p. 13337.

65 Hearing transcript, vol. 61, p. 13368.

> to be critical of in his playing that role. . . . [H]e generally intervened where he thought it could speed up the process or he could improve the quality of the dialogue between the Federal Government and the Province. And that was an appropriate role for somebody who was anxious to see it proceed.[66]

Rogers also commented on his dealings with Cameron, provincial minister of industry, trade and technology. While Cameron's department was negotiating with Curragh on a provincial level, the provincial government also became, in a sense, a party to the negotiations with the federal government because of such issues as the long-term agreement between the federally owned coal supplier Devco and the provincially owned power corporation.[67] Rogers had the following to say about Cameron's demeanour:

> Q. In our interview you referred to Cameron and MacKay as "good cop, bad cop." What did you mean by that?
>
> A. Well . . . on occasion, Minister Cameron would become quite testy, and he would try to use an intemperate response as a means of avoiding whatever the rest of the discussion was. . . . And Minister MacKay on other occasions would be quite conciliatory after I'd had such a conversation and would go and try to lay oil on troubled waters. . . . On other occasions, Minister Cameron was very forthcoming and very agreeable to deal with. So it was possibly strategic in terms of dealing with me.[68]

Both Rogers and Cameron commented on the involvement of Prime Minister Brian Mulroney. Rogers believed that Mulroney's role in the development of the Westray project was no different from any other prime minister's involvement in such projects. Rogers agreed that Mulroney was aware of the project but was careful not to commit to a position. Rogers did not see any indication that the Prime Minister's Office actively promoted the project or facilitated it through the process.[69] Cameron similarly described Mulroney's role as "very normal" in the development of such a project.[70]

There is no question that Cameron was actively lobbying in support of the Westray project. MacKay had also expressed his support for the development of a mine in the area. And Buchanan had publicly endorsed the proposal. According to Rogers, Curragh officials were aware of the strong political support for the project and felt they had the project in the bag: "I believe they felt that they were riding high with respect to a proposition that they would get approved as requested. And I think that

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66 Hearing transcript, vol. 61, pp. 13359–60.

67 Rogers testified that he had attempted to obtain from Cameron the written commitment between the province and Westray about the contract for coal purchases. According to Rogers, Cameron refused to reveal the formal document on principle – Cameron felt that his word should be sufficient. In the final analysis, however, Rogers insisted that the document be reviewed (Hearing transcript, vol. 61, pp. 13360–61).

68 Hearing transcript, vol. 61, p. 13361.

69 Hearing transcript, vol. 61, pp. 13364–66.

70 Hearing transcript, vol. 67, p. 14678.

accounted for what I would regard as *intransigent behaviour* with respect to discussing or negotiating any changes from the original request."[71]

Rogers agreed that much of the delay in getting the federal financial assistance package finalized was arguably due to Curragh's intransigence. He agreed that the uncompromising behaviour of Frame and others was likely based on the belief that the political support for the project would carry the day. Rogers believed that Curragh probably underestimated how seriously the federal government viewed the issues to be resolved respecting Westray.[72]

Curragh's Application for Financial Assistance

Curragh's formal application in November 1987 for financing under the Atlantic Enterprise Program (AEP) represented the start of long and serious negotiations over the level of federal financing for the Westray mine. Rogers explained that the AEP was a small program run by the Cape Breton Development Corporation (Devco) to provide loan guarantee and interest buydown support for projects. He stressed that the AEP was established to deal with small projects, not one the size of Westray. Nonetheless, Curragh used the terms and conditions of that program as the basis for approaching the federal government for funding.[73]

Curragh was seeking an interest buydown at the 6 per cent maximum rate for a period of 15 years on a loan of $117,378,900. The company also requested a 100 per cent loan guarantee.[74] The proposed equity investment by the company was 8 per cent, with the federal government at risk for 92 per cent. The normal program maximums were 6 per cent interest for seven years, and an 85 per cent loan guarantee with the proponent's minimum equity investment of 20 per cent.[75] Curragh's initial bargaining position clearly fell outside permissible government guidelines. It is important to realize that Curragh's application countered a policy of the federal government, espoused shortly before. As Rogers told the Inquiry, "it was only in May 1987 [just months prior to Curragh's approaching the federal government] that the government had adopted a policy of *not*, in fact, providing support for mining development in the country." In the department's view, there were adequate incentives and markets for support to be sought independently by the developers themselves.[76] The federal government's ultimate decision to assist Curragh was clearly not in accord with policy.

While the negotiations between Curragh and the provincial government will be addressed later in this chapter, it is important to note that the ultimate financial package offered to Curragh was dependent on

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71 Hearing transcript, vol. 61, p. 13351. Emphasis added.

72 Hearing transcript, vol. 61, pp. 13447–48.

73 Hearing transcript, vol. 61, p. 13324.

74 Exhibit 35d.0012.

75 Exhibit 139.16.013.

76 Hearing transcript, vol. 61, pp. 13332–33. Emphasis added.

Curragh's negotiating and securing the financial support of the province. It is quite obvious, from a review of the evidence on the point, that federal financing would not be forthcoming to Curragh, or any promoter, without the required equity of 20 per cent. Obviously, Curragh showed great reluctance to commit its own resources to this extent and therefore turned to the province for support. By agreeing to make up a portion of the required equity, the province, in effect, diminished Curragh's interest in the project to the extent that the company was not a full "equity participant." It may be in this respect, as well as with respect to the take-or-pay agreement, that the province was less than astute with the public purse. The ramifications of the take-or-pay agreement are significant and are discussed later in this chapter.

Opposition to the Project

Although the federal government ultimately assisted Curragh through a loan guarantee of approximately $85 million and a direct contribution against interest, Curragh's initial approach to the federal government was met with much opposition. On receipt of the company's application, a cabinet committee discussed the project and identified a range of issues to be resolved.[77] Officials expressed concern for the amount of support being requested by Curragh – the sum was more than half the department's annual disbursements for government-funded projects. The effective cash cost to the federal government for the requested loan guarantee and interest buydown was approximately $27 million. There was concern within the federal government about establishing a mine in the Pictou County area and the impact that that would have on Devco, a federally funded crown corporation. There were environmental questions, such as the impact on the salmon spawning beds, the effect of trucking large quantities of coal on a daily basis from the mine to the generating plant, the effect of constructing a railway access line, and the effectiveness of the low-sulphur coal in reducing sulphur emissions as needed. There were other issues to be resolved, including the sufficiency of Curragh's equity investment in the project, the confirmation of a contractual agreement between Curragh and the province with respect to the purchase of coal, the technical feasibility of the project, and the aforementioned policy of no government support for mining initiatives.[78] The federal government's overriding concern, however, was the requested level of support.[79]

Rogers testified that opposition to the project at the time was extensive: "Unequivocally this [proposal] was up in the air right until the end. I mean, the extent of opposition to this was not simply in the hands

77 Rogers (Hearing transcript, vol. 61, pp. 13325–31).

78 The federal government's technical review of the project was conducted by CANMET. In the final analysis, the review concluded that the project was technically feasible, although it did express some reservations. See Chapter 11, Department of Natural Resources, for a review of this study.

79 Hearing transcript, vol. 61, p. 13331.

of a few intransigent bureaucrats. There was extensive opposition from a whole range of people."[80] He went on to elaborate his own views:

> My own particular concern throughout this was that DRIE was going to get saddled with the financial responsibility for this project, and that this was going to disable an emerging department that was moving rapidly away from extensive subsidies to business and that this would be seen as . . . totally inconsistent with the objectives of the emerging new department.

As deputy minister of the department, Rogers attempted to be objective with both Curragh officials and politicians. He found this stance to be particularly difficult with his own staff, all of whom were opposed to the project both in principle and for financial reasons. In the final analysis, Rogers did not feel the proposal warranted the federal government's support.[81]

During the initial months of the review, there was "a lot of challenge and a lot of back and forth" between Curragh and government officials with respect to the adequacy of documents and investment levels. The business plan would have generated "a very healthy amount of cash starting in about four years out" for Curragh. The department's primary argument, in a financial sense, was that the requested level of support was not warranted. Both Curragh and the department put their evidence forward, and the debate continued for months without agreement between the two sides. Ultimately, the department arrived at a "reasonable business case" with Curragh.[82]

In a memorandum dated 2 May 1988 to Robert de Cotret, minister of the Department of Regional Industrial Expansion, Rogers provided a financial analysis of the Westray proposal. He advised that there was "currently no DRIE budget allocation for this project, and funds would have to be taken from other DRIE A-base budgets, or approved separately by ministers, through reserves." Rogers further noted that the Department of Energy, Mines, and Resources "states that there is no precedent in Canada for federal financial assistance for primary coal extraction, and consequently that assistance to Westray could result in criticism from Western Canadian coal producers."[83]

In another memorandum, dated 1 June 1988, Rogers presented the minister with two options: first, if the minister intended to provide federal assistance, further negotiations and consultations would be required; second, if he intended to reject the Westray proposal, communication with the company should emphasize the high cost of the project to the government, the disproportionate sharing of risk, and the necessity for the department to authorize an assistance package that exceeded the normal maximum assistance levels of the AEP.[84]

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80 Hearing transcript, vol. 61, p. 13356.

81 Hearing transcript, vol. 61, p. 13359.

82 Hearing transcript, vol. 61, pp. 13336–37.

83 Exhibit 139.16.006–07.

84 Exhibit 139.16.019–20.

In July 1988, Rogers reported to de Cotret that Westray had apparently been successful in convincing the province, specifically Buchanan, to assist the project. The province agreed to buy one million tonnes of coal from the mine and to provide Westray with a subordinated loan to meet the department's equity requirement, thus enabling a revised Westray request to be technically within normal AEP assistance levels.[85] Despite Westray's progress in its negotiations with the province, Rogers recommended that the Westray application be rejected, based on "the high cost to the federal government, the large negative impact on Devco, the potential closure of the Sydney to Trenton CN line, the existing world-wide overcapacity situation, and the poor precedent-setting nature of the proposal."[86] Rogers testified that he was persuaded by the negative impact on Devco to an extent he had not been before. His recommendation was not approved.[87]

The possible impact of the Westray mine on Devco sales to NS Power posed a major concern for the federal government as it tried to ensure that the Devco market would not be jeopardized by the development of a new coal mine in the province. The province did not exhibit the same degree of concern. Elmer MacKay told the Inquiry that there was greater consciousness with respect to Devco at the federal level because of the federal connection with it.[88] The Devco board of directors had expressed strong concern that the Pictou project would have a direct and very negative impact on the corporation. In the final analysis, Devco doubted the feasibility of two commercially viable coal mine operations in Nova Scotia competing for a limited power generation market.[89]

In a 20 April 1988 memorandum, Rogers advised de Cotret of the potential impact of the project on Devco. He noted that, while Buchanan had given public assurances that Devco's local market would not be eroded (NS Power was committed to purchasing Devco coal), the premier had not provided any specifics. Rogers concluded by recommending that "appropriate safeguards be negotiated with the province of Nova Scotia and NSPC to ensure Devco a significant share of the NSPC market, in keeping with Premier Buchanan's public assurances in this regard."[90]

In October 1988, Louis Comeau, president of NS Power, wrote to Peter White, principal assistant to the prime minister, advising that NS Power had no intention of defaulting on the contract it had signed with Devco in 1978. The contract stipulated that the agreement would operate for a full 33 years. Comeau reiterated that "it is still Nova Scotia Power's obligation to live within the general terms of this contract. We need CBDC [Devco] coal."[91] Comeau went on to express concern about

85 Exhibit 139.16.022.

86 Exhibit 139.16.023.

87 Hearing transcript, vol. 61, p. 13390.

88 Hearing transcript, vol. 65, p. 14271.

89 Exhibit 139.16.114.

90 Exhibit 139.16.115–16.

91 Exhibit 139.16.024.

"environmental considerations which were not in effect in 1978." NS Power could not agree to specific quantities for the long term unless it had "some assurance of quality and price." This commitment did not satisfy Rogers, who was looking for a contractual commitment from NS Power.[92] Negotiations continued with the province for a contractual commitment between Devco and NS Power, as well as a formal agreement that, pursuant to the province's take-or-pay agreement, Westray coal would not replace Devco coal.

The federal government expressed further concern about the environmental impact of establishing a coal mine in Pictou County.[93] A series of environmental assessments were completed, and a public hearing was held at the provincial level. Rogers explained that the federal department could either conduct its own hearing or adopt the findings of the province. The government ultimately decided that the provincial findings, along with some environmental impact assessment done by Acres Limited, were adequate to satisfy the basic requirements of the *Environmental Assessment and Review Act.*[94]

The Continuing Debate

At a 26 October 1988 meeting between the federal government and Westray, Rogers laid out six outstanding issues: "If we can satisfactorily resolve these, then we (DRIE officials) will make a favourable recommendation to Cabinet."[95] On 28 October 1988, Frame wrote to Rogers outlining his understanding of "the consensus, I trust you will agree, reached during the meeting" about the outstanding issues. Frame reminded Rogers of the inherent risks associated with the development of the project. He noted that, although the shareholders were making an important direct investment of $15 million, the most significant financial commitment by the shareholders could be at the end of the development in the event of any difficulties.[96] Rogers made the following comments about Frame's position:

> What it portrays is the continuing disagreement with respect to the sort of project financial analysis, the assessment that was being made by myself and my officials where we were basically saying that they were requesting a far greater level of financial support than their own financial analysis indicated would be warranted.
>
> And their rebuttal was that our analysis was deficient and that our analysis did not take into account a whole series of potential outturns on

92 Hearing transcript, vol. 61, p. 13392.

93 The environmental aspects of the Westray project are well outside the Terms of Reference of this Inquiry. The following commentary is included in this Report only to provide some indication of the complexity of the negotiations and the various regulatory agencies and statutes involved in the total project. Similarly, although the Inquiry received thoughtful submissions on the environmental aspects of the Westray project, they did not come within the ambit of this Inquiry.

94 Hearing transcript, vol. 61, pp. 13335–38.

95 Draft minutes of meeting (Exhibit 139.16.026). The issues were labelled "Minimum conditions to Westray financial assistance" (Exhibit 139.16.032).

96 Exhibit 139.16.038–39.

cost overruns or on other financial commitments they would have to make to the project and, for this reason, the base of our assessment should be changed.

This went on beyond this meeting and I suspect even after the project was approved, they probably would still argue that they had a valid position and that our position was not valid.[97]

On 4 November 1988, Rogers responded by letter to Frame. He expressed concern about Frame's version of the conditions to be resolved between the parties. Rogers believed that Curragh failed to account for the fact that the federal government, not the shareholders or the commercial lender, was being asked to assume the bulk of the financial risk on the project. Accordingly, Rogers told Frame that his department would be suggesting that the minister require the following from Curragh:

- the insured loan to carry a first charge on all company assets
- a copy of any shareholder agreements
- the right to restrict any corporate restructuring or reorganization if impacting on federal fiscal revenues or impairing the government's security position
- assurances as to the willingness and financial ability of the shareholders to fund any capital cost overruns.[98]

The federal government and Curragh continued to debate outstanding issues well into 1989. On 11 July 1989, Rogers wrote to Merriam outlining the three issues that required further clarification: the requirement for an agreement between Devco and NS Power; an agreement that there would be no diversion of Westray "take-or-pay" coal to replace Devco coal; and the province's intention with regard to its policy on sulphur dioxide emissions.[99] Rogers again expressed his ongoing concern that the level of financial assistance requested by Westray was not warranted in light of the company's projected financial returns.[100]

Merriam responded to Rogers in a letter dated 20 July 1989. First, discussing a contractual arrangement between Devco and NS Power, Merriam relied on the existing contract. He stated that the contract had worked to the benefit of both Devco and the federal government in the past and he believed it reasonable to expect that the existing arrangement would deal adequately with any future arrangements. In Rogers's opinion, however, Merriam's reply did not by any means firm up the contractual arrangement with Devco; rather, it was "a further attempt to obfuscate the

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97 Hearing transcript, vol. 61, p. 13404.

98 Exhibit 139.16.052.

99 Exhibit 139.16.057. Rogers said that he was not disagreeing with a policy to reduce sulphur emissions, but felt that the environmental concern was being used as a bargaining tool. Cameron had, in Rogers view, precluded the possibility of burning Devco coal at the Trenton 6 station. Rogers felt that a judicious mixture of higher-sulphur washed coal with a low-sulphur anthracite coal would produce a low-sulphur-content coal for burning (Hearing transcript, vol. 61, pp. 13424–25).

100 Exhibit 139.16.057.

issue and skate on it."[101] Second, Merriam advised that the take-or-pay contract was initiated to help the company arrange financing; it was not anticipated that it would ever be exercised.[102] Third, Merriam commented on the federal-provincial sulphur emissions agreement, noting that the Westray project would assist the province "to more than comply" with the agreed reductions. Finally, considering the technical risks associated with mine development, the time-frame for payback of capital, and the substantial loan and completion guarantees given by the company, Merriam felt that Westray's request was not unreasonable.[103] In his testimony, Rogers said that Merriam was making it clear in his letter that the federal government would not be able to enlist the support of the Nova Scotia Department of Industry, Trade, and Technology in debating with Curragh over the level of assistance.[104]

On 6 September 1989, Rogers wrote to Merriam, informing him that the federal government was willing to assist Curragh through "loan insurance of 85% of a $100 million loan, valued at $21.25 million," and an "approximate 2 percentage point interest rate buydown for 7 years with a maximum value of $8.75 million." Rogers advised that the assistance package was subject to the usual government approvals, compliance with environmental requirements, and the attainment of the following contractual agreements between Devco and NS Power:

- a firm ten year contract at acceptable prices for the coal quantities previously agreed to by Devco and NSPC . . .
- a formal contractual agreement that there will be no diversion of Westray "take-or-pay" coal to replace Devco coal.

Finally, Rogers required clarification by the province of its future intentions regarding sulphur emissions standards.[105] According to Rogers, it was "decision time." While the same three issues were being debated, Rogers was putting Merriam on notice that this was the end of the negotiating process.[106]

On 2 October 1989, Frame responded to Rogers's formal offer. Rogers told the Inquiry why he felt Frame had accepted the offer:

> Eventually, the perception of strong unrelenting support from the three Ministers was becoming, I am sure in his mind, frayed at the edges. And suddenly, I think, he was perceiving that they had a way to, more in sorrow than anything else, come back to him and say, "We tried, God knows we tried, but we can't get more than this, obviously. So if this isn't satisfactory – It would have been a great thing." But they could walk away with their dignity and their political reputations unimpaired, that they had really tried. And I think what he realized was this was the end. He either accepted this

101 Hearing transcript, vol. 61, p. 13429.
102 See the section on the take-or-pay agreement in this chapter.
103 Exhibit 139.16.058–60.
104 Hearing transcript, vol. 61, p. 13432.
105 Exhibit 139.16.064–65.
106 Hearing transcript, vol. 61, pp. 13440–41.

> or there was no deal. And that he did not have support from those quarters that he believed that he had had up until that point.[107]

On 14 December 1989, Buchanan and NS Power president Comeau jointly sent a letter to Rogers advising that the province and NS Power agreed that all coal requirements for existing and new thermal generating plants in Cape Breton would be purchased from Devco. The agreement further applied to new thermal plants on mainland Nova Scotia, except Trenton.[108] This was the provincial commitment to Devco that the federal government had been looking for. Rogers made the following comment in relation to the province's commitment:

> It does not contain specifics on price; it does not contain specifics as regards quantities. . . . It was my opinion . . . that this was the best we could get, and that this document was, in my opinion, binding on the Province. And since it was a codicil to the original contract, it had the force of contract law, and that was accepted.[109]

The Final Deal

On 27 June 1990, Curragh and the federal government finalized an agreement. The federal government provided Curragh with a loan guarantee of approximately $85 million and a direct contribution against interest. Rogers spoke to the two major improvements in the agreement that had been achieved by the federal government. He compared Curragh's requested level of assistance to the amount it ultimately received. He testified that, in both instances, the amount of loan guarantee was "the same budgeted appropriation value of $21.75 million." The difference came in the level of interest buydown. Curragh's original request was $26.75 million, but the federal government and Curragh settled on $8.75 million. As well, pursuant to the final deal, if the cash surpluses shown in Curragh's plan materialized, for every dollar Curragh took out of Westray up to $20 million, another dollar had to be paid back to the lenders. This reduced the overall payback period from 15 to 10 years.[110]

Curragh technically complied with the 20 per cent equity requirement of the federal government's AEP. It contributed a $9 million cash investment, supplemented by a deferral of management fees of $6 million and a $12 million fully subordinated loan from the provincial government.[111] It was Rogers's understanding that the province had provided Curragh with the $12 million loan to meet the federal government's equity requirement and to give Westray the required

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107 Hearing transcript, vol. 61, p. 13446.

108 Exhibit 139.16.071.

109 Hearing transcript, vol. 61, p. 13444.

110 Hearing transcript, vol. 61, pp. 13468–69.

111 **Comment** The word "technically" is used here intentionally. No matter how one interprets these numbers, Curragh injected only $9 million to assist in getting the project under way. In my view, the deferral of management fees is a somewhat hokey accounting manoeuvre, one that didn't make any actual funds available for development. It seems that both Rogers and Merriam had similar reservations.

infusion of cash to continue to proceed with the project before federal funding was approved.[112] Although "equity" was arguably defined quite loosely in this instance, both the $6 million in deferred management fees and the $12 million fully subordinated loan fell within the definition of equity pursuant to the AEP guidelines. Rogers testified that, whether one viewed these sources as good elements of equity, they met AEP stipulations. Personally, he did not feel there was sufficient equity in the project.[113] Merriam testified to the importance of the level of equity investment in a project. His comments are well founded:

> I think we've learned the hard way over many years that if an owner doesn't have a substantial stake in the project, then when difficult times come, and they always do to every project, there may not be enough both commitment and resources to deal with those problems. . . . if the owner is going to feel a lot of pain as a result of the project either failing or getting in serious difficulty, then that motivates them to burn the midnight oil, as it were, in order to work hard to find solutions to whatever those problems might be.[114]

The negotiating process between the federal department and Curragh officials was protracted and complex. The parties reached an impasse on more than one occasion. The issues to be resolved – the appropriate level of financing, the equity requirement, the impact on Devco, and environmental concerns – were by no means simple. They were further complicated by the infusion of politics into the process. All these factors contributed to the delay of federal funding to Curragh. Although Curragh officials did not get all they had asked for, they did get a federal package that enabled them to develop the Westray project with minimal investment and maximum profit potential.

Finding

The arrogance and the tough negotiating stance of Curragh officials were probably rooted in their awareness of, and reliance on, the political backing for the project.

Provincial Support

The province made significant concessions in its negotiations with Curragh. The record reveals that single-minded political support for the proposal overcame intense bureaucratic opposition. As a result, Westray managed to negotiate an attractive provincial financial assistance package on the strength of the political support it had rallied for the project: a $12 million loan, an $8 million interim loan, and a take-or-pay agreement, which guaranteed a sale for Westray coal.

112 Hearing transcript, vol. 61, pp. 13338–39.
113 Hearing transcript, vol. 61, p. 13493.
114 Hearing transcript, vol. 72, pp. 15673–74.

The Westray Negotiations: A Standard Provincial Deal?

The Department of Industry, Trade, and Technology conducted negotiations with Curragh for the provincial government. In his testimony, Tom Merriam, deputy minister of the department from 1987 to 1992, provided insights into the negotiations and dynamics between the province and Curragh. Merriam first learned of the Westray project in June 1988. At that point, the Westray proposal had been in the federal system for some months. Federal officials had had an opportunity to assess the proposal, articulate their position, and determine the project's eligibility for AEP assistance.[115] Merriam stated that the Westray proposal received different treatment from that accorded to others. Although it was common practice for the staff of the department to assess a proposal for government assistance and to develop recommendations for the minister's review, that did not occur in the case of Westray. Rather, the federal government had identified shortfalls in the financing package that needed to be addressed, and there had been some discussion that the province would address those issues.[116] Merriam told the Inquiry about the instructions he and his staff received in relation to the project:

> Q. In this case, your Department wasn't asked to do the normal assessment that you and I talked about earlier?
> A. No, and the fact that the vehicles were to be put in place were already pretty much determined, we weren't asked to do that assessment.
> Q. You were basically told it was going to be a loan and a take-or-pay type of arrangement?
> A. That's right. The direction was to negotiate the details of those two forms of assistance.

The proposal was reviewed by the federal government, but it did not receive the customary provincial assessment.[117] In fact, by 9 September 1988, Cameron had already written to Westray to advise the company of the province's commitment:

> Further to recent discussions in respect of the development of a coal mine at Foord Seam near Stellarton, Nova Scotia, by Westray Coal Inc., I am pleased to advise that the Province agrees to provide: a Mining Lease . . . a loan in the principal amount of $12 Million Dollars Canadian to assist in financing the development of the Project on the terms and conditions outlined in Schedule "A" attached hereto; and a take or pay contract for 275,000 tonnes per year for a term of fifteen years on the terms and conditions contained in Schedule "A" attached hereto.[118]

As a result of the manner in which the proposal developed within the department, the provincial department did not address a fundamental issue: Did Curragh require such a strong financial commitment from the provincial government? Cameron himself could not comment on whether

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115 Hearing transcript, vol. 72, pp. 15651–52.

116 Hearing transcript, vol. 72, pp. 15654–55.

117 Hearing transcript, vol. 72, p. 15656.

118 Exhibit 141.03.011.

the department had investigated Curragh's ability to raise the money on its own. He suggested asking the officials who were involved in the day-to-day negotiations.[119] Merriam was not aware of anyone from the province requesting that Curragh prove or justify the need for such a level of government assistance. Although Merriam said that Cameron was convinced that the support was necessary, he was not aware that this need had been confirmed in any technical or business sense. The province relied on the federal assessment and believed it to be complete and appropriate. It was Merriam's personal opinion that the proposal was too risky – too much public money was being invested in the project.[120]

Cameron was the minister of the Department of Industry, Trade, and Technology at the time the negotiations began, and his support for the project was unequivocal. Merriam said that the minister was both interested in and committed to the project from its inception and that he had a fairly heavy involvement in its development. According to Merriam, Westray was "one of a handful of projects that he [Cameron] chose to be involved in on a daily basis."[121] Merriam was inclined to say that "Westray was unquestionably the project he [Cameron] was most interested in."[122]

During the negotiations between Curragh and the province, Westray management called the minister directly on occasion to express dissatisfaction with members of the department and their particular approach. Cameron felt that the company had been challenged on many occasions, since it complained of tough negotiating with his staff. He said that he advised the company that they were to deal directly with his officials.[123] Merriam's testimony on this point varies somewhat with Cameron's. Merriam said that, in most cases, Cameron advised the department to continue negotiating, but that, on occasion, Cameron would tell staff that the company's position was acceptable to the province.[124] He testified that Cameron was involved in the negotiating process:

> He was involved in the process, although I think . . . his approach was to press the company to negotiate with officials. And it was only when either he or the company, I guess, felt that things might be breaking down in terms of making progress on an issue that he would inject himself into the decision on the issue.[125]

Merriam agreed that, because of Cameron's involvement, the job of his department was somewhat more difficult in the case of Westray.[126]

Cameron was determined to see the development of the Westray mine proceed. His involvement in the negotiation process attests to this goal. In

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119 Hearing transcript, vol. 66, p. 14468.

120 Hearing transcript, vol. 72, pp. 15684–86.

121 Hearing transcript, vol. 72, pp. 15656–57.

122 Hearing transcript, vol. 72, p. 15761.

123 Hearing transcript, vol. 67, p. 14699.

124 Hearing transcript, vol. 72, p. 15658. The discussion of the *pari passu* security on Westray's interim loan from the province is an example of such an occasion.

125 Hearing transcript, vol. 72, p. 15659.

126 Hearing transcript, vol. 72, p. 15660.

fact, when there was some doubt whether the federal government would complete a deal with Westray, Cameron spoke with Westray manager Gerald Phillips about a provincial deal without federal input. On 20 March 1990, in an inter-office Westray memorandum, Phillips wrote to Curragh officials:

> Don met with Premier Buchanan last night, at which time he suggested to the Premier that he phone Harry Rogers and tell him to forget about the meeting on Thursday, because, as they were told last week, the Provincial Government is prepared to finalize a deal with Westray.
>
> . . .
>
> It is my impression that Don wants to finalize a Provincial/Westray deal. I will ask Don if he thinks it will help if Mr. Frame calls Premier Buchanan to let him know how frustrated we are with the Federal Government and the continued delays we have had to put up with.[127]

In another inter-office memorandum, dated 29 March 1990, Phillips wrote:

> Don Cameron phoned me this morning to inform me that Westray will not receive Treasury Board approval today. Don was speaking with Harry Rogers. Don is absolutely disgusted that we are not going to get the approval this week.
>
> . . .
>
> After Don talked to Harry Rogers, he met with the Premier. Don told the Premier that the federal government was not going to give their approval today. Don also told the Premier that he was going to complete a provincial deal with Westray and the Premier told Don that he cannot do that. *Don said he does not care what the Premier says, he is going to do a deal regardless because this is becoming an embarrassment to everyone involved.*[128]

On 30 March 1990, Phillips relayed the following:

> Don also said that he was speaking to Harry Rogers today. Harry Rogers told Don that the deal is done and will be approved this Thursday. *Don has obtained the approval of the Premier and his other Cabinet colleagues* that if the federal deal is not done this Thursday, the Province will negotiate a deal with Westray.[129]

Cameron commented on Phillips's account of the development of a Westray-provincial deal.[130] In response to the claim that he would do the deal without the premier, Cameron testified that you simply do not do a deal without the premier: "If the Premier says in Cabinet, 'We're not doing that,' then it's not going to be done. And the orders won't be signed.

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[127] Exhibit 141.03.052–53. It is interesting to note that Cameron had expressed his dissatisfaction and frustration with the manner in which the federal department had handled the Westray proposal (Hearing transcript, vol. 72, pp. 13449–50).

[128] Exhibit 141, tab 3, p. 56. Emphasis added.

[129] Exhibit 141, tab 3, p. 58. Emphasis added.

[130] **Comment** The entire series of memoranda from Phillips to senior Curragh officials in Toronto has caused me some concern. It consists solely of Phillips's interpretation of discussions with provincial officials. The accuracy of the contents of these memoranda was questioned by some witnesses. In many cases, I formed the opinion that the memoranda not only relayed information but were composed to impress Frame and other Curragh executives with Phillips's prowess as a negotiator and his close connections with the senior provincial people. To this extent, these memoranda ought not be relied on as reflecting the events and discussions they purport to relate.

So it's just that simple."[131] Cameron could not say that a cabinet decision had been made authorizing a provincial deal.[132] He felt that the discussion around the provincial deal was a good tactic "to allow the feds to know that we were negotiating, so they would start playing fair."[133] In the event that the federal government decided not to proceed with the project, Cameron thought the province would have initiated a deal with Westray.[134]

Finding

Donald Cameron, a Pictou County MLA, was totally committed to the concept of having a coal mine in that county. This commitment is laudable and represents the sort of activity expected of politicians. It is, perhaps, one of the most rewarding of their duties. Cameron, as minister of industry, trade, and technology, continued with the same single-minded determination to work to ensure that Westray became a reality. In this context, he may have exceeded the limits of ministerial prudence and responsibility. He became an advocate of the project in much the same way that the promoters were in their dealings with the government of Canada.

$12 Million Equity Loan

The provincial government ultimately agreed to provide Westray with a $12 million fully subordinated loan at an interest rate of 11.75 per cent.[135] Merriam commented that equity loans are usually granted to existing companies in financial difficulty and require the province's assistance in corporate restructuring. They are granted less frequently for new projects. In the case of Westray – a new project initiated by a reportedly healthy company – such a loan was an unusual kind of financial assistance.[136]

Curragh's equity in the project consisted of a cash outlay of $9 million and deferred management fees of $6 million. The province had adopted the same guidelines as the federal government – at least 20 per cent of the project cost should be in the form of equity by the owner. Merriam testified that, ideally, "equity" was considered "cold, hard cash," and, therefore, the company's equity in this project would normally have been considered insufficient to qualify for either provincial or federal assistance.[137] On 19 December 1988, Marvyn Robar, a certified accountant and part of the department's business advisory group, sent a memorandum to Merriam in which he appeared to question whether the company's $9 million investment and $6 million deferred management fees were

[131] Hearing transcript, vol. 66, p. 14597.

[132] Hearing transcript, vol. 66, p. 14605.

[133] Hearing transcript, vol. 66, p. 14600.

[134] Hearing transcript, vol. 66, pp. 14601–02.

[135] "Fully subordinated" means that the provincial loan would be the last in line to be paid, thereby qualifying it as equity invested in the project.

[136] Hearing transcript, vol. 72, pp. 15671–72.

[137] Hearing transcript, vol. 72, pp. 15672–73.

adequate equity.[138] In testimony, Merriam responded by stating that deferred management fees constitute adequate equity pursuant to the AEP guidelines. Both the federal and the provincial departments accepted that interpretation. Merriam did not feel that a $15 million investment was adequate; nor did the province or the federal government. It was his view that $25 million, or 20 per cent, in some acceptable equity form would have been appropriate.[139]

Cameron provided some background for the province's decision to support the Westray project with a $12 million loan. His first knowledge of the loan was just before his department became involved in the negotiations with Westray. According to Cameron, the province's support came about as a result of the federal government's refusal to "accept some of the money the company was putting in as equity."[140] As we know, the company needed additional equity to meet the requirements of the AEP. Cameron believed that the federal government was determined to have the province financially involved in the project: "And so that initially, it came to us that we would be required to give them a $12 million loan. And then when we agreed to that later on they said, 'Now you have to fully subordinate it.' "[141] Cameron was not able to offer any further basis or justification for the province having lent Westray $12 million.[142]

On 10 May 1990, Elizabeth Cuddihy, solicitor for the Department of Industry, Trade, and Technology, wrote a memorandum to Robar in which she advised:

> He [Sheldon Plener, a lawyer acting for Curragh] seems insistent on us drafting a letter to Curragh confirming the $12 million arrangement including the subordination matter. I advised him that we are reviewing the issues and we will be prepared to move as soon as the Federal offer is received and accepted by the Company and unless I am instructed otherwise that is the course we intend to follow.[143]

Merriam also testified that he was not eager to have the province's position subordinated "the way it had to be to have those funds considered equity."[144] Notwithstanding Cuddihy's advice, Cameron wrote to Frame on that very same day, confirming that the province was "prepared to enter into a subordination agreement in respect of the $12 million loan on terms and conditions satisfactory to Curragh Resources Inc. and the province."[145] Phillips responded with a letter asking the province to confirm that it would do whatever was necessary to ensure that

138 Exhibit 142.01.022.

139 Hearing transcript, vol. 72, pp. 15677–78.

140 Hearing transcript, vol. 66, p. 14462.

141 Hearing transcript, vol. 66, pp. 14459–62.

142 Hearing transcript, vol. 66, p. 14467.

143 Exhibit 141.03.063.

144 Hearing transcript, vol. 72, p. 15689.

145 Exhibit 141.03.064.

the $12 million loan qualified as equity under the AEP.[146] Cameron testified that the province made that commitment. His response about whether Cuddihy's memorandum and his letter were inconsistent was vague and evasive: "Well . . . the letter is different than this. The one aspect of subordination is certainly in here, and she didn't want to discuss it with them."[147] According to Cameron, the subordination issue was clear-cut – it was a request by the federal government that had already been agreed to by the province. Cameron testified that he was not keen about subordinating the loan, but realized it was the only way it was going to be done.[148]

$8 Million Interim Loan

In January 1989, Curragh and the Department of Industry, Trade, and Technology entered into serious discussions about the advance of funds to Westray on an interim basis. Westray had already invested $10.5 million in the development of the project. The company wanted the province to advance a portion of its funding – approximately $4 million at that time – to permit continued site preparation and tunnel excavation. Westray's investment had been contingent on both an imminent decision from the federal government to assist with the project and the $12 million provincial financing arrangement provided to the company in September 1988. Because of delays in securing federal financing, the company was not prepared to make any further investment in the project; nor did it want to delay the project, since it was determined to meet the production commitment to NS Power.

In a memorandum dated 18 January 1989, Merriam presented two alternatives to the minister: first, mine development could be suspended until federal financing was secured; or second, the province could advance up to $4 million subject to the company's agreeing to provide a first security position on all assets, though once permanent financing arrangements were concluded, security would be subordinated to the prime lender. The company argued that it required full compensation should the province take control of the project. In this event, Merriam recommended that Westray be compensated on the percentage of its capital contribution vis-à-vis the total capital contribution of the project.[149]

Cuddihy, in a memorandum to Cameron dated 26 January 1989, advised that interim financing to Westray without confirmation of federal financing had to be treated as a separate loan apart from the $12 million equity loan, since the equity loan was contingent on federal support.[150] She did not believe that the $4 million allotment would be sufficient for continued progress on the project; nor did she believe that it was realistic

146 Exhibit 141.03.065.

147 Hearing transcript, vol. 66, pp. 14508–09.

148 Hearing transcript, vol. 66, pp. 14507–08.

149 Exhibit 141.06.001–03.

150 Exhibit 141.03.022.

to consider partial interim financing. Shortly thereafter, in a memorandum to file dated 8 February 1989, Cuddihy reported that the company was reluctant to accept a forfeiture of the assets in the event of default, notwithstanding that the province was prepared to advance $8 million.[151] Westray felt that it should be compensated for getting the project under way. Cuddihy also commented on a letter from the Prime Minister's Office advising the conditions under which the federal government might be prepared to advance financing: "Overall," she concluded, "it seemed negative. Accordingly, the risks of the Province providing the interim financing could not be ascertained, but did not look good."

Merriam said it was clear that the company would not provide the security that the department felt was appropriate, and, in light of that, the department was not prepared to recommend the advance of an interim loan to Curragh.[152] He believed that there should be normal commercial security for a loan of this kind, not only because of the amount but also because of the possibility that there would not be a federal offer and that the province would have to proceed with Curragh or another operator on a different basis altogether. In the event of such an occurrence, the province wished to have control of all the assets.[153]

On 8 February 1989, Merriam advised Cameron that the company was asking for *pari passu* security with the province on its own assets and, in the event of a default, the entitlement to release its interest in the security for its share of the value of the project as a going concern.[154] Merriam went on to explain the impact of such a request:

> The *pari passu* clause would essentially mean that the Province is entering into a joint venture with Westray with the Province assuming the financial risk. The provision for valuation as a going concern would mean that the Province would have to write Westray another cheque for $10.5 million to gain unencumbered rights to the property after having already laid out its $8 million in interim financing which would never be recovered.

Merriam concluded the memorandum with the following remark:

> It is the company's position that we are at an impasse if we cannot resolve the security issue. Westray is now inclined to wait for the Federal offer to see if that will . . . provide us with a way around this problem.

It was clear from Merriam's memorandum to the minister that his department was not in favour of granting an interim loan to Westray on this basis. Merriam testified that, although he was somewhat sympathetic to the company's argument that it could potentially come away with nothing, having already invested $10.5 million, he felt the counterarguments outweighed this consideration. The minister, on the other hand, thought a partnership was a reasonable compromise. Merriam believed that Cameron felt it would be unfair for the company to go away

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151 Exhibit 141.03.023.

152 Hearing transcript, vol. 72, p. 15717.

153 Hearing transcript, vol. 72, p. 15721.

154 Exhibit 141.03.024–25.

with nothing, after all it had invested. The minister, accordingly, sided with company officials on the issue. Merriam said, "Well, all I can tell you is we gave the Minister the best advice we could and, in the end, he exercised his responsibility to make a decision. And he chose to do otherwise."[155]

Cameron testified that the interim loan resulted from the delay in federal financing and the need to keep the project going until such financing was secured. He did not regard the advance of $8 million as a difficult issue, because the interim loan came out of a $12 million loan that the province had already agreed to provide to the company.[156] Cameron did not consider the company's position on the security issue to be unreasonable. He understood the company to be saying that, in the event that the province shut the project down, the company would want to recover the amount of money it had invested. Cameron did not appear to have any problem with such rationalizing.[157] Merriam's suggestion that the province would be entering into a joint venture with Westray did not cause Cameron any real concern:

> No, I didn't see it that way. I had every confidence that the Federal Government would go through with their funding; the money would be paid back, and we went back to the original $12 million loan. And, as you know, that's exactly what happened, plus a quarter of a million dollars in interest.[158]

Provincial consent to provide interim financing to Westray required the approval of cabinet. On 17 March 1989, an Order in Council authorized financial assistance to Westray in an amount not to exceed $8 million. The terms and conditions relating to security for the loan specified that there would be a fixed and floating charge debenture on a *pari passu* basis with shareholders. The loan was to be repaid in full on the earlier of 30 September 1989 or 70 days from the date of the written offer of project financing under the AEP.[159] Shortly thereafter, on 19 April 1989, Westray and the province signed an agreement setting out the terms and conditions of the interim loan.

Take-or-Pay Agreement

By the summer of 1988, discussion concerning a provincial take-or-pay agreement with Westray had begun. In a letter to Cameron dated 4 July 1988, W.R. Redrupp, of Price Waterhouse, alluded to the take-or-pay agreement ultimately provided by the province. According to Redrupp, Westray required a provincial guarantee for the sale of up to one million tonnes of coal as soon as the project reached that level of production. He

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155 Hearing transcript, vol. 72, p. 15724.

156 Hearing transcript, vol. 66, pp. 14474–75.

157 Hearing transcript, vol. 66, p. 14500.

158 Hearing transcript, vol. 66, p. 14503.

159 Exhibit 35c.0022–23. The date of repayment of the interim loan was eventually extended; it was not paid back until the provincial government's next fiscal year.

understood that a contract to purchase 710,000 tonnes had been committed by NS Power:

> Westray Coal undertakes to use best efforts to sell the balance of the one million tonnes. . . . The wording of the guarantee should be worked on with you as soon as possible . . . The guarantee will be most important for use in arranging senior debt financing as well as the AEP application.[160]

A few days later, on 8 July 1988, Cameron wrote to de Cotret and said that the province had agreed, *in principle*, to provide assistance to Westray, including a take-or-pay agreement for 275,000 tonnes of coal.[161] On 9 September 1988, Cameron wrote to Frame, stating that the province agreed to provide "a take or pay contract for 275,000 tonnes per year for a term of fifteen years." The conditions specified that the agreement was to terminate on 31 January 1989 if by that date the parties had failed to conclude a formal agreement.[162] It is important to note that written cabinet approval for the take-or-pay contract – a mandatory requirement – had not been given at this juncture. In fact, on 20 September 1988, an Order in Council authorizing financial assistance to Westray for the $12 million loan made no mention of a take-or-pay contract.[163]

At Westray's request, the 31 January 1989 date specified in the conditions attached to Cameron's offer of assistance was extended to 31 March 1989.[164] Subsequently, on 31 October 1989, Marvin Pelley, president of Westray, wrote to Cameron asking him to confirm that the termination date for the agreement would be again revised – this time to 28 February 1990.[165] In a memorandum to Merriam dated 2 November 1989, accountant Marvyn Robar advised against such an amendment by the minister:

> In order to extend this same offer now as requested would first require the approval of Cabinet for the take or pay contract.
>
> I would therefore strongly recommend against the Minister approving this request. *In the event that he does wish to sign, he must first obtain the approval of Cabinet for the take or pay contract.*[166]

On 3 November 1989, Robar and Cuddihy advised Cameron against extensions to the take-or-pay agreement without the approval of cabinet. Their words were unequivocal:

> You will recall that the Cabinet did not approve the execution by the Department of any arrangement relating to the take or pay and *if such were to be granted at any time a specific Cabinet authority would be required.*[167]

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160 Exhibit 141.03.006–07.

161 Exhibit 141.03.009.

162 Exhibit 142.01.006–14.

163 Exhibit 35c.0017.

164 Exhibit 142.02.008.

165 Exhibit 141.03.034–35.

166 Exhibit 142.02.008. Emphasis added.

167 Exhibit 141.03.033. Emphasis added.

On 14 December 1989, Cuddihy was instructed to draft a cabinet minute to seek authority for Cameron to sign a letter of undertaking with Westray for a take-or-pay contract involving 270,000 tonnes of coal per year for 15 years.[168] On 9 January 1990, Cameron wrote to Cuddihy: "I have received Cabinet authority to finalize the contract with Westray regarding a $12 Million loan and Take-or-Pay Contract."[169] On that same day, Cameron wrote a letter to Frame:

> [T]his will confirm that the Province is prepared . . . to enter into a take or pay contract for 275,000 tonnes per year for a term of fifteen years substantially on the terms and conditions attached hereto.[170]

This letter was much the same as the letter he had written to the company well over a year before on 9 September 1988 – *without* cabinet approval.

Cameron had an opportunity to testify to this issue at the Inquiry, though he was less than forthcoming in his answers:

> Q. So my question to you is: Did you have Cabinet approval to commit the take-or-pay agreement in September of 1988?
> A. I would not put it in the letter without having Cabinet approval. Absolutely not.
> Q. Well, you tell me: Did you take it to Cabinet and did Cabinet approve committing to a take-or-pay agreement in September of '88?
> A. I would not write a letter saying that we – you have a take-or-pay agreement without going to Cabinet and having approval.
> Q. Your staff is saying here you didn't have it, that Cabinet had refused to give you that authority.
> A. Maybe at that time. But I would not write that letter if I didn't get permission from Cabinet to do it.
> Q. They're saying you did not have approval prior to 1989, July –
> A. What they –
> Q. – sorry, '90.
> A. What they may be saying is that we didn't have the documents. But lots of times in Cabinet we would have a decision – we'd go through the book and then have a decision made on a number of issues after we got the agenda done to the book, and agree to do certain things. So they may be saying that I didn't have the paperwork done, but I can assure you that I did not write a letter on this or any other item that Cabinet didn't give its approval.
> Q. Tell me about Cabinet approval. Tell me when you took it [to] Cabinet; tell me what was passed in Cabinet.
> A. Well, if we agreed in Cabinet to do this, then we'd follow it up later with an Order-in-Council.
>
> . . .
>
> Q. . . . Now this is a point that I think is of some significance, and I want your evidence on the point. *If you got Cabinet approval to make the commitments that you did in '88, you should be able to point me to something that evidences that because I've got two pieces of paper from your staff that said you don't – that you didn't.*

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[168] Exhibit 141.03.036. The 270,000 tonnes is likely a typographical error. All other references are to 275,000 tonnes.

[169] Exhibit 141.03.037.

[170] Exhibit 141.03.038.

A. Mr. Merrick, I think you're more interested in trying to embarrass me than get to the truth. *The truth is that I would not write a letter to any company on any issue without having Cabinet approval.*

. . .

Q. Do you remember in 1988, prior to your writing to Mr. de Cotret in July and prior to your writing to Mr. Frame in September, taking that issue to Cabinet as to whether you could commit the province to a take-or-pay agreement?
A. Mr. Merrick, you asked this question 15 times.
Q. Yeah.
A. I'm telling you that I didn't sign a take-or-pay agreement with this company or any other issue without having Cabinet approval.
Q. Yes.
A. Now that should be very clear for you.
Q. I've got that.
A. Good.
Q. Now my question is do you remember your request to Cabinet –
A. I don't remember –
Q. – in '88?
A. – the exact day. But all I can tell you is I did it.
Q. You remember taking this request in '88 to Cabinet? Have I got that?
A. I don't know when I took it to Cabinet. All I can tell you, I took the request to Cabinet.
Q. Do you recall how Cabinet dealt with it the first time?
A. No, I don't.
Q. You don't remember if they authorized it or didn't authorize it?
A. No, I don't. I don't know how many times we discussed – I don't know.
Q. So that do you – I take it then you cannot dispute the statement that appears in this memo by Elizabeth Cuddihy and Mr. Robar that the Cabinet did not approve the execution by the Department of any arrangement relating to take-or-pay and if –
A. I don't know –
Q. – such were to be granted –
A. There was a piece of paper that – it wasn't done.
Q. Are you able to –
A. I don't know.
Q. – dispute whether that is the reality?
A. I'd have to understand the surroundings of this. Was the day – draft a piece of paper and I took it and it was turned down? I don't know. Did they look through the book and say, "Hey, we don't have legal authority to do so"? I don't know. That happens lots of times. They will say, "Well, we don't have legal authority to do this yet. You will have to take this in before we can exercise this." I don't know what they're referring to here. I'm not reading anything into it. The bottom line is that Cabinet approved every part of the deal.
Q. Ultimately.
A. That's the bottom line.
Q. Ultimately. I'm talking about '88. Let me ask you this: Mr. Rogers, when he was on the stand, said that he consistently was asking you for a piece of paper that confirmed that the province was prepared to make that commitment.
A. Uh-huh.

Q. And you consistently put him off and put him off for some period of time. And that he was skeptical that such a piece of paper [ever] existed.
A. Well, it existed.
Q. Here's my question: *Is it possible that his evidence is correct, that you were not able to show him a Cabinet document because you didn't have a Cabinet document?*
A. *No, that's not true. I didn't want him to see it because I didn't trust them.*
Q. *What Cabinet document did you have prior to 1990?*
A. *I don't know, but I didn't want them to see it because I didn't trust them.* I figured they'd –
Q. So you had –
A. – give it to – I figured, before the day was over, they would give it to Devco.
Q. So you had a piece of paper that you didn't want him to see, but you don't know what that piece of paper was?
A. Not on a particular date.[171]

Senator Buchanan commented on the authority Cameron would have had for the take-or-pay agreement in September 1988. He testified that Cameron had Cabinet *direction* to continue to negotiate a take-or-pay agreement, but that he had no *authority* to bind the province to any contractual obligation or to confirm that the province would in fact give a take-or-pay agreement.[172]

Merriam testified that it was his understanding that Cameron had received cabinet approval to commit the province to a take-or-pay agreement. According to Merriam, Cameron advised him that he had cabinet's blessing and that the 9 September 1988 letter was to be prepared for his signature. Although the cabinet minute for this meeting made no reference to the take-or-pay agreement, Merriam was reluctant to say that the minister had misled him about the authority he had in fact been given: "I wouldn't say the Minister misled me. Whether there was some differing interpretation by he and his Cabinet colleagues of what they agreed to in that discussion, I can only assume there must have been."[173] It was Merriam's understanding that Cameron had the authority to make the agreement in September 1988; he subsequently learned that no such authority had existed.[174]

Finding

The evidence is unequivocal that, by September 1988, the cabinet had not approved a take-or-pay agreement with Westray for 275,000 tonnes of coal per year. Although the issue may have been discussed in cabinet, there was no existing authority for the minister to confirm that the

[171] Hearing transcript, vol. 66, pp. 14551–58. Emphasis added.

[172] Hearing transcript, vol. 68, pp. 14973–74.

[173] Hearing transcript, vol. 72, p. 15695.

[174] Hearing transcript, vol. 72, pp. 15695–96. It is important to note that Merriam raised the question whether Cameron in fact required cabinet authority to write a letter of this nature and the level of commitment the letter actually represented from a legal point of view.

province was willing to enter into the agreement. In spite of this, Cameron, in his letter of 9 September 1988, committed the province to the take-or-pay agreement. That action on the part of the minister was clearly improper. Cameron may have felt secure that the negotiations, which were all that had been authorized by cabinet, would mature into formal approval for the agreement. It would appear that Cameron allowed his determination to cloud his judgment. The fact that the agreement received cabinet approval two years later in no way excuses Cameron's earlier unauthorized action.

Opposition to the Take-or-Pay Agreement

The take-or-pay contract elicited no support among senior staff members and solicitors of the Department of Industry, Trade, and Technology. Nor were officials in the Department of Mines and Energy interested in becoming involved. Eventually, Novaco Limited, a provincial crown corporation, entered into the contract with Westray. Even this arrangement raised questions whether Novaco was the appropriate body, and whether there was a conflict of interest with Novaco taking on the role.

The questionable authority to enter into the agreement in large part fostered the opposition to the take-or-pay agreement. Some did not consider it to be a standard commercial agreement. Nancy Ripley-Hood, solicitor for mines and energy, in a memorandum of 15 July 1990 to deputy minister of mines and energy John Laffin, provided a summary of the background to the take-or-pay agreement as relayed to her by Merriam. She informed Laffin that Cameron's staff had advised him that his department had no authority to enter into the take-or-pay agreement and that "they will not do the necessary drafting." She went on to say: "Since DC [Don Cameron] can't get the work done in house, he goes to MCR [law firm McInnes Cooper & Robertson]. MCR also advise he has *no authority* and that *TOP [take-or-pay] not in best interests of Province*."[175]

Senator Buchanan testified that he was not aware that officials within the Department of Industry, Trade, and Technology thought that the take-or-pay agreement was illegal, that they had refused to draft the necessary documentation, and that the law firm McInnes Cooper & Robertson had rendered an opinion on the issue.[176] Cameron, in his testimony, did not dispute that his department had advised him that he had no authority to make this deal and that they would not draft the documents. But he was adamant that outside counsel had been retained to do the entire deal; they were not retained to do only the work that his staff was reluctant to perform. Cameron said he was unaware of McInnes Cooper & Robertson's opinion that there was no authority for the take-or-pay agreement.[177]

Merriam himself testified that he did not like the take-or-pay agreement and could not identify any department, agency, or individual

175 Exhibit 141.03.068. Emphasis added.

176 Hearing transcript, vol. 68, pp. 14978–79.

177 Hearing transcript, vol. 66, pp. 14560–62.

who was enthusiastic about it. The bureaucracy was concerned about the risks associated with a contract of this nature and was not eager to inherit the potential of Westray's calling on the agreement.[178] Ripley-Hood stated that she did not like the deal from day one.[179] She saw no need for the agreement, and, in her July 1990 memorandum to Laffin, she said: "Our staff . . . have concluded that if no one entered the TOP, the rate of return to CF [Clifford Frame] and terms of financing are such that this is the best deal CF will ever get anywhere and that any 'threat' to pull out should be firmly ignored."[180] Ripley-Hood questioned whether there was any authority for the Department of Mines and Energy to enter into the deal if, in fact, the province was contemplating such action. She explained that any department entering the take-or-pay agreement required a statute giving cabinet the authority to enter such an agreement; cabinet did not have such a statute.[181] Ripley-Hood subsequently found a somewhat antiquated statute that did provide cabinet with the necessary authority, via the Governor in Council, to allow the contract.[182]

Laffin testified that he did not want his department involved in the take-or-pay agreement. It was not Laffin's idea of a usual take-or-pay contract, in which a purchaser and a seller make an agreement, and the purchaser commits itself to take a certain amount of a particular product. In this case, a third party – the provincial government – was involved. Laffin believed that a normal take-or-pay agreement should have been executed between Westray and the power corporation.[183] Phelan also described a take-or-pay agreement as "a usual type of agreement between a buyer and a seller," but he did not seem to have reservations about this particular agreement.[184]

On 31 August 1990, almost two years after Cameron committed the province to a take-or-pay agreement with Westray, cabinet passed an Order in Council authorizing Novaco Limited "to enter into a take or pay agreement with Curragh Resources Inc. as part of the development of a coal mine" in Pictou County.[185] The agreement was ultimately finalized, but the record suggests that there was considerable discussion within cabinet about how to handle it. Merriam agreed in testimony that, between

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178 Hearing transcript, vol. 72, pp. 15689, 15713–14.

179 Inquiry interview, 26 April 1996 (Exhibit 138, pp. 64–65).

180 Exhibit 141.03.069.

181 Exhibit 138, p. 45.

182 Exhibit 138, p. 66.

183 Hearing transcript, vol. 70, pp. 15366–68.

184 Hearing transcript, vol. 53, p. 11553. During independent research, I had the opportunity to discuss the concept of take-or-pay agreements with several mining executives. Such agreements are not unusual. These executives were not aware of situations where a third party such as a government, entered into an agreement of this kind. Though the agreement appears most unusual, more puzzling, in my view, were the lengths to which Cameron went to rationalize the agreement and his firm understanding that the province would never be called upon to honour it – another example of his seeing only what he wanted to see.

185 Exhibit 141.07.002.

the fall of 1988 and the summer of 1989, there was a belief, at least by his department, that the take-or-pay agreement would not proceed:

> A. It was [an] unresolved issue, is my memory of it. It was in question whether it would be done and who would do it, and our approach was, when in doubt, go with the directions you have in writing, which were to proceed to negotiate the loan and the take-or-pay was –
> Q. Off the table?
> A. Well, or at least set aside temporarily.[186]

The minister, according to Merriam, did not particularly care what arm of government executed the agreement, as long as the project proceeded and the federal assistance requirement was met.[187]

The take-or-pay contract was considered and debated as late as 16 August 1990. A set of unidentified handwritten notes of a meeting among Cameron, Laffin, Cuddihy, Premier Buchanan, and others indicates that the take-or-pay agreement was still very much under consideration. The author made the following notation: "John Laffin and J. MacIsaac [minister of mines and energy] would like to offer another way around the take or pay."[188] Senator Buchanan agreed that it was fair to conclude that right up until cabinet finally approved the agreement, there were discussions whether there might be another way to deal with the situation.[189] Clearly, the provincial government was not sold on the deal.

In the end, the province decided that the agreement was to be signed between Novaco Limited and Westray. There is some question whether Novaco's involvement constituted a conflict of interest situation. In her July 1990 memo to Laffin, Ripley-Hood commented on the appropriateness of Novaco's participation in the deal:

> 3. If Nco [Novaco] was to enter TOP *we* (ie Minister) would have a conflict of interest (MCR now agrees with this)
>   a) Minister is responsible for NSPC, Nco and our Dept.
>   c) Minister becomes bad guy if he exercises his regulatory function under MR Act & closes Project for any period, CF [Clifford Frame] will scream that we are frustrating TOP
>   d) Minister will be sole guy responsible in House for *all* aspects of this Project. He is responsible for operation of mine, for NSPC and for TOP if Nco gets involved. My opinion & it is also opinion of both ADMs is that Nco not be involved.[190]

In her pre-hearing interview, Ripley-Hood elaborated on Novaco's involvement in the take-or-pay agreement. She explained that McInnes Cooper & Robertson had advised that a numbered company should be established to enter into the take-or-pay agreement. But since Novaco was already established as a corporate entity, the discussion centred on Novaco as the vehicle to implement the agreement. Although Novaco was

186 Hearing transcript, vol. 72, p. 15704.
187 Hearing transcript, vol. 72, p. 15705.
188 Exhibit 141.08.008.
189 Hearing transcript, vol. 68, p. 14972.
190 Exhibit 141.03.070–71. Emphasis in original.

mandated to provide advice to the province on near-surface coal mining, excluding Devco, it "could provide advice regarding coal markets which, by implication, would involve Devco."[191]

Phelan, in contrast, never saw himself in a conflict of interest situation.[192] As director of mining engineering with the Department of Mines and Energy, he operated in compliance with the *Mineral Resources Act* and had the authority to forfeit Westray's mining permit. At the same time, he sat on the board of Novaco. In his view, the department's responsibility under the act encompassed both promotional and developmental activities as well as regulatory duties. His deputy minister, Laffin, though, accepted the possibility of a conflict between the terms of the take-or-pay agreement and the regulatory authority within his department.[193]

Finding

The whole question of the take-or-pay agreement was fraught with difficulties. It was an unusual agreement in that it provided for a third party, the province, to commit public funds for the purchase of coal for which it had no immediate market. The agreement was roundly criticized as a bad deal for the province, and, moreover, the agreement was not really required in order to conclude the deal with Westray.

Cameron piloted this agreement through cabinet, which finally gave its approval. Although a minister is under no obligation to accept the advice of his or her departmental staff, the minister does at least have an obligation to consider that advice. The evidence is strong that Cameron did not give prudent and thoughtful consideration to the advice coming from his, and other, government officials. Notwithstanding the overwhelming opposition to the take-or-pay agreement, the political support for it became the final and decisive factor in pushing it through.

Enforceability of the Take-or-Pay Agreement

There is no question that the final take-or-pay agreement between Novaco and Westray was a legally binding contract. In the event that Westray elected to give notice pursuant to the agreement, the province would have had no choice but to comply with its terms. Notwithstanding this fact, Cameron was adamant that he and the company had reached an understanding about the enforceability of the take-or-pay agreement. According to Cameron, the company merely pursued the agreement for the benefit of securing financing, and had absolutely no intention of relying on the agreement:

> And the take-or-pay was . . . very simple – everyone has tried to make it very complicated and make it something it's not. What we said to them was, "Okay, to help put your financing in place, with a clear understanding that

[191] Exhibit 138, pp. 54–56.

[192] Hearing transcript, vol. 53, p. 11549.

[193] Hearing transcript, vol. 70, pp. 15380–81.

> you will never get one red cent out of this. You have to understand that." And I think they . . . at least, Gerald Phillips and Marvin Pelley understood it very clearly, believe me.[194]

Cameron went on to explain that Westray would have had absolutely no problem selling its low- sulphur coal "in these environmental times." For the contract to be implemented, the company had to prove, without doubt, that it had tried and was unable to sell its coal at world price. The potential of this scenario happening did not concern Cameron.[195] While still maintaining his position that the take-or-pay contract would never be exercised, Cameron did say: "If they wanted to break their word, they had every right to exercise that document. And I can tell you it would have got a tough response from us."[196]

Merriam was clearly not as confident as Cameron that Westray would not exercise its rights flowing from the agreement. In a memorandum to Cuddihy dated 14 December 1989, Merriam wrote:

> [T]he Minister is aware that, while it is the intent of Westray not to call on the Take-or-Pay contract, the legal commitment will be there for the Province, and there is always a possibility that we may be required to fulfil the purchase requirement of the contract in some future year.[197]

Merriam had no doubt that the take-or-pay agreement was a legal commitment; he was suspicious that it would be exercised at some point during the 15-year term. He told the Inquiry that, given the project and the commitment in the agreement, there was a "reasonable possibility" that the province would be called to honour the take-or-pay agreement at certain times.[198] Merriam commented on Cameron's belief that the company would not exercise the agreement:

> Q. Did you ever see any signs of a binding commitment by the company that they would never seek recovery under the contract?
> A. No, there was no such commitment I'm aware of. A verbal commitment, but no binding legal commitment.[199]

Rogers testified that he did not accept Cameron's argument that Westray's low-sulphur coal would be disposed of readily. He believed that, because the coal would be entering the world market at highly subsidized levels, it would likely be in contravention of both the General Agreement on Tarriffs and Trade (GATT) and the Canada–United States Free Trade Agreement. He thought there would be very quick responses and trade action from coal producers in other markets: "[T]hat's . . . why I think it was wise to presume that from a planning point of view, that the Nova Scotia Government probably would be paying for some coal."[200]

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194 Hearing transcript, vol. 66, p. 14510.

195 Hearing transcript, vol. 66, pp. 14511–12.

196 Hearing transcript, vol. 66, p. 14524.

197 Exhibit 141.03.036.

198 Hearing transcript, vol. 72, p. 15726.

199 Hearing transcript, vol. 72, p. 15727.

200 Hearing transcript, vol. 61, pp. 13430–31.

Senator Buchanan understood the take-or-pay agreement to be a binding commitment on the province: if the company after due diligence could not sell its low-sulphur coal, the province would be on the hook. Buchanan went on to say that the recommendation to cabinet indicated that there was a market for low-sulphur coal and that the province would *probably* never have to honour the agreement. Although Buchanan accepted the information that came through the minister and his department, he commented that "it would be a strange government that would sign something and . . . not intend to honour it."[201]

There was a clear indication that Westray was in fact serious about exercising its rights in accordance with the take-or-pay agreement. In November 1991, Curragh requested an amendment to extend the date by which Curragh could give notice under the agreement. In a memorandum to Ripley-Hood dated 4 December 1991, Phelan wrote:

> When the Board of Novaco Limited met with Marvin Pelley of Curragh Resources Inc. on November 22, 1991, he informed us that Curragh Resources Inc. have not been able to sell the coal they expect to produce in the calendar year 1993. Curragh will be required to give an election notice pursuant to Clause 3.01 of the "Take or Pay Agreement" to Novaco by December 31, 1991 so as not to be in breach of the agreement with their bank.[202]

The board agreed to Curragh's request to amend the agreement so it did not have to give the election notice until 30 June 1992. The board's decision was subject to Ripley-Hood's concurrence that the contract could be legally amended, that the other parties agreed, and that Novaco could agree to the delay of the notice without compromising its position or the position of the provincial government.[203] On 11 December 1991, Ripley-Hood wrote a memorandum to Phelan. She was adamant that the agreement should not be amended:

> There is no legal reason to amend this Agreement. It puts the Province and Novaco in a less than optimal position so that the Company can be put in a better position.
>
> I recommend that the Province does not agree to such amendment.[204]

Ripley-Hood outlined the repercussions of agreeing to such an amendment:

- In all probability, the company would have time to produce enough coal to kick in the provisions of the agreement. If such an extension was not

[201] Hearing transcript, vol. 68, p. 14986.

[202] Exhibit 137.04.12. Clause 3.01 of the take-or-pay agreement provided that "[i]f CRI [Curragh Resources Inc.] anticipates that its sales of coal in connection with the Westray Project from production from the Mine will aggregate less than 975,000 tonnes in a particular Year during the Term, CRI may given written notice (the 'Election Notice') in accordance herewith to the Purchaser within thirty (30) days prior to December 31 in any Year, but in any event no earlier than December 1991 requiring the Purchaser to take or to pay for the applicable Obligation Amount in respect of the Year (the 'Take or Pay Year') commencing twelve (12) months after such December 31" (Exhibit 141.07.014–15).

[203] Exhibit 137.04.12.

[204] Exhibit 137.04.15.

provided, the province probably would not have to take or pay for coal, because the company would not achieve the full production level.

- The province would reduce the time to give its take-or-pay option. This time was also needed to ascertain whether Westray used its best efforts to sell the coal.
- There would be a possibility of receiving two election notices in one year. The political ramifications were obvious.
- The extension of time had potential ramifications for the other provisions of the agreement, including its term, further amendments, etc.
- The amendment required cabinet approval.

The agreement, however, was ultimately amended. The chairman of Novaco wrote to Curragh on 19 December 1991 amending the election date from 31 December 1991 to 1 October 1992. The date by which the purchaser was to notify Curragh was extended from 30 June 1992 to 15 November 1992, giving the province only six weeks (as opposed to six months) in which to consider its option pursuant to the agreement.[205]

In her pre-hearing interview, Ripley-Hood maintained her position that there was no reason for the province to have amended the take-or-pay agreement.[206] Phelan agreed that Ripley-Hood had raised some legitimate concerns about an extension of the notice period, but noted that "Novaco had decided they wanted to do this" as long as the agreement could be legally amended. Phelan did not see it as an issue or a major concession.[207]

Cameron agreed that Curragh was apparently getting ready to give notice so it could call on the province to honour its obligations under the agreement for the 1993 year. He was aware of this intention at the time and explained how he had addressed the issue:

> We had a very tough conversation about it. And I reminded them of the commitment made and that they simply wouldn't be getting one cent of money from the Provincial Government, that they could sue us, they could do anything they want, but they were going to honour their commitment. And their commitment was that they would not exercise this agreement.[208]

Cameron was not concerned about the advice he received from Ripley-Hood. According to Cameron, amending the agreement would not make any difference because Westray was not going to get any money out of the province:

> [T]he Board was happy to change it. I was happy to change it. The bottom line was that they were never going to get any money and they knew it. And they were told directly from me, and they repeated that to our officials. So I didn't care what they did. They just weren't ever going to use it.[209]

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205 Exhibit 137.04.28.

206 Exhibit 138, p. 97.

207 Hearing transcript, vol. 53, pp. 11539–47.

208 Hearing transcript, vol. 66, p. 14539.

209 Hearing transcript, vol. 66, p. 14544.

Finding

The take-or-pay agreement executed by Curragh, Novaco, and the province was enforceable, notwithstanding a purported understanding between Cameron and Curragh officials that the agreement would never be exercised. To exercise the agreement for a given production year, the company had to choose to do so, well in advance, by a date specified in the agreement. The company would have to demonstrate at that time that the mine was capable of full production for the forthcoming year. Curragh indicated its intent to avail itself of the agreement when it requested an extension to that date, presumably to give itself time to get up to full production. Cameron's support for the agreement was based only on Curragh's word that the take-or-pay agreement would never be exercised. This attitude indicates startling naivety for a person of experience in the political milieu. If not naivety, it is another compelling example of Cameron's obdurate and single-minded determination to bring Westray to reality.

Having criticized Cameron for his conduct throughout the development stage of the Westray project, I must carefully note that my criticisms cannot be construed as evidence of any sort of complicity in the many defaults and oversights that led to the terrible event of 9 May 1992. There is no evidence that Cameron was ever told by his staff that the Westray mine was poorly or inadequately planned, poorly and unsafely operated, or operated in contravention of the *Coal Mines Regulation Act* and the *Occupational Health and Safety Act.*

The Economic Costs of Westray

The reason politicians found development of the Westray mine so attractive was that it created a number of jobs in an area of high unemployment and it supplied low-sulphur coal at a time of increasing concern for the environment. Yet, in the wake of the explosion, the economic costs of the disaster, as distinct from the human tragedy, have been enormous. Once again, these costs underline the need for safe mine production.

The Inquiry engaged the services of Professor Cyril Grant, an economist at St Francis Xavier University, to assist in preparing the figures and financial components for this report. In his submission, he said: "The statistical nature of the estimate must be emphasized as it cannot be interpreted as putting a dollar value on the life of a specific individual but it is useful in determining the economic desirability of proposed safety legislation." Although Grant did calculate the losses experienced by Curragh relating to the Westray disaster, it is sufficient for my purposes to say that the company was placed into receivership in September 1992. The major thrust of the analysis here is related to the economic costs of the Westray mine to public funds.

Provincial government loans We have seen that on 19 April 1989 Curragh signed an agreement with the province of Nova Scotia for an interim loan of $8 million. By an agreement dated 14 September 1990, this

loan was absorbed into another loan with a principal amount of $12 million bearing interest at 11.75 per cent. The loan was secured by debenture on the Westray project and was subordinated to a loan from the Bank of Nova Scotia. On 9 September 1992, the province gave Curragh notice of default and demanded payment of the principal amount plus interest. That amount remains unpaid.

Government of Canada loan guarantee By an agreement with the Bank of Nova Scotia dated 14 September 1990, Curragh obtained credit up to a limit of $100 million. This line of credit was secured by the assets of the Westray coal project and was guaranteed to a maximum of 85 per cent by the government of Canada (by the agreement of 27 June 1990). In December 1992, the government paid $80.75 million to the Bank of Nova Scotia and thereby acquired an interest in the assets secured. As a result of acquiring that interest, the federal government was entitled to a portion of an insurance settlement amounting to $13.4 million. The net loss to the government of Canada under its loan guarantee to the bank totalled $67.35 million.

Workers' Compensation benefits The families of the 26 miners who died in the explosion were entitled to a number of annuities. According to reports in the media, each widow was entitled to a lump-sum payment of $15,000 and a pension equal to 75 per cent of her late husband's salary to a maximum of $27,000 per year.[210] In addition, there was entitlement for child-support payments and funeral payments. The Workers' Compensation Board of Nova Scotia placed the actuarial value of these payments at between $13.3 million and $15 million.

Canada Pension Plan benefits The widows and families also became entitled to certain benefits under the Canada Pension Plan. These benefits were estimated at about $5 million.

Unemployment Insurance (UI) benefits After the explosion, many Westray workers were left without employment. Grant estimated the cost of UI payments at $2.38 million. He indicated that this figure might be "biased upwards," because 47 of the laid-off employees entered retraining programs and might in future gain increased earnings. On the other hand, in light of current economic conditions, some of the miners may have exhausted their unemployment benefits. No calculations have been made for any claims for social assistance.

When these five factors are combined with the costs of this Inquiry, it appears that the total direct public cost of the Westray mine disaster is more than $105 million.[211] In addition, there are other losses that are difficult to evaluate in hard dollar terms, such as the value of future lost

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210 Halifax *Chronicle-Herald*, 22 December 1992.

211 This amount includes only a small portion of the true public costs of this Inquiry (see Appendix K), the RCMP criminal investigation, and the subsequent aborted criminal trial of Gerald Phillips and Roger Parry.

income through unemployment in the Pictou area and the loss to Nova Scotia Power Corporation of the 700,000 tonnes of low-sulphur Westray coal it had contracted to purchase each year. Ironically, it was these "softer" issues that enticed the politicians to support the Westray project in the first place.

Curragh had projected that the Westray mine would employ 241 persons when it was fully operative. This number of employees would result in a total of 339 jobs created in the community as a direct result of the operation of the mine, once the multiplier of 1.41 (an economist's way of estimating the spinoff jobs created in the service and supply industries) was applied. At the time of the explosion, there were 223 employees at Westray, a figure that, applying the multiplier, amounted to 310 jobs. Grant cautioned, however, that it was impossible to make a direct translation of these numbers:

> It would not be correct to say that the explosion *caused* the loss of 310 jobs since various payments arising out of the disaster, the re-training of individuals and the alternative source of coal for the Trenton generating stations all had positive effects on employment. It would be safer to say that, other things being equal, in-province job opportunities would be 310 higher with a profitable Westray operation.

These huge economic costs of the mine disaster at Westray should cast a new light on the whole question of underground mine safety. As Kevin Burkett stated in his report, *Towards Safe Production:*

> Apart from the moral, social and legal reasons which underpin a strong commitment to safe performance, the direct financial costs associated with poor safety performance surely serve as an incentive to the chief executive officer of any organization to require safe production. Beyond the direct costs of compensation, the company is burdened with the indirect costs associated with lost time, post-accident production losses, accident investigation, damage to property, etc. . . . We believe that it is essential that accident costs be computed in order to underscore the financial implications and thereby to serve as a further incentive to improved safety performance.[212]

Burkett went on to cite a study by the U.S. Bureau of Mines showing that the total cost of 9,286 underground coal mine accidents in 1974 was $56.9 million. In 1997 dollars, this figure could represent a cost in excess of $200 million, or more than US$21,000 each. In 1993, J.C.H. Longden told a mine safety conference that mining accidents in the United Kingdom cost the employer £11,600 (or approximately C$25,000) for each lost-time accident.[213] These are mine accidents that involve an injury of sufficient gravity to cause the miner to miss some time, and do not relate to circumstances in which a miner or some miners are killed.

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212 Joint Federal-Provincial Inquiry Commission into Safety in Mines and Mining Plants in Ontario, *Towards Safe Production*. (Toronto, 1981) (Chair Kevin M. Burkett).

213 J.C.H. Longden, "The Management of Health and Safety at the Workplace" (paper presented at Minesafe International Conference, Perth, Australia, 1993).

I hope that the figures presented in this section will cast a different light on the question of underground mine safety. They must be viewed in the context of the total coal mining environment, both economic and social, rather than in isolation. Only then can we realistically move towards the goal so aptly expressed by Burkett as "safe mine production."

3 Organization and Management at Westray

Although the development of the Westray project has been set out in detail in Chapter 2 of this Report, a brief chronology should help to set the scene for the commentary that follows on the organization and management of Westray.

To inquire into . . .

(c) whether any neglect caused or contributed to the occurrence;

(g) all other matters related to the establishment and operation of the Mine which the Commissioner considers relevant to the occurrence

Chronology of Underground Development

For the underground workers, the Westray story began early in 1989 with the driving of the main access roads. The Department of Natural Resources had processed and approved Curragh's application for the mine permit. In January 1989, the first compliance issue surfaced as the department discovered that the tunnel alignment had been changed from the approved layout.

Site preparation was completed early in 1989, however, and the official start of underground development was later commemorated in a ground-breaking ceremony on 10 April 1989.

The development of the tunnels was subcontracted to Canadian Mining Development (CMD), with some project supervision by Kilborn Limited. Westray management was already on site. The company had committed to supply coal to the new Trenton power plant, scheduled for completion in 1991. Both companies hired a few local workers, but many of the 34 development workers came from CMD hard-rock mining crews. The workers understood that CMD was going to provide them with employment driving the main tunnels to the limits of the planned workings. Westray would later take on the development of coal-producing sections off the mains.

The maps reproduced in Reference illustrate various aspects of the underground development. Map 1, The Westray Mine, Post-Explosion, depicts the basic structure of the mine, and map 2, Development Chronology, shows the progress made from 1989 to May 1992. By the end of May 1989, No. 1 Main had advanced 75 m to a point ahead of the first cross-cut between the two tunnels; No. 2 Main had advanced 30 m. The rate of advance declined as the first section of the main conveyor system was installed in No. 2 Main. The main ventilation system was developed, the fans being installed at the No. 2 Main portal.

Meanwhile, several provincial government departments were engaged in continuing negotiations with Curragh, negotiations that were proving both long and inconclusive. The Department of the Environment became concerned about suspended solids in the settlement pond and the possibility of damage around the proposed rail spur across the East River to the new power plant. The Department of Labour was concerned about training and certification, equipment approvals, plans for emergencies, and

delays in setting up a workplace safety committee. The Department of Natural Resources was concerned about the possibility that the new tunnel alignment would intersect major geological faults at oblique angles, resulting in extensive zones of main tunnel development through bad ground. Roof conditions in the earliest days of tunnel development gave credence to that concern. By mid-July 1989, the two tunnels had encountered ground problems, which CMD anticipated would persist for the duration of the driveage. There were three zones of bad ground where steel arches had to be used in addition to roof bolts, straps, and screen. CMD began to spray a shotcrete shell after blasting, followed by roof bolting and more shotcrete. (Westray would later discontinue the practice of shotcreting.) The roof above the first intersection collapsed in July, resulting in construction of an unconventional concrete pillar to support the roof.

In late July 1989, when the funding for the project had not been finalized, development was suspended. Only a skeleton maintenance and security crew was left on site. On 18 October, there were 42 employees, with nine men working underground on each of three 8-hour shifts per day. In February 1990, the mine inspector noted two underground workers carrying out maintenance. The mine manager told the inspector that construction was slated to restart around the middle of April. By May 1990, blasting had resumed and both tunnels were advanced to 270 m, but only one shift per day was working at the site.

Construction resumed fully in the fall of 1990 when the federal government guaranteed financing for the project, less than a year before the mine was contracted to begin shipping coal to the new Trenton power plant. By December, the mains were passing through thin bands of coal. That same month, the mine inspector issued the first of the Department of Labour's four orders to Westray, requiring that a certified mine examiner test for methane to reduce the risk of working and blasting in the presence of the gas. By February 1991, No. 1 Main had advanced 730 m.

Roof conditions emerged as a major concern early in 1991. Senior staff from the mine inspectorate came to look at the roof in mid-February, and the company hired an engineering consulting firm to monitor conditions. Westray took over tunnel development from CMD in early April 1991, stopped blasting, and began using mining machines to drive the mains. The company also stopped reinforcing the tunnels with shotcrete. A decision was also made to scrap the original mine layout and change direction to tap into the coal seam sooner, despite concerns that this would have a negative impact on both roof conditions and coal quality.

CMD workers had expected CMD to finish the tunnel work. Some were able to transfer to jobs with Westray, which needed experienced miners to meet project deadlines under challenging mining conditions. Efforts were made to recruit experienced miners from other room-and-pillar coal mining operations. Local workers were applying for what was described as long-term employment at good wages, and more workers

were hired every month. Underground workers were organized into four crews working 12-hour shifts, four days on, four days off.

Although the engineering consultants and the mine inspector reported in April 1991 that roof conditions were improving, a large section of No. 2 Main collapsed during the night shift on 23 May 1991, narrowly missing several miners. Some miners spotted signs of movement in the roof before the fall and retreated from the area in defiance of a supervisor's orders. This incident led to a confrontation between miners and the manager, who angrily dismissed the miners' concerns and implicity threatened their jobs. Shortly thereafter, the incident was cited in the Legislative Assembly by members of the opposition.

Both mains were advanced more than 1,200 m by 28 June 1991. The coal preparation plant was commissioned early in August 1991. Underground development was well into the Foord seam coal, and No. 10 Cross-cut was completed. On 13 August, however, there was another major roof collapse.

Other aspects of development were also not going well. The company had decided to make a turn into an area of coal in the direction of the old Allan workings, a change that took development into the Southwest section of the mine. Development also continued down into the North mains, splitting the mine into two distinct sections, each with its own crews and supervisors. Workers without adequate coal mining experience were promoted to newly created supervisory positions. No workers were trained in safe work methods or in recognizing dangerous roof conditions.

By the end of August, crews had advanced 120 m into the Southwest. The two mains had been advanced 1,430 m each. The growth and splitting of the mine into sections meant that there were not enough experienced coal miners to ensure that each working group included at least one experienced miner. It also meant that routines for basic safety measures, such as stonedusting, were being ignored or performed inadequately. Despite the vital importance of stonedusting to safety, the company's solution to the problem of coal dust accumulation was to ask for volunteers to work overtime stonedusting between shifts.

The inspectorate's ineffectual attempts to have the company plan and implement a proper stonedusting program continued sporadically throughout the short life of the mine. Other violations of regulations or poor mining practice were noted by the inspectors. The electrical inspector, for example, noticed an injured worker on light duty with bandaged hands, and had to issue an official order before the company gave an account of the electrical accident that had burned the worker's hands. The company was slow to report roof falls and was frequently reminded of reporting requirements.

The official grand opening of the mine was held on 11 September 1991. The mine was cleaned and stonedusted for the occasion. More than a thousand people toured the site on the weekend after the ceremony.

Four more roof falls were reported in September and October. The mine manager minimized the seriousness of roof problems, claiming that

the falls were controlled and that they posed little threat either to the miners or to production. Realistic accounts of the miners' experiences, however, revealed a series of near misses and increasing danger. The company's engineering consultants noted that the shotcreted portion of the mains was showing signs of deterioration. They recommended a study to pinpoint causes and plan solutions. The inspectorate also warned the company that a roof support plan was needed to decrease risks to the workers.

There were approximately 160 employees at the site by October, most of whom were working shifts underground. Major and minor roof falls had occurred throughout the mine. Management dismissed the concerns of workers who left jobs at the mine, claiming that those workers were hard-rock miners who could not adjust to the different environment of a coal mine. Production seemed to be the imperative at Westray, even at the expense of safety.

Union organizers had not garnered much support from the transient CMD workers. With the increase in experienced miners at the mine, however, or because of the poor working conditions, organizers began to find growing support for a union. The first drive to unionize the workforce at Westray was officially started on 2 October 1991 by local 26 of the United Mine Workers of America.[1] The union had to apply for certification by January 1992. Miners voiced their concerns about working conditions at a number of organizing meetings throughout the fall. The required number of workers signed union cards and a vote on union status was held in January, but the union was defeated by 20 votes. Organizers attributed the loss to the inclusion of surface workers in the bargaining unit and to other workers who did not appreciate the worsening conditions underground. Other factors may have influenced the vote, including company anti-union tactics and traces of a local historical bias against the United Mine Workers of America. In the spring of 1992, the United Steel Workers of America began a certification drive at Westray. This union had strong representation in the hard-rock mining industry in Ontario and had also organized the Curragh operations in Yukon. This drive was a success, albeit a somewhat hollow one since certification was not granted by the Nova Scotia Labour Relations Board until after the 9 May explosion.

Between 29 September and 12 October 1991, there were three major rock falls even though the roof in those areas had already been supported with bolts or arches. The miners were getting increasingly worried about the roof, and the mine inspector asked his department to engage an independent expert to assess conditions and evaluate the company's response. Instead, the Department of Labour borrowed an engineer from the Department of Natural Resources to sit in on meetings of the company and review the consultants' reports.

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[1] This is the same local that had represented the miners at Devco and its predecessor DOSCO in Cape Breton. The principal UMWA organizer for the Westray workers, Bob Burchell, was from the Glace Bay office.

By November, despite numerous undertakings by management, the company had not provided roof support and monitoring plans to the inspectorate. The mine inspector wrote another order requiring that roof support plans be produced by mid-month, but the company simply did not accept the registered letter containing the order and was able to put off supplying the plans until the end of the month. A plan for stonedusting was deferred again and again, and even the inspectorate seemed confused about what was being sought.[2]

In late November 1991, Curragh let it be known that Westray was available and on the market for sale. The company alleged that the production problems were of a temporary nature, but there is no record of any serious interest by potential buyers at the time.

The northern part of the Southwest section was plagued with roof problems. Senior officials from Curragh took an active role in working out alternative mine plans. A task force was struck to deal with ground conditions, and various consultants recommended a variety of solutions. The company hired a geologist from the potash mining industry who worked out terms for investigating and reporting roof falls.[3] At informal sessions, the engineers explained their roof support and ground control plans to the underground workers.

In December, Westray was at odds with the Department of Natural Resources. The decision to drive into the Southwest section was proving a mistake. Both the levels of production and the quality of the coal were less then anticipated, and roof conditions were hazardous. Natural Resources staff expressed concern about proximity to the old Allan mine workings, a greater risk of subsidence, and deviations from the approved mine plan. (Map 10, Approved Mine Layouts, in Reference shows the location of the Allan mine.) Yet the department, having suggested that non-compliance could threaten the company's mining permit, retreated by the end of the month. Skeletal new plans were approved, and the department worked to help the company develop a surface mining operation to help meet its coal supply obligations. Federal and provincial money and expertise met most of the costs of technical studies for monitoring roof conditions and subsidence.

Despite the decision in the summer of 1991 to turn into the Southwest district to reach minable coal sooner than originally planned, coal production remained behind schedule. The wait for funding guarantees and the persistent roof problems in both sections of the mine only exacerbated the problem. The company was not able to meet its 1991 commitments to supply coal.

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2 See the section on the actions of mine inspectors in Chapter 9, Dust, for commentary on director of mine safety Claude White's confusing testimony about stonedusting and coal-dust sampling.

3 There was general agreement among Inquiry experts that potash mining presents an entirely different array of ground control problems than does coal mining, the conclusion being that expertise in potash is not entirely applicable to underground coal.

Meanwhile, members of the underground workforce at Westray were bringing their concerns both to management and to the inspectorate. At the urging of the Department of Labour, the company had recruited representatives from the crews to serve on a workplace safety committee. On 27 January 1992, three members of the committee met with inspector Albert McLean to discuss the miners' safety concerns. Individual miners also expressed concerns to the inspector; one even called him at home in Cape Breton to try to get something done about safety problems at Westray. Nothing changed.

By early February, development in the Southwest had moved into what would became the Southwest 1 section. Coal from a nearby open-pit mine helped the company nearly double coal production for February and March 1992. Production from Southwest 1 in February and March was initially promising, but the mining methods proved to be extremely risky. The workers were offered incentives under a production bonus scheme, but were only able to make bonus quotas for one month. Miners frequently experienced physical symptoms resulting from the presence of high concentrations of methane.

By the end of March, roof collapses forced the company out of Southwest 1. Men were put at risk to pull out the equipment, and the abandoned area, although still producing methane, was left unsealed as the company turned its attention elsewhere in the Southwest section. Supervisors heard that the company planned to delay construction of adequate stoppings at the entries to the abandoned Southwest 1 until stoppings could be placed to seal off the entire Southwest section. Gas readings in the abandoned section showed very high levels of methane. The mine inspector himself recorded up to 4 per cent methane coming out of the abandoned area – the *Coal Mines Regulation Act* requires workers to be removed from areas where methane exceeds 2.5 per cent – but he allowed the company to determine how to deal with it.

The North mains were also experiencing problems. Major faulting occurred inbye No. 10 Cross-cut. The entire intersection of No. 2 Main and 3 North Main had a major fall early in February, followed by a fall at the intersection of 2 North Main and North 4 Cross-cut, and then by another major fall at 3 North Main and North 3 Cross-cut on 10 March. Falls continued in April 1992.

The steep grades of the roadways created additional problems The floors of the roadways generally consisted of coal, and vehicles driving and spinning their wheels on the grades produced coal dust. Left untreated, this additional dust added to the danger of a coal-dust fire or explosion.

In April, the company sought approval to continue taking coal from the surface mine, at a rate of 200,000 tonnes per year. The underground mine was not producing enough to meet contract commitments with the power corporation. There was pressure on the company, its workers, and management. Curragh sent a corporate executive, Colin Benner, to take charge of the project. The mine planning task force was reorganized

to study ground control problems in a systematic and orderly manner. Changes were planned not only in management staff but in management style as well.

On-site conditions were in fact worse than they appeared in reports and in financial projections. Roof falls continued to delay operations, and they posed risks to the underground miners. Methane was being released into the workplace and was layering at the roof. Unsafe mining practices, such as the unapproved use of non-flameproof vehicles, presented potential sources of ignition. The poorly planned ventilation system could not deal with the accumulations of gas. The planning and operation of both the main and the auxiliary ventilation was substandard, increasing the danger. Coal dust was allowed to accumulate untreated.

Near the end of April, mine manager Gerald Phillips and miner Eugene Johnson, whose name had been drawn by lot, travelled to Montreal with their spouses to accept the 1991 John T. Ryan trophy, an award given annually by the Canadian Institute of Mining, Metallurgy, and Petroleum to Canadian mines with the best safety record.[4] Selection for the Ryan trophy was based on company records of lost time, supported by the recommendation of the chief inspector – in this case, Claude White.

On the morning of 29 April, three inspectors arrived on site to inspect the Westray mine. As a result of that inspection, orders were issued requiring that the coal dust in the mine be immediately cleaned up or rendered inert with stonedust, as required by law. The company was also given until 15 May to file the stonedusting and dust sampling programs promised since the previous year. There was no follow-up on the orders, even though inspector McLean was back at Westray within the week. Ten days later, the mine blew up.

Organization and Management

Westray's management hierarchy began in the offices of Curragh Resources Inc. in Toronto:

- Clifford Frame, president and chief executive officer, unquestionably called the shots for all Curragh undertakings; and
- Marvin Pelley, executive vice-president, corporate development and coal, was president of Westray Coal.

At the mine site in Plymouth, Nova Scotia, were:

- Gerald Phillips, vice-president and general manager;
- Roger Parry, underground manager;
- supervisors; and
- mine workers.

[4] The award was presented at a dinner on 28 April 1992.

The Underground Workers

The term "underground workers" includes the underground mechanics and electricians as well as the production workers. The underground production workers were organized into four shifts labelled A, B, C, and D. Each group worked 12-hour shifts in sets of four days on and four days off, alternating between day shifts starting at 8 AM and night shifts starting at 8 PM. After mine development branched into different sections, the shifts were divided into crews that were regularly assigned to particular sections, either Southwest or North mains. Each section crew was headed by a supervisor referred to variously throughout the evidence as a first-line supervisor, foreman, shifter, shift boss, or fire boss. For consistency and clarity we refer to all these designations simply as "foreman." An extension from the North mains eventually became another designated working section, the Southeast (see the area on the far right of map 3 in Reference), which had its own foreman on some shifts and shared one with the North mains on others. The crews were subdivided into working groups of three, assigned to a particular task or piece of equipment. Each shift also had workers assigned to deliver materials and supplies throughout the mine. The conveyor maintenance and roof support crews, nominally the training groups, worked five 8-hour day shifts per week in small groups under the direction of leadhands.[5]

Mechanics and electricians were assigned to 12-hour shifts with a specific crew, alternating with periods of day shifts at the maintenance shop. The tradesmen had their own foremen, senior foremen, and maintenance superintendent. They were also subject to direction by production supervisors, especially when they were on 12-hour shifts with production crews. Statutory requirements for the appointment of a chief electrician under section 85(2), rule 6, of the Nova Scotia *Coal Mines Regulation Act* were not met prior to the explosion. The electrical engineer-in-training, who was responsible among other tasks for the underground environmental monitoring system, was supervised by the general electrical foreman and the maintenance superintendent.

Tradesmen were required to file written reports each shift, covering both their activities and the condition of equipment. The written record did not accurately reflect conditions or activities, as tradesmen had learned not to put safety concerns in writing. Repeated reports of problems either went unanswered or the tradesmen faced unpleasant consequences for recording safety concerns. Electrician Mick Franks described the futility of reporting concerns such as burning cables or malfunctioning communications lines in the underground environmental monitoring system:

Q. And what was the point of completing the belt run report and outlining the state of the problems?

A. There didn't seem to be too much of a point to it because I brought up maybe three or four different safety infractions that I thought should be

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[5] Because much of the information that follows is dealt with in detail throughout the Report, only testimony and evidence not cited elsewhere will be referenced in this chapter.

> repaired, and after maybe seven or eight times putting it down on the sheets . . . you just give up. All I need to do is check off that everything is good and let it go. Just a piece of paper, basically.[6]

Mechanic Wayne Cheverie explained omissions in his 8 May shift report:

> Q. Now I don't see anywhere on here, Mr. Cheverie, where you've noted that the continuous miner was operating without a methanometer.
>
> A. I believe I stated before that writing things about safety on reports would only bring undue hardships to you . . . I always reported things to my first line or second line supervisor, but I made a rule not to write safety concerns on my report.[7]

Westray's Operation and Maintenance Employee Handbook outlined the responsibilities of workers in regard to occupational health and safety:

> It is the personal responsibility of each employee to ensure:
>
> - that safe and productive work procedures are known and practised;
> - that all accident prevention measures, directives and regulations are strictly adhered to; and
> - that support and assistance be given to the Health and Safety Program to ensure that the goal of a safe and productive operation can be achieved.[8]

The handbook further instructed the workers to use all required protective clothing and gear, and to correct or report any unsafe conditions or practices to their supervisor as soon as it was practical.[9]

The Foremen

Section 38 of the *Coal Mines Regulation Act* requires that the manager of a coal mine appoint a sufficient number of persons certified as competent mine examiners "*whose sole duty it shall be* to make such inspections and carry out such other duties as to the presence of gas, coal dust, ventilation, state of roof and sides, as are required by this Act and by any special rules" [emphasis added]. The examiners are expected to play an important role in ensuring the safety of mine workers by:

- examining all working faces within 4 hours before the start of a shift;
- reporting on conditions to the mine workers and management;
- placing "danger-boards" to warn of any dangerous condition (workers are not to work in areas so marked until the dangers are removed and the place reported safe);
- checking for noxious gases with an approved gas tester, assessing the adequacy of ventilation, and noting readings of the barometer, the thermometer, and the water gauge before miners go into the mine; and
- keeping daily written "true and correct" records of observations made in the area of the mine that is in their charge.

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6 Hearing transcript, vol. 21, pp. 4115–16.

7 Hearing transcript, vol. 21, pp. 4026–27.

8 Exhibit 119.156 These responsibilities are generally consistent with the duties of an employee while at work, as described in section 12 of the *Occupational Health and Safety Act*, RSNS 1989, and c. 320.

9 Exhibit 119.192.

Westray chose to combine the role of mine examiner with the role of first-line production supervisor. The foremen were charged with ensuring that each crew met the production goals set by management. The Westray employee handbook set out each supervisor's personal responsibility to ensure:

- that employees have received adequate training in work procedures so maximum productivity can be achieved within a safe work environment;
- that employees follow safe work procedures and related accident prevention directives; and
- that all accident-prevention directives and regulations are consistently enforced.[10]

All the witnesses who had acted as mine examiners at Westray saw a conflict between their statutory responsibilities and their assignments as production supervisors, despite the handbook's reference to safety standards. Fraser Agnew stated:

> It was a conflict; that's for sure. You're looking at trying to keep your men safe. That . . . it should have been your first priority, to try to keep your guys safe. And then you got guys upstairs that's pushing you, trying to get more production. And for me to get more production, it would be for me to put my men in greater risk than what they was already in. And I don't think I've ever asked anybody or any of my guys to do anything that I wouldn't have done myself.[11]

The foremen who had worked in other coal mines found it unusual that the mine examiner and the production supervisor roles were combined at Westray. Bryce Capstick, qualified as a mine examiner even though he had no coal mining production experience, had expected from his examiner training that he would exercise some control and would be expected to rectify unsafe conditions:

> Well, I understood a person would have control over their section. They would be able to make decisions, you know, as to how to keep your section in good working order. But you had no control. You had to do exactly what they said. If you didn't, you would be replaced.[12]

Agnew thought he had been appointed to the mine examiner role only to satisfy provincial regulations, "because I was never called to any of the supervisory . . . or production meetings . . . to me, I was one of the workers. . . . I went down my shift just like the rest of the men. I had no contact, other than in deployment when Roger [Parry] would come down and tell me what was supposed to be up.[13]

The foremen were given production plans on the first of each set of four shifts, or sometimes more often as management changed immediate objectives. They were also given oral instructions by the underground manager and the overmen. Workers were assigned to tasks or equipment

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10 Exhibit 119.155.

11 Hearing transcript, vol. 37, pp. 8057–58.

12 Hearing transcript, vol. 42, p. 9299.

13 Hearing transcript, vol. 42, pp. 8014–15.

by the underground manager. Shift foremen had no discretion to reassign workers to address safety problems – stonedusting or removing coal dust or installing additional roof support. Only the underground manager could shut down a working face.[14] Even temporary withdrawals from hazards such as high methane concentrations could prompt criticism from management if production goals were not met.

There were no negative repercussions for failure to maintain or improve safety in the mine. There was no barometer, thermometer, or water gauge to check before entering the mine, no methanometer extension probe for gas checks at roof height. Some examiners were told not to include high gas readings in shift reports. A number of examiners told the Inquiry that it was pointless to write up safety hazards.

Mine examiners are supposed to play a key part in the statutory scheme for mine safety. Monitoring ventilation is a major part of their duties. Clearly, most of the foremen tried to do their jobs to the best of their knowledge and abilities, but they were hampered by insufficient experience, training, and technical support – and by management.

The Overmen

Section 25 of the *Coal Mines Regulation Act* requires that underground workings be under the charge of a properly certified mine official. Although the mine manager and underground manager at Westray were somewhere on site much of the time, they could not be present at all times. An additional tier of mine officials, overmen, was eventually added, as is generally required in larger operations.

Until the development of the Southwest section, the Westray mine was a fairly straightforward operation. Once the crews were expanded and split into different sections, however, three of the original foremen were promoted to overman positions, and some of the miners were moved to shift supervisor jobs. One of the new overmen, Glyn Jones, became the assistant underground superintendent, working 12-hour day shifts Friday through Monday, while the underground manager, Roger Parry, worked day shifts Monday through Friday. The underground manager and his assistant shared the job of company representative on the safety committee. The other two new overmen alternated four-day sets supervising the mine on permanent 12-hour night shifts.

Section 37 of the *Coal Mines Regulations Act* sets out the qualifications, duties, and the responsibilities of the overman, who is required:

- to attend personally to duties in the mine, to carry an approved gas tester, and to see that the act is enforced in its entirety;

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14 When engineer-in-training Trevor Eagles was asked by Inquiry counsel if he clearly understood that management personnel or underground supervisors believed that they had to go to Roger Parry before they could decide to shut down, Eagles replied: "I believe so, yes. That includes mine examiners and people from the engineering department" (Hearing transcript, vol. 76, p. 16602).

- to carry out all management instructions and to report all violations to the underground manager, subject to the requirement to enforce the act;
- to perform the underground manager's duties in his absence;
- to visit and inspect daily the workings in his charge, with daily written reports;
- to examine the ventilation system to ensure that the air supply is adequate and that all stoppings, regulators, doors, and air crossings are in good condition;
- to be familiar with the mine plans and draw the attention of the manager to any errors or omissions; and
- to withdraw workers immediately from any unsafe area and remedy defects if possible.

Overman Jay Dooley testified that the Westray second-line supervisors did not have company authority to exercise their statutory duties. He had been instructed not to make the daily written report required by statute. He could correct short-term safety hazards, but was not permitted to interfere with production to deal with coal-dust accumulations or inadequate stonedusting. The underground manager gave detailed instructions to the overmen and foremen, and also gave assignments directly to the underground workers. No one ranked lower than the assistant underground superintendent could attend production meetings. This hierarchical system surprised miners accustomed to a more consultative approach to mine planning and operations. According to Dooley, when he spoke to Parry about Westray practices compared with those of other mines, Parry bluntly told him, "'You work for us and . . . that's not our method and we do not do it like that. You do it like I say or you won't be here.'"[15]

Finding

The foremen and overmen at Westray had little or no opportunity to perform their duties as set out in the *Coal Mines Regulation Act.* They had little or no say in the day-to-day operation of the mine and were expected only to carry out the orders of Westray mine manager Gerald Phillips as delivered to them by him personally or through his underground manager, Roger Parry.

Miners and their supervisors reported safety concerns up the chain of command as well as directly to the managers. Jay Dooley had expected to act as a link between workers and managers, but said he was frustrated by the lack of any meaningful response when he reported workers' concerns. Rather than remedies for unsafe conditions provided by management, he found only bad examples, instructions that neglected safety concerns, and directions to hide matters from the inspectors. The supervisors received the same message as the miners: anyone caught making complaints outside the mine would be fired. There were confrontations between

15. Hearing transcript, vol. 38, p. 8420.

supervisors and more senior management, described by Dooley as "screeching matches," when supervisors questioned unsafe practices.[16] The options for supervisors were to accept the company's approach, to work towards fulfilling their statutory duties as best they could, or to quit.

It is clear that senior on-site management – Phillips, Parry, Jones, and the maintenance superintendent, Bob Parry – made all the decisions at Westray. Referred to by some as "the four horsemen," they ran the mine. Foreman Don Dooley said:

> [T]hese four . . . they ran the mine. Now, no doubt, they probably had some input from David Waugh and other engineers, but these were the four that the working men would deal with, myself included . . . supervisor/mine examiner, whichever you want to call me. These were the people that all direction came from.
>
> They would never seek your input on a decision before, during or after it was being made or implemented. If they made a decision to turn a road somewhere, you . . . found out about it eight o'clock that morning when you went to work. I mean, you were not consulted, period.[17]

Finding

Management at Westray was closed, and four of the senior staff – Gerald Phillips, Roger Parry, Glyn Jones, and Bob Parry – ran the mine with little or no input from others. Input was not sought, and when offered was usually disdainfully rejected. It is probable that Phillips, as vice-president and general manager, would be the most influential of the four.

The Underground Manager

Section 33 of the *Coal Mines Regulation Act* requires an underground manager to ensure that the act is enforced and that deviations are dealt with as the law directs. Section 36(3) states that the underground manager "shall, at all times, exercise every possible precaution to protect the lives and property entrusted to his care, and insist upon all rules and regulations being strictly adhered to." According to section 35 of the act, the duties of the underground manager include:

- ensuring that the roof support method set by the manager is carried out and that the ground is secured properly in all working places;
- arranging for necessary supplies for ground support and ventilation work;
- seeing that all working places are kept in a safe and orderly manner;
- seeing to the regular inspection of the condition of airways, escape ways, and stoppings, the examination of gobs and unfenced old workings, the placement of stoppings on the lower side of openings, and the construction of self-closing doors in stoppings;
- ensuring that inspections are done by competent persons, and that records of conditions and any unusual occurrences are kept;

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16 Hearing transcript, vol 38, p. 8487.

17 Hearing transcript, vol. 37, p. 8125.

- reading and initialling daily reports of overmen and examiners;
- ensuring that conditions are reported to the manager daily, and that unusual occurrences are reported promptly;
- making sure that all requisite safety notices are properly posted, and that all required caution signs and "danger-boards" are placed where necessary;
- weekly recording of anemometer readings and daily acquaintance with readings of barometer, thermometer, and water gauge;
- daily consultation with overmen;
- keeping personal acquaintance with all airways, working places, and ventilation;
- carrying an approved gas tester underground; and
- assuming the duties and responsibilities of the manager in the manager's absence.

The Nova Scotia *Occupational Health and Safety Act* places further responsibilities on employers. These responsibilities became part of Roger Parry's job at Westray, with duties to consult and cooperate with the safety committee and to take every reasonable precaution to ensure the health and safety of those in the mine. The Westray employee handbook set out the responsibilities of each member of management:

- that safe and productive work procedures are developed and followed;
- that the necessary education and training are provided to equip all employees to encourage a zero accident rate while reducing possible threats to good health and safety;
- that buildings, structures, equipment, and surface/underground work areas are developed and maintained to a high standard; and
- that a high standard of housekeeping is established and maintained.[18]

Parry was usually present at both shift changes, staying after the evening shift change to talk with the night overman, and returning by 7 AM to be briefed on what had happened overnight. He was in the mine on night shifts for events such as conveyor moves, and he consulted by telephone or returned to the mine for any night-shift emergencies. Trevor Eagles, the engineer-in-training who made ventilation measurements and observations, reported to him, and Parry generally made decisions about auxiliary ventilation as well as other aspects of underground operations. Capstick described Parry's behaviour: "You didn't know when he was going to be there. That man would appear any hour of the day and night. He just materialized . . . no matter where you were in the mine, all of a sudden Roger Parry would be there. . . . He kept control that way."[19]

The volatile manner with which Parry related to workers, his colleagues, and the regulators is dealt with at length elsewhere in this Report. Deficiencies in his ability and competence were subject to much testimony at the Inquiry. Witnesses generally said that the job was beyond

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18 Exhibit 119.155.

19 Hearing transcript, vol. 42, pp. 9335–36.

his ability, but some showed sympathy for his position. As former Westray surveyor Ray Savidge said:

> Well, he is a pretty tough individual. He was very hard on the men. But in some respects I felt sorry for him because he had what I considered an impossible task which was possibly the reason why he was in such a foul mood and, really, he didn't get a great deal of help. And he spent a horrendous amount of time in that mine. I'm not trying to make excuses for anybody.
>
> But there is more to it than meets the eye. . . . how could he get any help because you had an office full of people with no previous coal mining experience?[20]

The physical challenges underground, the various pressures, the mine manager's growing preoccupation with other business matters, the self-imposed limits on delegation of authority and consultation, the limited coal mining experience or qualifications of the technical people – factors such as these made Parry's job extremely onerous and stressful.

The Mine Manager

The mine manager carries the heaviest responsibility for mine conditions and operations under the *Coal Mines Regulation Act.* The manager has charge and control of the mine, with personal responsibility for its supervision. The manager must "at all times, to the best of his power, knowledge and ability, enforce observance" of the act and all of its rules and regulations. He must appoint qualified persons as the mine officials required by law and must also appoint "as many competent persons as may be necessary" to carry out the act. He must maintain a detailed mine plan and make mandatory reports to the inspectorate.[21]

The manager appointed under the act must hold a certificate of competency. In Nova Scotia, the manager is not required to be a professional engineer. In the United Kingdom, in contrast, where Gerald Phillips began his coal mining career, a mine manager must hold a first-class certificate of competency; even to sit for the examination, candidates must have mine management and engineering qualifications – a degree in mining and a higher national diploma from a recognized mining institution – and have the required number of years of work experience in a position of authority in a coal mine.

In Nova Scotia, the mine manager must carry out statutory duties set for the employer under the *Occupational Health and Safety Act*, and "take every precaution that is reasonable":

- to ensure the health and safety of persons at or near the workplace;
- to provide and maintain equipment properly furnished with safety devices;
- to supply such information, instruction, training, supervision, and facilities as are necessary to the health or safety of the employees;

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20 Hearing transcript, vol. 22, pp. 4352–53.

21 Sections 21–32.

- to conduct his undertaking so that employees are not exposed to hazards;
- to consult and cooperate with the joint occupational health and safety committee and with any person performing a duty or exercising a power conferred by the *Occupational Health and Safety Act;* and
- to comply with, and ensure that employees at the workplace also comply with, the *Occupational Health and Safety Act.*"[22]

Modern safety programs emphasize the critical role of management, not just in establishing and enforcing safe practices but also in leading by example. The manager carries the duty to set a good example, as well as the other responsibilities for workplace safety set by statute and by company policy.

At Westray, all lines of authority through engineering, operations, maintenance, surface plant, and general administration led to the mine manager. Senior Curragh officials played some role in operations – in hiring middle management and consultants, in mine planning, and in making applications for regulatory approvals – but Phillips managed on site.

The autonomy exercised by Westray's manager was appropriate for the development stage of a project, but the skills necessary to promote and develop a project are not the same as those required to manage an ongoing concern. According to Benner, as a project moves from new project status to be a regular operation, it needs a more orderly structure, as well as routine, team play, and delegation of both authority and responsibility.[23] A manager must keep informed and be in charge, but one person cannot retain direct control of everything. Safe production is enhanced by separating functions and by balancing authority. This equilibrium had not been achieved at Westray.

Phillips played multiple roles instead of establishing the usual pattern for mine administration and technical support. He was the safety officer of record in the John T. Ryan trophy application. He acted as ventilation engineer, as senior mine planner, and as senior production manager. He had a hand in personnel work, from new employee orientation to mediating differences between miners and Roger Parry. He responded to the union drive, and he dealt with government and community relations, communications with regulators, and the media contacts. He did marketing and contract negotiations, and promoted the open-pit project.

Phillips ran underground operations, both through the underground manager, and in person. He sometimes took part in underground operations, not just directing the crews but also working on conveyor moves with the miners or going up in the bucket of a Scooptram to help with roof support. Tradesmen who tried to take a lunch break during a conveyor move were quickly and crudely sent back to work. When Savidge refused to mark cutting lines for development without an approved development plan for the layout, Phillips went underground and

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[22] Sections 9(1) – 9(2).

[23] Hearing transcript, vol. 73, p. 15907.

painted the lines himself.[24] The manager involved himself in every aspect of the operation, at every level.

There was little consultation with workers or supervisors. Production supervisors were chastised for criticizing, or for urging correction of, unsafe mining practice where that would interfere with management directives. Information and advice in conflict with management opinions or directives were poorly received, and staff might be berated when things did not work out as the manager expected.[25] Fiery arguments with mine inspectors sometimes arose when the manager disagreed with them. The inspectors were not immune to verbal abuse from Phillips.

Control was tightly centralized. Staff in different departments got information about each other's work through the manager, including production projections that were more optimistic than accurate. Phillips was the conduit for information that was permitted to flow to the parent company. He even reprimanded his own staff for speaking about their work with Phillips's own boss, Marvin Pelley.[26] Professional and technical staff were not permitted to correspond directly with regulators, only through Phillips. Control at times seemed obsessive.

Phillips played a central role in bringing the Westray project into existence; he had been working for Suncor when Curragh took over the project. He was under pressure to produce a successful coal mine, despite the geological challenges. He had to meet coal supply contractual commitments, develop an open-pit mine, and generate a profit for Curragh.

Qualifications – The Westray Managers

There was much comment, both at the Inquiry hearings and in the media, about the background and qualifications of the manager and the underground manager at Westray. Some relevant evidence came out during the aborted criminal proceedings.

According to British coal mining expert and Inquiry witness Andrew Liney, mine manager Gerald Phillips had neither an engineering degree nor a higher national diploma. He held a higher national certificate, which, Liney assumed, was roughly equivalent to a fire boss (first-line supervisor or foreman in Canada).[27] This information was confirmed to the Inquiry by the British Coal Corporation: "We have confirmed through this Government Office that Gerald James Phillips of Telford, Shropshire, was

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24 Hearing transcript, vol. 22, pp. 4346–47.

25 In one example, Ray Savidge recalled the manager's oral abuse of mine geologist Arden Thompson when the coal seam dipped steeply where Phillips had expected it to be level. Phillips would not accept that the dip had been obvious from the beginning to anyone able to work it out from the geological drawings (Hearing transcript, vol. 22, pp. 4383–84).

26 Thompson had been in a meeting with Phillips and Pelley about the mine geology. Phillips later made it clear to Thompson that he wasn't to tell "them" anything (Hearing transcript, vol. 40, pp. 8838–40).

27 Hearing transcript, vol. 19, pp. 3594–95.

authorized as a deputy and shotfirer in 1974, which was after he left employment with the National Coal Board."[28]

In his own resume, Phillips makes the following anomalous entry under the education heading: "North Staff Poly-tech. Mining Engineer." At page 5 of the resume, he indicated that he joined the National Coal Board in 1965 (he was 15 years old in 1965) and served for ten years successively as a "Miner, Shot Firer Deputy, Overman, Assistant to Underground Manager."[29]

Phillips did receive certification as underground manager in Alberta after successfully completing examinations in 1978. There is no record of his receiving any higher academic or technical designation before coming to Nova Scotia. In his resume, he describes positions held variously as chief mine engineer (1987–88), chief mine engineer – mine development (1985–87), and mine manager/project manager (1980–85). In this same resume, Phillips lists responsibility for "safety" in four of the positions he held.

On the strength of his Alberta certification, Phillips was able to satisfy Nova Scotia competency requirements as a mine manager by successfully completing one examination dealing with Nova Scotia coal mine legislation and regulations.

Roger Parry became authorized as a deputy and shotfirer while still in the employ of the National Coal Board.[30] Although he did not receive this designation until 1972, he listed his employment with the Coal Board from 1971 to 1974 as foreman and senior mine foreman, neither of which title appears to be used in the UK coal mine regulatory regime. Parry came to Alberta from the United Kingdom in 1974 and joined the Smoky River Coal mine at Grande Cache. In 1983, he received his certificate as assistant underground mine manager after completing the requisite examinations.

In December 1990, Parry was granted a Nova Scotia provisional certificate of competency on the strength of his being a holder of "a certificate of competency as an underground manager from the Province of Alberta (Certificate No. 502)." In February 1991, Parry received full certification as underground manager from Claude White, secretary of the board of examiners.

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28 Fax from Mike McNamara, head of administration, British Coal Corporation, Technical Services, 6 February 1996.

29 This description is confusing. Phillips was authorized as deputy and shotfirer in 1974, after he left the National Coal Board. Yet, in his resume, he claims status as an overman and as "assistant to underground manager."

30 With respect to both Phillips and Parry, the British Coal Corporation report stated: "This means that neither of these men have, as far as we can establish, gained significant mining managerial qualifications in this country. They have not qualified at either 1st or 2nd class certificate of competency level which would be a statutory pre-requirement in this country before they could be appointed to an Undermanager or Managers position."

Finding

The evidence raises serious questions as to the qualifications of the mine manager and the underground manager at Westray. Gerald Phillips represented himself (at least in his resume) as having attained standing as a "mining engineer," and he listed several such positions held. This representation is clearly misleading.

Roger Parry was granted a provisional certificate by the director of mine safety, Claude White, even though there is no authority for such action. Parry's resume also listed employment as "underground manager" in Alberta, despite his having attained only the assistant underground mine manager certificate.

RECOMMENDATIONS

1 **No provisional mining certificates should be issued in any circumstance. The process of granting certification based on status in other jurisdictions must be refined to ensure that qualifications are consistent with provincial requirements. The burden should be on the applicant to establish that his or her qualifications are sufficient to support the requirements for the certification sought. Any person granted certification based on status in another jurisdiction should be required to be examined in Nova Scotia for such certification at the earliest reasonable time.**

2 **Every position in a mine should have a written job description setting out the duties and responsibilities of that position, with particular reference to safety. Each employee should be provided with a copy of his or her job description. A copy of all job descriptions should be prominently displayed in an area frequented by employees.**

Curragh – The Parent Company

Curragh purported to be heavily involved in managing Westray. When Curragh claimed equity of 20 per cent in the project in order to satisfy eligibility requirements for federal financial assistance under the Atlantic Enterprise Program, deferred management fees of $6.5 million made up a significant portion of this total.[31] Moreover, in a response to federal questions about the services that were to be provided in return for these fees, the company's agent wrote:

> 4. a) Senior management at Westray who have had significant coal mining experience (Smoky River, Quintette) will be heavily involved in all levels of senior management of the project including general, engineering and finance, throughout the construction and development stages. Westray management, in conjunction with Kilborn Engineering Ltd., will be responsible for ensuring that the construction proceeds on a timely and efficient schedule.
>
> b) Senior Westray management because of their past coal experience and their involvement in the construction and development stages will be

[31] See Chapter 2, Development of Westray, for details.

> required to manage the project over its life. Specifically, they will have executive mine responsibilities in all phases of the mine operations.[32]

C.H. Frame Consulting Services Inc. (Frameco), wholly owned by Curragh chairman and chief executive officer Clifford Frame, executed a management agreement with Westray Coal Inc. to provide "management and development services, liaison services with government agencies, labour negotiations, contract negotiations, financial, legal and engineering related services and such other related services" for fees of $8,275,000, to be paid after achievement of commercial production, subject to prior claims of lenders and investors in the project.[33]

The involvement of Curragh officials in the acquisition of the site and financing of the project are dealt with in Chapter 2. As mine development proceeded, Frame appointed Marvin Pelley as Curragh's executive vice-president of corporate development and coal. Pelley, later titled president of corporate development and projects, was responsible for Westray, among other projects, and reported directly to Frame. Pelley was very involved in the process of applications for leases and permits, and with presentations to provincial regulators concerning approval of Westray's mine plans. His predecessor as president, Kurt Forgaard, had already hired Phillips from Suncor to head up on-site management at Westray, with a bonus promised for bringing the project in under budget.[34] The on-site management at Westray included people with coal mining backgrounds. After Forgaard's departure in mid-1990, none of Curragh's more senior officials had any experience in the development or operation of underground coal mines. Pelley visited the site a few times during development, and more frequently as ground control problems led to his involvement in the task force set up to address that concern.[35] He claimed to have had little to do with day-to-day operations at the mine, though he was in almost daily telephone communication with the manager, and indicated in a post-explosion interview that he had believed on-site management was doing the right things.[36]

There were some exceptions to this arm's-length approach. At a time of growing concern about ground conditions, Frame took a more active role in mine planning, and Pelley's involvement also intensified. In January 1992, Pelley wrote a memo to the senior on-site staff, directing them to establish and follow layout and sequencing controls designed to improve roof conditions, on pain of discipline or dismissal.[37] Pelley later

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32 Exhibit 35d.0005.

33 Exhibit 64.16. This agreement was subsequently assumed by Curragh from Westray when Westray was voluntarily restructured by Curragh as a subsidiary of Curragh rather than as an independent corporation. The agreement was then assigned to a numbered Ontario company owned by Frame.

34 RCMP statement of M. Pelley, 28 April 1994.

35 The task force is addressed in the section on experience and expertise at Westray in Chapter 10, Ground Control.

36 RCMP statement, 28 April 1994.

37 Exhibit 35b.0189.

reported that he had directed the mine manager to have the location of the old Allan workings confirmed more exactly by advance drilling before Westray encroached on the barrier. He had also directed an improvement in housekeeping standards in the mine after an April 1992 visit.

On that April visit, Pelley was accompanied by Colin Benner, the Curragh executive designated to take over responsibility for Westray after Pelley moved on to other projects. Benner was given the job of guiding the project during its transition from development to full-scale production. He said it was common to make changes in management during this sort of transition, since different skills and styles are required at different stages in the life of a mine. There are indications that Curragh senior officials were realizing that all was not well at Westray. There was concern that ground control problems would interfere with production goals. During his April 1992 visits to Westray, Benner wrote to Frame to rectify any optimistic expectations that Westray would be able to meet a commercial production test on schedule.[38]

There were other indicators of troubles at Westray. Pelley had been embarrassed by the condition of the mine site when he and Benner toured. He was annoyed to discover that Phillips had introduced a production bonus scheme without his approval.[39] Benner was aware of problems with the manner in which Phillips neglected Curragh procedures for corporate communications and decision making. Benner addressed a number of administrative issues in a 17 April memo to Curragh's vice-president of administration, Diane Webb. He referred to a number of flaws in the bonus scheme. His greatest concern lay in the general administration of the mine, where he cited "a desperate need for a more open style of management at the site."[40] He saw an immediate need for a competent underground superintendent to oversee, and then replace, Parry, whose manner of dealing with workers was unacceptable. The new position required a person with coal mining experience, good people skills, and the ability to understand geomechanics and the need for systems and standards. The person hired must be capable of replacing the mine manager, or at least substituting for him for a long period of time. The manager was not to be replaced immediately, just relieved of some responsibilities, but might eventually have to go if he could not adapt to necessary changes in the way the mine was managed.

Benner saw the mine manager as overextended and autocratic. It was a shock for Benner to discover that even he, as a senior official and Phillips's superior, could not get a congratulatory memo out to employees because the manager's secretary would not release a communication

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[38] Exhibit 35b.0196. Only open-pit production left some chance of satisfying the commercial test.

[39] Benner (Hearing transcript vol. 73, pp. 15976–77).

[40] Exhibit 120.051.

without Phillips's approval.[41] Benner thought it highly unusual that professional and technical staff were not allowed to communicate directly with regulatory agencies, that everything had to be channelled through the manager.[42]

Benner thought the manager was occupied with matters such as the coal contract and open pit development to the detriment of the underground. In his memo to Webb, Benner described Phillips as doing a good job in some areas but neglecting two key aspects: "people and underground. It is the writer's opinion that given the proper direction he will come around – we will see."[43] Benner planned to hire an assertive, no-nonsense human resources supervisor who would require the manager to address workforce problems. He insisted that Phillips chair the revitalized ground control task force, to focus on the ground problems so that the group's work would not falter again. This would also ensure that the manager would continue to be involved before decisions were made.

Benner was concerned that decisions had been made without consultation with those affected.[44] He initiated a system of meetings to encourage the contribution of middle managers. Benner's memo to Webb noted that Phillips had "had his own way for so long that he will have a bit of difficulty at first working in a team environment. He is extremely domineering of his staff and has the answers before he even talks to them. He is not indispensable."

Where matters lay in Benner's areas of personal and professional competence, he took some first steps to address deficiencies. Unfortunately, Benner, like the rest of Curragh's senior officials, had no coal mining training or experience. His early observations of underground conditions did not impress on him the deadly hazards building up in the mine. He seemed to have a responsible and pragmatic approach to the problems at Westray. His first priority was to get the mine roof under control, followed by efforts to improve labour-management relations in the face of the recent union certification drive. Colin Benner had the program and the ability to turn Westray around, but he was not given the time.

After the 9 May explosion, and following the cessation of rescue activities at Westray, Frame, in a press release directed "especially for our employees, their families, and their friends," expressed his personal grief. He also said:

> It is too early to speculate on the reasons for Saturday's explosion. But whether they are natural or human, we are committed to determining the causes. We will take every step available to us to ensure that the lessons of this explosion can be understood.

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41 Hearing transcript, vol. 73, pp. 15901–02.

42 Hearing transcript, vol. 74, p. 16158.

43 Exhibit 120.052.

44 Hearing transcript, vol. 73, pp. 15904–05.

This Inquiry had been announced earlier that same day by Premier Cameron. Frame said:

> [W]e wholeheartedly welcome the announcement of a provincial public inquiry under Mister Justice Richard which will provide an understanding on how to avoid this kind of accident. *We will devote our energy and our resources to cooperating fully with this inquiry.*[45]

From my perspective, the only "energy" and "resources" devoted by Frame to this Inquiry, have gone into mounting numerous and relentless legal challenges to efforts to have him and Pelley appear before the Inquiry to give evidence.[46]

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45 Curragh media release, 15 May 1992. Emphasis added. As a measure of Frame's sincerity and concern, contrast this statement with his later shrugging off any responsibility for the Westray disaster by terming it a "simple accident" (*Globe and Mail*, 17 February 1997).

46 These efforts are detailed in the section on the legal environment in Chapter 16, The Inquiry.

4 Training at Westray

To inquire into . . .

(c) whether any neglect caused or contributed to the occurrence;

(g) all other matters related to the establishment and operation of the Mine which the Commissioner considers relevant to the occurrence

A comprehensive and ongoing training program is essential to the safe operation of any mine. It should be a mix of classroom and hands-on preparation for the work underground, as well as continuing retraining and upgrading in safe operational standards. It should involve all employees, including technical and supervisory staff. In his testimony before the Inquiry, expert witness Dr Miklos Salamon commented on the importance of training:

> I think it's a very important, very fundamental aspect of our industry, because you are taking people into an environment which . . . need not be dangerous, but it can be very dangerous.
>
> Now, for example, no one would really seriously think to put the population into motor cars without any training and say, well, you chum, go and drive. We all accept that – although people sometimes break the law, but we all accept that people need to be trained to drive a motor car. Well, I think if that is so, then . . . people need to be trained how to be a miner, how to be a safe miner.[1]

The mining experts agreed that education, training, and supervision were essential to instil correct attitudes about safety in the miners and to maintain standards for operational safety. They said it was imperative that both management and the regulators set a good example and always insist on safe practices. According to Salamon, regulatory agencies must ensure that "training is carried out by the company and that training meets reasonable, generally accepted standards."[2]

The regulatory framework in Nova Scotia requires that almost every person employed in underground coal mining hold a certificate of competency. Section 11 of the *Coal Mines Regulation Act* sets out the education and work experience required for the various certificates. The act also requires the applicable minister to appoint a board of examiners responsible for advising the minister on the certification of applicants. The board delegates the administration of certification for mine rescue and for competency as a coal miner to the Department of Labour, which is generally responsible for the enforcement of the act. In some jurisdictions, the details of training required for underground work are laid out in the legislation, but in Nova Scotia the company is responsible for training miners.[3] The role of the regulator is to ensure that the company complies

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1 Hearing transcript, vol. 14, pp. 2457–58.

2 Hearing transcript, vol. 14, p. 2454. Except for the Westray experience, such standards are widespread. Underground mines in the United States must provide comprehensive training programs that meet or exceed the requirements of Title 30 of the *Code of Federal Regulations* [30 CFR]. Devco provides modular training programs for underground supervisors.

3 In the United States, Part 48 of 30 CFR details the requirements for training and retraining underground miners.

with the *Coal Mines Regulation Act* and the *Occupational Health and Safety Act*.

At Westray, it is clear that both the company and the regulator were derelict in their respective obligations for training. The testimony of the miners shows that training fell far short of need. Don Mitchell, mining consultant for the Department of Labour, concluded from his post-explosion investigation that the mine "had no program that was appropriate to the needs of that mine."[4] And expert witness Dr Malcolm McPherson referred to inadequate training of mine workers as one of the non-technical matters that had "contributed in an equally potent manner towards the propagation of a mine explosion"[5] as the ventilation engineering deficiencies.

A Mixed Workforce

At Westray, the demands of the site and the varied work experience of the employees added to the challenge of designing and implementing suitable training programs. A crew with different levels and types of work experience creates a number of problems in the development of a safe mining operation. Quite simply, each member requires different educational and training programs. Experts agree that it is imperative that mine management maintains a genuine safety mentality at all times. This mind-set requires supervisory behaviour to counteract the nonchalant attitude often encountered in more experienced workers, who may have adopted hazardous shortcuts and a dangerously complacent approach to occupational risks. The training requirements for workers new to mining are different but just as important, as lack of knowledge and experience makes them hazardous both to themselves and to others. Salamon described the kinds of problems arising with these two groups:

> [O]ne, I will refer to as the experienced miner, a man who should know better. I've seen people who have been handling explosive for 20 years do things that you're terrified to watch. And he really should know better, but . . . "familiarity breeds contempt" . . . Now it's not an issue which can be ignored, and if the management is not devoting a lot of effort, it's going to become more and more prevalent in a mine. So there is this problem . . . even among the experienced miners that they will do things which they should know better not to do.
>
> Then there are the other people who have the other extreme, who have no background. Now there you have an overwhelming responsibility to make sure . . . that they get training, exposure, experience and [that] they work under supervision initially.

Salamon suggested that there was a third major category, the hard-rock miners, who were "probably the most dangerous ones because they think they know mining, but they're not aware of . . . specific hazards that arise in coal mining. And because they're familiar with other types of mining,

[4] Hearing transcript, vol. 17, p. 3103.

[5] Hearing transcript, vol. 9, p. 1705.

they may not appreciate the significance, or may not even [be] willing to be too concerned about it."[6]

Mitchell emphasized the need for "an intensive training program to make them [miners] sensitive to the specific conditions that must be maintained in a gassy coal mine." As he explained:

> The most important thing I've learned from this disaster is that if I were a mine operator . . . at Westray, I would want to have had a education and training program. I would start, really, with the training program[, b]ecause I had miners from a wide variety of backgrounds and with different concepts of mining, quite different concepts of mining, few of whom had experience in room-and-pillar mining in gassy coal mines where the roof conditions were suspect.[7]

The underground workers at Westray ranged from miners with more than 20 years of underground coal mining experience to new workers fresh out of school. About one-third of the Westray underground workers hired by 1992 had some previous coal mining experience, about one-third had previous underground work experience in hard-rock mining, and about one-third had no prior underground work experience.[8] Westray reported a total of 188 employees as of 27 January 1992.[9]

The testimony of Westray miners demonstrated the accuracy of the assessment of the multiple safety problems in a mixed crew. The resulting hazardous practices will be addressed later in this Report. Among the many examples was the roof bolting crew who continued bolting in a blind heading with the fan turned off even after the safety committee representative told the workers that they were in 2 per cent methane. There were stories about an experienced coal miner who drove an unapproved dozer within 2 m of the working face, and a mine rescue trainer who altered the set point on a methane detection instrument to keep equipment in production despite the presence of methane at levels higher than statutory limits.[10] Fraser Agnew told of one novice miner, half-buried by a roof fall, who seems to have stood there watching the roof work loose while others on his crew ran from the spot.[11] Inexperienced miners simply did not know enough about underground work to avoid common hazards. When experienced coal miner David Matthews was asked about the new miners, he testified:

> Q. Did you have any concerns about the type of training new recruits were getting, Mr Matthews?
> A. Yeah, we talked about it as a crew.
> Q. And what would you talk about?

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6 Hearing transcript, vol. 14, pp. 2451–52.

7 Hearing transcript, vol. 17, pp. 3091–92.

8 Based on information from interviews and employment application forms filled out by the workers themselves. Workers include miners, labourers, skilled tradesmen and apprentices, foremen, and some surface workers, such as welders, whose duties took them underground at times.

9 Exhibit 76.17.063.

10 These examples are cited elsewhere.

11 Hearing transcript, vol. 35, pp. 7672–73.

A. New hires that never worked in a coal mine before going second operator on the miner and didn't know what to look for, didn't know what to do actually with the cable.
Q. And why would that concern you as a coal miner?
A. Because I was driving shuttle car coming into the miner, and these guys would be standing anywhere. They didn't even know which side to stand where I could see them.[12]

An additional component of the Westray situation was management's repeated dismissal of legitimate safety concerns expressed by hard-rock miners, on the basis that these miners knew nothing about coal mining.[13] Hard-rock miner Bryce Capstick recounted how the miners had become concerned about roof conditions in No. 2 Main in May 1991 and had approached Gerald Phillips, the mine manager:

A. And we told him, "The back is getting pretty heavy . . . the plates are starting to pop off the bolts and whatnot. We've got to do something about that." And I will quote what he said, "You fucking hard rock miners just don't know your sedimentary rock"

. . .

Q. That's what Mr Phillips reply was?
A. That was his reply. Well, the next day he almost lost three quarters of a crew of men because we almost all got killed.[14]

Early Assessments of Training Needs

The need for training the Westray workforce had been predicted well in advance of the start-up of the mine. This need was accentuated by the geology of the mine site. The technical review of the project carried out by the Canada Centre for Mineral and Energy Technology (CANMET) described the implications of training needs in the challenging work environment that was to be created at Westray. Federal research staff there warned:

> Room and pillar mining forces face workers to make frequent value judgements (particularly in depillaring) that impact coal recovery, safety and the like. To initiate such mining in a new set of site specific conditions you must expect to have a lengthy learning curve even with experienced people. There are no experienced thick seam room and pillar miners in Canada except for miners who have worked in the western Rockies. Some of them originally came from Nova Scotia and recruitment of them must be a priority.
>
> . . .
>
> There is always some risk associated with thick seam room and pillar mining. With time and site specific experience, thick seam room and pillar

12 Hearing transcript, vol. 31, pp. 6597–98.

13 William MacCulloch, Westray's training officer, explained safety complaints by ex-employees as the failure of hard-rock miners to adjust to coal mine conditions (Hearing transcript, vol. 41, p. 9204). It seems that management, while acknowledging that hard-rock miners and others did not know coal mining, made little or no attempt to remedy this deficiency by sufficient training.

14 Hearing transcript, vol. 42, p. 9333. Doug Macleod recalled that incident from the perspective of the rookie miners, who were called "dummies" and threatened with replacement by other workers (vol. 27, pp. 5684–85).

> mining should work in Pictou conditions. The real question is whether this property can wear the cost of the learning curve to get to a routine development/extraction practice. That routine took many years to establish in western Canadian underground coal mines.[15]

Dr Thomas Brown, then director of CANMET's Coal Research Laboratories staff who reviewed Westray's project proposal in 1989, added the caution:

> The extent to which western Canadian experience is relevant and transferable to Westray's conditions is very uncertain.
>
> What is clear is that the likelihood of Westray developing a routine and relatively trouble-free mining method in the short term is very low. Methane (the coal is very gassy), faulting, depth, seam thickness, and the lack of experience with mechanized room and pillar mining in this geological environment all indicate that a lengthy learning curve/teething period should be expected.[16]

Brown told the Inquiry that this combination of factors, each "individually and independently capable of being addressed," interacted to provide a complex mining environment, a conclusion that would have been apparent to "any mining engineer who had a good breadth of experience."[17]

To compound the problem further, Westray had no experience in developing or mining in the conditions expected in the Pictou project, though some of Westray's on-site managers had some experience in western Canadian thick-seam room-and-pillar operations. Combined safety and operational training for employees who lacked adequate experience in comparable coal mining conditions should have been a paramount consideration. In his memo, Brown observed that "[t]o succeed, the workforce *and* management must be well trained, observant, and committed to safety."[18]

The provincial government had also shown an interest in training issues in the early stages of the project's development. When the project was first proposed, there were discussions in the Department of Mines and Energy (later the Department of Natural Resources) about the need for training and the responsibility for a training program. The Department of Labour recognized that proper training was essential for working in the hazardous environment of a coal mine, with Westray no exception. The history of coal mining in Pictou County, the new technology proposed for the Westray project, and the scarcity of miners experienced in the type of mining operations planned made training programs even more crucial. In a 14 November 1988 meeting, staff from both departments apparently regarded training as top priority for "everyone" involved with the Westray project.[19]

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15 CANMET review, Exhibit 137.07.41–44.

16 25 August 1989 memo to M.D. Everall, assistant deputy minister (Exhibit 137.07.01).

17 Hearing transcript, vol. 52, p. 11270.

18 Exhibit 137.07.01. Emphasis added.

19 Memo from John Smith to Claude White (Exhibit 139.07.006).

On 12 June 1989, John Laffin, deputy minister of mines and energy, wrote a memo to his assistant deputy minister: "Will you please have staff discuss training of miners for the Westray mine with Gerald Phillips as soon as possible. I told the minister that if he gets a question to advise them [media] that we were discussing it with Mr Phillips of Westray."[20] Deputy minister Richard Potter replied on 7 July 1989: "Gerald Phillips['s] remarks to Pat Phelan [Mines and Energy director of mining engineering] reflect Cliff Frame's *modus operandi*. He always maintains that local workers *stick*! I am sure Westray's training programs will be first class."[21]

Feasibility studies for the project referred to statutory requirements that the mine be safely operated by properly qualified, trained, and experienced personnel, albeit in the same sketchy manner that ventilation engineering was outlined. The 1989 Kilborn review, which was Westray's planning document, included a few paragraphs on statutory training and certification requirements and noted briefly: "A detailed training program will be developed for the personnel required to fully man the mine."[22] Although Westray and Curragh were aware of the necessity to plan and implement training programs for Westray's workforce, it is not clear that they appreciated the problems in expecting a Pictou County mine to replicate coal mining operations in western Canada either quickly or closely.[23] The company's 1990 training proposal referred to the need for a thorough training program if the company was to make maximum use of the *local* workforce, who were mostly new to modern room-and-pillar coal mining.[24]

Westray intended to build up to a workforce of 241 people. The company sought to recruit experienced and certified coal miners for about a quarter of this total, "to provide initial underground practical training to inexperienced recruits."[25] Few local workers were qualified. The company reported that only 24 of the 680 applicants from the Pictou County area who had contacted Westray by May 1990 had the required certification as underground coal miners. And even those 24 had little or no recent coal mining employment or experience with the highly mechanized room-and-

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20 Exhibit 141.15.009.

21 Exhibit 141.15.011.

22 Exhibit 4, s. 3.9.1.

23 George Klinowski, CANMET ventilation and mine environmental specialist, had worked as project engineer at an Alberta mine where both Phillips and Roger Parry had been employed. In a 12 January 1994 statement given to the RCMP, he described how he later quit a job at Westray after only two days because he felt there was no way to mine it safely. He explained: "I felt that Roger Parry had the mind set that they could mine in Westray as they did in Smoky River and it couldn't be done as the geology was different."

24 Clifford Frame, chief executive officer of Westray and Curragh, implicitly acknowledged the necessity of training. In a letter to Harry Rogers, deputy minister of regional economic expansion, of 9 November 1988, Frame said that Westray was "prepared to cope" with several anticipated problems, including "unskilled and inexperienced personnel." Presumably, some budget amount was factored into Westray cost estimates to remedy this problem, along with the others listed in the Frame letter.

25 Exhibit 141.01.018.

pillar mining planned for Westray.[26] Jobs for an area of high unemployment had been an important selling point for the project. The company indicated that it would recruit experienced thick-seam room-and-pillar miners from western Canada, but would train local workers for many of the remaining jobs.[27] The company also expressed its desire to develop a training program jointly with the federal and the provincial government, to facilitate hiring from the local workforce.[28]

Yet no new government programs were developed to train local workers to meet the requirements for work at the mine.[29] It was left to the company to provide a suitable training program, with some federal funding assistance possible if the company met federal guidelines. The Department of Labour remained responsible for ensuring that the mine workers were qualified and certified, as part of its general occupational health and safety mandate and, more specifically, as dictated by subsection 11(11) the *Coal Mines Regulation Act*.

The certification process basically requires only that a coal miner be a minimum age and "has had at least twelve months experience in a coal mine, of which at least six months shall have been at a working face; or . . . has had six months systematic training at a working face approved by the Minister as a training place, and is recommended for a certificate of competency as a coal miner by the supervisor of such place." Other subsections deal with certification of mine officials (1–3), mine surveyors (4), electricians (5–6), stationary engineers (7–9), mine examiners (10), and firemen (12). Complete training for safe operations would also include other matters, such as the use of particular pieces of equipment, to complement the certification training. The scheme assumes that a company will see to the proper training of workers as they acquire the necessary periods of work experience set for the various certificates. The issue of training was raised in early meetings between regulators and the company. But the Department of Labour, rather than taking the initiative in assuring compliance with the safety and training requirements, chose instead to await the company's proposal as to how this essential matter would be addressed.

The Training Proposal

Phillips submitted a training proposal to the Department of Labour in July 1990. Westray's training officer, William MacCulloch, testified that it

26 Exhibit 119.053.

27 Exhibit 119.082.

28 Exhibit 119.052.

29 Staff from the Department of Labour discussed a training program for underground miners with the Department of Advanced Education and Job Training, which had been given much of the Department of Labour's old role in trades training administration. Labour had retained only more limited safety-related training. In 1989, the deputy minister of training, Hugh Macdonald, wrote a letter to the other department's deputy supporting the idea of a coal mining vocational training program for Nova Scotia (Exhibit 141.01.015), but there is no record of follow-up on the proposal. The company also slowly and intermittently pursued the possibility of training programs through Advanced Education.

looked as if it "was sort of adopted from the Alberta people," with no consideration for Westray's different circumstances.[30] In August 1990, Westray's proposal was presented to the board of examiners by Allen Karasiuk, Westray's supervisor of human resources. It was a modular training program with a core set of modules that all new underground employees would be required to take, regardless of experience, and a supplementary set of modules on various aspects of safe underground operations. The supplementary modules would be in packages tailored to the needs of trainees with different work backgrounds. Each module set out an amount of classroom training in an aspect of occupational safety or mining operations, followed by a period of practical training under the close personal supervision of a qualified miner. In the supplementary modules, the time to be worked under close supervision might vary depending on the trainee's background and experience.

The core training proposed an orientation covering mine safety basics and company regulations, followed by a short course on emergency first aid and modules on the workplace hazardous materials identification system (WHMIS), fire prevention, fire fighting, and mine survival. This last module related to emergency procedures, including self-rescuers, as well as basic information on mine ventilation and hazardous mine gases. The supplementary modules included more detail on mine ventilation and mine gases, together with such topics as fires and explosions, roof support, underground electrical hazards, conveyors, coal haulage, materials handling and operation of supply vehicles, operation of continuous miners, mine rescue, and maintenance of mine rescue equipment. The modular training program seemed consistent with conventional patterns of training for underground miners: new workers would receive classroom instruction and then work under the supervision of experienced miners as they progressed through a series of assignments before being allowed to work in coal extraction at the working face.[31]

The board of examiners was not impressed with the training proposal and criticized it for failure to provide levels of training specific to the certification requirements under provincial legislation, especially for mine examiners.[32] The board recommended that the company develop modules specifically for certification purposes and offered to supply the company with guidelines to assist in preparing these modules, including a list of subjects required for examinations set by the board. It questioned how the company would conform with statutory requirements while personnel were obtaining the training and work experience needed for certification. It was concerned about Westray's ability "to manage training in relation to safety concerns and production requirements." It rejected Phillips's

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30 Hearing transcript, vol. 40, p. 9030.

31 The various experts who were asked to comment in testimony on the Westray proposal saw nothing out of the ordinary.

32 A training proposal from a small independent coal mine in Cape Breton was submitted at that same board meeting. It outlined 60–90 hours of training for candidates with the required years of experience, in preparation for testing for certification as mine examiners (Exhibit 119.078).

proposal to relieve the board of the burden of certification by establishing Westray's own board – to consist of a provincial inspector, a Westray certified miner, and Phillips himself. The board retained responsibility for examinations for certification of more senior job classifications and delegated responsibility for certification of miners and mine rescue trainees to the inspectorate.[33] The inspectorate was also responsible for determining which of Westray's job classifications would require certification in accordance with the *Coal Mines Regulation Act.*

Karasiuk reported to Phillips that he had taken the position with the board that the company had never been apprised of the training requirements under the *Coal Mines Regulation Act.* In Karasiuk's opinion, his August 1990 meeting with the board had been sidetracked from its proper agenda – Westray's training proposal – by the persistent emphasis on certification issues.[34]

There is no record that the board considered whether the standards for certification had kept pace with developments in mining technology, and whether they would be appropriate or sufficient for the Westray mining operation. Roy Elfstrom noted in his 1979 inquiry into a Cape Breton mine fire that "[c]hanging mining technology has meant that mine environmental conditions can no longer be evaluated by persons whose training has not kept pace with the changes."[35] He recommended that standards for certification as a mine examiner be brought up to date and that certification be for terms of two to five years, with appropriate retraining before re-examination. Training on such matters as methane layering or the effect of modern production methods on gas release rates would have been appropriate for Westray examiners. Department of Labour inspector Albert McLean did demonstrate the use of hand-held methanometers to mine examiner candidates at Westray. But instruction and testing on such things as extension probes and environmental monitoring systems were also needed, and standards for other certification levels should have been reviewed and updated.

The board of examiners, in December 1990, approved the training proposal for certificates of competency as coal miners, based on 58 days of formal training for miners with previous underground work experience and 199.5 days for new employees with no previous mining experience. Claude White, director of mine safety, and also a member of the board, informed Phillips by letter on 17 December that the board had approved Westray's training proposal "for certificates of competency as coal miners in accordance with the Common Core Modules and Training Summary Table" (see table 4.1).

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33 Exhibit 119.095–99. Mine rescue training, testing, and certification did not exhibit the pattern of problems associated with operational and occupational safety training at Westray.

34 Exhibit 119.095–96.

35 Commission of Inquiry into Explosion in No. 26 Colliery, Glace Bay, Nova Scotia, on February 24, 1979, *Report* (Canada: Department of Labour, 1980) (Chairman Roy Elfstrom) [Elfstrom Report], 83.

Table 4.1 Westray Training Proposal Summary, in Days

Content	Classroom training	Close personal supervision	Total
Common core modules			
1 Orientation: safety and administration	2.0	1.0	3.0
2 Emergency first aid/CPR	1.0	–	1.0
3 WHMIS training[a]	0.5	–	0.5
4 Fire prevention and fighting	2.0	0.5	2.5
5 Mine survival training	1.0	0.5	1.5
Subtotal	6.5	2.0	8.5
Supplementary modules			
6 Mine ventilation	2.0	5.0	7.0
7 Mine gases	1.0	0.5	1.5
8 Fires and explosions	1.0	0.5	1.5
9 Roof support	2.0	15.0	17.0
10 Electrical hazards in U/G coal mining	1.0	1.0	2.0
11 Conveyors	1.0	10.0	11.0
12 Coal haulage	2.0	10.0	12.0
13 General	1.0	5.0	6.0
Subtotal	11.0	47.0	58.0
14 Continuous miner and Roadheader	3.0	130.0[b]	133.0
Grand total: certified miner	20.5	179.0	199.5

Source: Westray training proposal submitted July 1990, table II (Exhibit 19.067).

Note: Within each module, the amount of close personal supervision time required may vary depending on the trainee's past background and experience.

a Workplace Hazardous Materials Identification System

b Westray was to develop a training package for its specialized equipment, based on its own mining methods. These 130 days were to be broken down as follows:
a) roof support, 30 days
b) continuous miner operation, 20 days
c) shuttle car operation, 40 days
d) maintenance of the face (would include work in a, b, c), 40 days.

Westray presented essentially the same proposal to staff of the Departments of Labour and of Mines and Energy in January 1991. On 5 April 1991, the board of examiners was advised by the Department of Labour that the tunnels at the Westray mine had been designated by the minister as an approved training facility in accordance with section 11(11b) of the *Coal Mines Regulation Act*.[36] This approval meant that new miners could be certified as competent coal miners after only six months of systematic training underground instead of the usual requirement for twelve months' underground work experience, including six months at a working face. The modules of the training proposal that were supposed to precede coal miner certification were presumably going to be provided within the halved time frame.

[36] Inquiry files, NSDL42 Tab4.

Resolution of the board's concerns about the content of the training proposal, especially for more senior levels of *Coal Mines Regulation Act* certification, is not documented in the records of the Inquiry. The issue of mine examiners' qualifications resurfaced regularly. The Department of Labour reminded the company several times during the mine's development that it was essential to train workers in the hazards of coal mining and to have qualified persons perform important safety checks, especially those the act required to be done by certified mine examiners.[37] The reminders were not particularly forceful or effective, and compliance by the company was not monitored in any meaningful way.[38]

Resolution of the board's concerns about the implementation of the proposal – issues such as compliance with statutory requirements for certification during the early stages of training, or managing training along with production requirements – is similarly not documented. It appears that the board left open the possibility that it would check for problems as the training proposal was put into practice, but the check never happened.

Training Records

The board reserved the right to monitor training when Westray's proposal for training miners was approved, and it instructed the company to keep logs documenting each individual's training. These training logs were to be presented for review by the inspectorate when the application for certification was submitted. The approval of a shortened period of underground work experience as a prerequisite for miner-level certification made it even more critical that training logs be submitted to the inspector examining candidates, so he could check on their "systematic training." In a 6 September 1990 memo to Phillips, Karasiuk referred to a comment made during his presentation of the training program to the board by Pat Phelan, to the effect that "things stated to happen were in fact not taking place"[39] – a suggestion that the board had been concerned for the actual implementation of the proposal as well as critical of its contents.

Westray agreed to keep training logs for each trainee. Following a meeting on 17 October 1991, at which Phillips assured White that training was going on every day, White reminded him about the company's commitment to document all the training given to the miners.[40] There is no evidence that logs were kept by the company or examined by the

37 Exhibit 139.05.003.

38 On 12 December 1990, for example, McLean issued an order for Westray to use a certified mine examiner to test for methane, but his director, Claude White, immediately helped solve the difficulty this might cause the company by issuing a provisional certificate to Roger Parry that same day (Exhibit 139.02.10).

39 Exhibit 119.096.

40 White's letter of 29 October to Phillips concerning Westray's production of training logs and stonedust plans came just after newspaper accounts referred to training, dust problems, and roof conditions, as well as Westray's embarrassing failure to meet coal supply commitments (Exhibit 119.204).

inspector,[41] though some records of training were produced at Westray in support of applications for federal funding assistance with training costs.[42]

The record suggests that the inspectorate and the board of examiners had persistent concerns about training at the mine, and that they continued to discuss the need for both training and documentation. At a February 1992 meeting between inspectors and Westray management, Phillips and Roger Parry reported on the training policy and program in place.[43] Parry had training officer MacCulloch draft a letter to Albert McLean on 5 March 1992, outlining the company's training program.[44] MacCulloch recalled that the company had not been able to implement the original training proposal, and that the letter to McLean intended to identify a training method that would permit certification "under the six-month rule."[45] The letter purported to describe Westray's miner training program as it existed at that time – a thorough orientation for all new underground employees followed by up to a year of intensive training, tailored to the individual trainee's work history.

Phillips made an oral presentation on Westray's training program to the board of examiners on 10 April 1992, covering much the same material as in Parry's letter and expanding slightly on the proposal that had been presented in 1990. The board asked again for documentation on each individual worker's training and experience, and for this information to be made available for assessment by the examining inspector. Fewer concerns with the contents of the training program were recorded at the 1992 presentation than in 1990.[46]

Finding

Westray management, from the chief executive officer down, paid little attention to the requirement for adequate training in underground coal mine safety and operations. The several training proposals produced by Westray seem to have been formulated to satisfy the inspectorate and the board of examiners while the company sent insufficiently trained persons into the mine. The record shows that the inspectorate did little to monitor compliance with the training proposals.

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41 McLean's testimony about his knowledge of the requirement for training logs to be shown to the examining officer was equivocal (Hearing transcript, vol. 57, pp. 12495–96).

42 Exhibit 119.275–80. As we will see later, miners' testimony shows that these records were inaccurate, inflating the hours of actual training provided.

43 Exhibit 73.08.025. According to a January 1992 site visit report by the lender's engineers, the company had told them that a shortage of experienced miners, due to the lack of opportunity for training, had contributed to production shortfalls, but that the problem had been largely overcome, as miner training was "now progressing well" (Exhibit 136.072).

44 Exhibit 119.116.

45 Hearing transcript, vol. 40, p. 9030.

46 Exhibit 76.17.063–64.

Actual Training

The training proposal outlined in the presentations and proposals never materialized. Training could not be documented as the board of examiners advised, simply because only a small fraction of the proposed training ever took place. Despite the miners' complaints to the managers, the company did not resolve the problem. And despite reports of inadequate training passed to the inspectorate, the regulators did not demand an effective training program. The inspectorate did not review records of training or check directly on the existence and quality of training during the operation of the mine. Mining consultant Don Mitchell testified to the necessity for a major training program to prepare the Westray workers for the kind of mining planned:

> Q. But have you seen any signs of them making any effort to do education on this form of mining?
> A. No . . . we didn't see any real education program that was going to be meaningful.[47]

Miner Rick Mitchell, who had himself been extensively trained in Alberta, reported the lack of training at Westray to mine inspector Albert McLean in January 1992:

> Q. What else did you and Mr McNeil and Mr Facette tell Mr McLean?
> A. Well, the training program that was promised was never started. . . . we actually had a mine full of inexperienced miners.[48]

Randy Facette also testified that the miners' concern about inadequate training had been taken to the inspector.[49] Both Facette and Rick Mitchell described how they had brought that concern to the attention of management, with little effect. Facette had raised the issue during a joint worker and management committee "safety walk" through the mine:

> I just made the recommendation that there should be a proper training program set up for new employees who were just coming into the mine, especially ones that never had any coal mining experience. Operators, for instance, that were being brought in, just given . . . a week, a few days even in some cases[,] and then put onto a machine and expected to operate it proficiently.[50]

That complaint did not appear in the company's record of the safety walk, and nothing was done about it. Rick Mitchell raised the concern about inadequate training with the underground mine manager:

> Q. What did Mr Parry say when you raised your concern about new recruits to him?
> A. He was telling me that there was going to be a proper training program set up soon and there never was.
> Q. Did you ever go back to Mr Parry and ask him why a proper training – the proper training program he told you would be set up wasn't set up?

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47 Hearing transcript, vol. 17, p. 3056.

48 Hearing transcript, vol. 31, p. 6728.

49 Hearing transcript, vol. 33, p. 7213.

50 Hearing transcript, vol. 33, p. 7190.

A. Yeah. And he just told me more or less it was in the works.
Q. So 13 months after the mine opened, it was still in the works?
A. Yeah.[51]

The model for Westray's 1990 proposal demanded a commitment of resources, time, and money to the teaching of safe operational skills. It proposed classroom facilities, trained and experienced instructors, and a defined curriculum with appropriate teaching and testing resources. The reality is striking: a cursory orientation program that was almost cynical in its operation, a little-used lunchroom for "classes," an unqualified training supervisor, MacCulloch, who claimed only to "administer" the program, and deployment of new unqualified workers based on production imperatives rather than job training.

Hard-rock miner Carl Guptill described his first day and week underground as "crazy":

Q. Do you recall making that statement? You were wandering around a lot down there?
A. Yeah.
Q. What were you alluding to there? What did you mean by that? Was it management wasn't assigning you to any particular job or –
A. Well, I felt that I should have tagged in and be told on surface where I was going, not go underground and be the last guy on the tractor, and then be "Who are you?" or "Where are you supposed to be?" by a stranger who I didn't know if he was a boss or not, then send me to do something when I was lost.
. . . it was a ball of confusion at Westray, where I didn't know who my boss was. They didn't know who I was, and I didn't know what I was supposed to do. And no one knew I was underground because I didn't tag in or out.
Q. Did that last throughout those entire 13 shifts? I mean, did you ever hook up to –
A. Towards the end of it, I got so I could recognize that okay, he's a boss, and he's the big boss, and he's a miner, and he's a new guy. Yes, I slowly caught onto who was who, but not at first. It was very, very confusing of where am I – the whole thing. Who's this guy? If this guy tells me to do this and that guy tells me, no, to go do something else, who do I listen to because who are they? I had no idea of anything that was going on.[52]

The bare outline of content in the training proposal was never developed, and only a modicum of training materials was acquired. The underground training crews were taught only the skills necessary to the roof support and belt maintenance labour they performed, plus whatever training and advice more experienced miners might supply. Miners' testimony consistently revealed the absence of a training program of the sort Westray's managers had represented was in place at the mine.

The board never exercised its right to monitor the training. The inspectorate did little or nothing to ensure that the training described in

51 Hearing transcript, vol. 31, pp. 6684–85.

52 Hearing transcript, vol. 29, pp. 6275–76. Guptill had spent years in hard-rock mining. It must have been even more confusing for new workers with no underground mining experience.

Westray's proposal was ever implemented. The traditional testing of candidates for certification as competent coal miners degenerated to a perfunctory formality, revealing nothing of the candidates' lack of training or experience.[53] As we have seen, the problem was made known to the inspector by a number of Westray miners before January 1992, but the only indications of follow-up on the complaints are the few sparse records of discussion about training at meetings between the inspectorate and Westray management.

Training Subsidy Records

One indication of the company's failure to provide the proposed training can be found in the records of its training subsidy applications. In February 1991, Westray applied to the local Canada Employment Centre for a federal 25 per cent wage subsidy for classroom training for 134 underground workers, 52 hours each for 42 workers with some coal mining experience, and 116 hours each for novices and hard-rock miners. The total amount requested for 1991 was $56,337.[54] The company negotiated five contracts under the Canadian Jobs Strategy program of Employment and Immigration Canada, the federal department that administered the subsidy program, whereby Westray proposed to provide training for 60 people for 152 hours per person, and 5 people for 208 hours each, including mine rescue training, totalling 10,160 hours spread over five terms of several years each.[55] Westray was to document that training and submit reports to obtain the negotiated financial assistance. The government required the documentation of distinct hours dedicated to training rather than to production. Westray did not comply and was unable to access much of the wage subsidy. According to Westray's own generous assessment, only 1,678 hours of training had been done from start-up to 30 March 1992, including training for individuals in addition to those covered by the five subsidy contracts.[56]

Mine Rescue Training

About two-thirds of the training that actually took place at Westray was documented as mine rescue training, and a portion of the remaining third was first-aid and CPR training provided to mine rescue trainees as part of their certification requirements.[57] The quality of Westray's mine rescue

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53 John Lanceleve received a certificate of competency after having worked only about 12 days as a coal miner (Hearing transcript, vol. 27, pp. 5536–38).

54 Exhibit 119.101.

55 Exhibit 119.276–80.

56 Westray Training Summary Startup – 30 March 1992 (Exhibit 119.281–88). The company records of training are sketchy and include such inaccuracies, probably typographical, as training recorded for a worker on a date half a year before the start date for his employment. The length of training sessions was inflated: one hour of watching a fire extinguisher demonstration became four hours of fire-fighting training, while less than one day filling out forms and watching videos got reported as 16 hours of orientation.

57 Of the 1,678 hours of training done, 1,093 hours were mine rescue training.

training is not at issue.[58] However, mine rescue training was no substitute for training in the safe operation of a mine, despite some overlap in topics that must be addressed in both.[59] Mine rescue trainee Steven Cyr suggested that some of their training course, especially the video on methane and coal dust explosions, should have been given to all underground workers, if only to increase the general level of appreciation for the risks involved in unsafe mining practices.[60] By the spring of 1992, mine rescue trainees were becoming increasingly aware of the hazards in coal mining, but were not getting training in the skills or workplace practices essential to the safe management of those hazards.[61]

Orientation

Employees at Westray were told by the company that they could expect 15 or more years of steady work at decent wages. Some among them were attracted by descriptions of opportunities for promotion in this expanding operation. The mine was described as a state-of-the-art operation where workers would advance as they acquired the necessary skills and proved their abilities. The faster they learned, the faster they would move up the pay scale. Very few details were supplied. Some miners assumed they would receive the necessary training, because they knew that to be the practice at other mines, or because they had signed forms related to the federal training subsidy. Other workers were told they would be assigned to a training crew and would work up to be coal miners. New employees were not shown the training proposal, or any other training course outline. There was scant discussion of training, and they had little idea what to expect. Novice miner Ted Deane's grasp of the training he was to receive was typical: "I had no direction as to what we were going to do. We just went underground and I watched what we did."[62]

Every underground employee at Westray, regardless of work history, was entitled to receive a basic orientation in mine safety and in the particular operation. Every employee covered by the federal training subsidy contracts was to receive 16 hours of orientation. None of the Westray underground workers received the full two-day orientation

58 There is no evidence that it was not top notch (see Chapter 15, Rescue Efforts).

59 As Lenny Bonner told the Inquiry, mine rescue training "will teach you about gases," but "does not go into detail about ground conditions and how to operate a mine or how to do it safe" (Hearing transcript, vol. 24, p. 4837). Doug MacLeod didn't learn about stonedusting or methane layering in mine rescue training (vol. 27, p. 5669). Shaun Comish didn't think that mine rescue training would prepare a person for work in an underground coal mine (vol. 28, p. 5762).

60 Hearing transcript, vol. 25, p. 5172–73. Salamon also spoke to the salutary effect of showing miners coal and methane explosions (vol. 14, p. 2455).

61 **Comment** One wonders why a disproportionate amount of time was spent in mine rescue training at the apparent expense of safety training aimed at keeping the miners alive and healthy. An obvious, though somewhat cynical explanation may be the public relations benefits accruing from performances at the various mine rescue competitions. Whatever the reason, it is suggestive of a dysfunctional set of priorities.

62 Hearing transcript, vol. 26, p. 5340.

described in the proposal submitted to the government, much less the three-day orientation proposal laid out in September 1991.[63]

Electrician Mick Franks's response to the description of a three-day orientation program was that of all the items listed – films, lectures, handouts, demonstrations, workshops, tours – he had probably filled out payroll forms and received a copy of the company handbook: "That's all I see there . . . I had lunch. That's all I got there."[64] The lack of organized introduction to his new work environment increased the hazards. It was two months before one of Franks's co-workers explained the miners' signalling system for underground communications, whereby miners convey basic information by particular movements of their lamps. Miners had been attempting to communicate with Franks, but he had not known "what they were flashing about."[65] Like other new underground employees, Franks was dependent on the informal acquisition of knowledge and skills from co-workers on an ad hoc basis. Some new employees did get training in lamp communications during their first days of work, but there was no consistent program to ensure that every new worker knew the lamp communication system and other similarly important information prior to work underground.[66]

Underground workers hired early in 1991 got little orientation; they merely completed administrative routines, picked up their gear, and went to work. Hard-rock miners who switched to Westray from jobs with the tunnel development contractor (CMD) were assigned tasks without appropriate training or any instruction on the special requirements of coal mining. They didn't even get the safety orientation common to hard-rock mines. Hard-rock miner Bryce Capstick said, "Every mine, even every contractor that goes onto a mine site has to go through an orientation as to . . . occupational health and safety, what their regulations are on site, fire regulations, what safety equipment is being used."[67] Hard-rock miner Wayne MacPhee switched from CMD to Westray on 1 April 1991:

Q. What, Wayne, when you moved over to Westray, what training did you receive from Westray?
A. None.
Q. . . . What kind of introduction were you given to the company?
A. None
Q. Were you told anything about working in a coal mine, as opposed to hard rock mining?
A. That was probably taken as general knowledge, that I would have picked that up through the grapevine, I guess. But as far as any classroom training or anything like that, or any handouts or anything like that, no, there was nothing.[68]

63 Exhibit 119.148.

64 Hearing transcript, vol. 21, p. 4105.

65 Hearing transcript, vol. 21, pp. 4107–08.

66 Johnathan Knock recalled learning lamp signals from Aaron Conklin shortly after starting work underground (Hearing transcript, vol. 26, p. 5318).

67 Hearing transcript, vol. 42, pp. 9343–44.

68 Exhibit 116.1A, pp. 6–7.

Shaun Comish and the other hard-rock miners who started at Westray in September 1991 received no orientation for coal mining – even though they weren't familiar with the site, as the hard-rock miners from CMD were:

Q. Now what type of orientation did you receive for your work at the mine?
A. Prior to going underground?
Q. Prior to going underground, yes.
A. We got dressed, went out into the waiting area and then went underground. Told us who to go with and we went.
Q. That was your orientation?
A. That was my orientation.[69]

Wyman Gosbee, who started the same day as Comish, recalled that the orientation also included a brief meeting with Roger Parry, who discussed the mining method and asked about their work experience before assigning them to their new jobs. The miners who that started that day were not taught the use of their self-rescuers; they were merely told to read the instructions.[70]

Coal miners who had been trained and certified in older, less-mechanized operations, or who had been out of the industry for many years, were expected to start in production work immediately. Ed Estabrooks had been out of mining for nine years. Like other underground workers, he was given a self-rescuer:

Q. Did anyone ask you if you needed . . . a refresher course, if you will, with respect to the use of it?
A. No, I was handed one and said, well, you don't need any training on this; you already know it.[71]

Coal miner Fraser Agnew started at Westray in April 1991 and did not receive the proposed orientation package for experienced coal miners:

Q. When you started at Westray, did you have any type of orientation or training?
A. No, I didn't.
Q. None whatsoever?
A. No, other than sign papers. That's all I did.[72]

That was typical for experienced miners. For workers new to the underground, the orientation for most of 1991 consisted of paperwork and the issue of mining gear. A few were fortunate enough to get instructions on self-rescuers or a few tips on mine hazards. Aaron Conklin, who left a job with the surface construction company at the site to start with Westray on 1 April 1991, had no underground mining experience. He recalled that his foreman, John Bates, talked to him for a couple of hours, demonstrated the self-rescuer, briefed him on a mine map, and showed him the working

69 Hearing transcript, vol. 28, pp. 5763–64.
70 Hearing transcript, vol. 25, pp. 4953–54.
71 Hearing transcript, vol. 24, p. 4870.
72 Hearing transcript, vol. 35 p. 7645.

face, before putting him to work with another miner at the feeder-breaker in No. 5 Cross-cut.[73] That was the most thorough introduction to underground work at Westray described in any miner's testimony.

Perhaps the most telling example of Westray's treatment of employees is the experience of Matthew Sears, a new worker who started on 6 August 1991. He spent an afternoon filling out paperwork and collecting his gear. He was told he initially would be a labourer on the belt crew, and would be a certified miner by the end of his training period. He was given no explanations or demonstrations of any equipment until the next morning, when the underground mine manager, Parry, briefly described a self-rescuer. Parry issued a self-rescuer to him, with instructions to put it on when methane levels became too high, and to walk slowly out of the mine while wearing the device or he would be "fucking dead."[74] Parry then took him to the portal of the mine, pointed out the lights belonging to a crew working several hundred feet down the tunnel, repeated his comment over the noise of the main fan, and shut the door behind the new recruit. Sears explained, "Well, to be honest, I thought there might be some lights underground. I was that naive that I didn't realize that it was going to be complete darkness. And I was rather shocked to just be more or less dropped off, and there you go, go to it." At that point, Sears did not even know how to turn on his cap lamp.[75]

Sometime during the fall of 1991, an abbreviated version of the orientation program was put together. New underground employees viewed several hours of videos related to topics covered in the course description. There was a film on the self-rescuer and a sample unit to inspect, though still no chance to practise with it. The actual orientation program never reached the standard proposed in plans submitted to the inspectorate. William MacCulloch, the training officer who administered the new and improved orientation, had no mining experience or mine safety training. He was unqualified and unable to supplement the materials or to answer questions about the underground operation. In compensation for MacCulloch's inexperience, trainees were supposed to be given a brief talk by the managers – if and when available.[76]

Lorne McLean began employment as a labourer with Westray in April 1992. He was the last "new hire" and received a cursory version of an orientation program:

> A. We had an orientation day. And that consisted of perhaps, four or five films. One about safety boots, one about [ear] protection. One was a

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73 Exhibit 115.1, pp. 4–5.

74 **Comment** If this is an accurate recollection of Parry's comments, it reveals a disturbing lack of understanding about the function of the self-rescuer. If an explosive air-methane mixture is present, no one should be there in the first place. The self-rescuer is effective against smoke and carbon monoxide, but only if there is sufficient oxygen in the air to sustain life.

75 Hearing transcript, vol. 29, p. 6045–48. Sears was seriously injured after only 12 shifts at Westray, owing chiefly to the company's failure to ensure safe lockout procedures on the conveyor. See Chapter 5, Working Underground at Westray, for details of this accident.

76 Hearing transcript, vol. 41, pp. 9157–61.

Curragh Resources overview, a company tribute type thing. One was the use and deployment of your self-rescuer. And one was the use of the different types of fire extinguishers. Other than that, Allen [Karasiuk] who was the human resources director at that time, said we would have a chance to talk to Roger Parry that day. But Roger was busy that day. So the only actual time we talked to Roger, perhaps, five minutes the morning – the next morning, prior to going underground.
Q. Who did you understand Roger Parry to be?
A. Oh, the boss, the main cheese, I guess.
Q. And what was the nature of your . . . conversation with him?
A. That morning, he told us some various methane levels that we should be aware of. Which he said at the time, "You'll forget as soon as you walk away." And he was right, we did. It was just basically a conversation, you know, good luck type thing.[77]

Despite representations to the Department of Labour as late as Parry's letter to McLean of 5 March 1992, there is no indication that orientation sessions ever covered mining and safety legislation. Miners testified to the difficulties they experienced in obtaining copies of the *Coal Mines Regulation Act*. Mick Franks resorted to "acquiring" his copy from a supervisor's office when he could not obtain one on request.[78] Copies of the *Occupational Health and Safety Act* were distributed to some workers, but without discussion or explanation. Company handbooks were also dispensed, but not reviewed beyond a description of employee benefits; Jonathan Knock recalled that he had been given the employee handbook:

Q. Did you read that book?
A. No.
Q. Did they explain to you when you received it what it was about?
A. Yes.
Q. What did they tell you?
A. Just gave an overall view of what your health care was and dental plan, stuff like that.
Q. And you didn't read it?
A. No.
Q. Did they tell you that it contained any policy, procedures or anything of that nature that you would be responsible to follow while employed at Westray?
A. No.[79]

Company codes of practice for such matters as diesel operation existed but were not issued. Operators said they had never seen the Code of Practice for Non-Flameproof Diesel Equipment while employed at the mine before the explosion.[80] The orientation did not adequately cover

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77 Exhibit 116.1A, pp. 9–10.

78 Hearing transcript, vol. 21, pp. 4103–04. On being asked if he had also been able to liberate a copy of the *Occupational Health and Safety Act*, Franks responded, "Well, if they treated this the way they treated the Coal Mines Act, I don't think there's much point looking for this either" (vol. 22, pp. 4232–33).

79 Hearing transcript, vol. 26, p. 5231.

80 Neither Knock (Hearing transcript, vol. 26, p. 5247) nor Deane (vol. 26, pp. 5350–51) had seen the code (Exhibit 69b.004), which came into effect in September 1991. Both men regularly drove the diesel-powered boom trucks.

mining terminology, coal mining hazards, safe work procedures, or underground emergencies:

Q. Were there any other safety things that were introduced? Safety devices or procedures that you were introduced to by Westray?

A. No, there wasn't even a . . . discussion, as far as I'm aware, of – on evacuation in case of fire or explosion or what was to take place. Everybody was just kind of . . . in the dark about what the main plan was to do, if something did happen, you know. It was only in the latter part of the year there that we even seen a fire hose.[81]

The Westray miners had to rely on their own initiative and resourcefulness to acquire the knowledge necessary to perform their jobs. The skills they did pick up came mostly through hands-on experience and the assistance of the more experienced members of their teams.

Self-Rescuers

Training newcomers to a mine in the use of emergency breathing devices is an industry practice.[82] At his first mining job in Alberta, Rick Mitchell, for example, had sufficient training on the self-rescuer before going underground that he could put it on properly in the dark.[83] Many jurisdictions even require that miners go through annual practice in donning the self-rescuer within an acceptable time limit. Mine mechanic Clive Bardauskas described the training in the United Kingdom:

> Well, one of the things that they did yearly, once a year, every person that worked underground, they took into a room, they gave them a self-rescuer and they turned the lights off, and they gave them 15 seconds to put it on, to give them some idea what it would be like underground. And if somebody failed, they made him do it again and again until they could actually open the rescuer, get it on the mouth in 15 seconds. Once they achieved that, they'd give them a small obstacle course to go through because when the self-rescuer is working, it gets hot. So they wanted to give everybody a good idea what it would be like to use this. And that was done every year to everybody.[84]

Expert witness Andrew Liney had this to say about self-rescuers: "They are an easy thing to put on when you're taught how to do it, but an extremely complicated looking thing if you're not really sure. And I doubt anybody who hadn't got through training could even conceive of putting one on."[85] Yet Westray management simply issued the equipment, mostly without explanation of its function and use. Sometimes a cursory explanation or a demonstration or video was provided, but there was no opportunity to practise. Some workers did not know the purpose of the

81 Pre-hearing interview with Wayne MacPhee, undated (Exhibit 116.1A, p. 8).

82 The self-rescuer that was issued to every underground worker at Westray is shown in photograph 9 in Reference.

83 Hearing transcript, vol. 31, p. 6847.

84 Hearing transcript, vol. 23, p. 4578.

85 Hearing transcript, vol. 19, p. 3674.

self-rescuer.[86] Robbie Doyle, one of the miners killed in the explosion, had earlier reported that he thought the self-rescuer was a first-aid kit.[87] Rick Mitchell reported that a novice coal miner sent to the face for training as a continuous miner operator surmised that his self-rescuer was a band-aid holder.[88] Underground electrician Harvey Martin remained unaware of the use of his self-rescuer for three months. Then he witnessed a mishap where another miner's self-rescuer accidentally broke open, giving those present an opportunity to examine the device.[89]

Some recruits were instructed by more experienced co-workers or supervisors. Jay Dooley thought it was a joke when a miner in his crew asked what the self-rescuer was for. He was appalled to realize that the miner was serious and that others on his shift were similarly uninformed, including Nova Scotia–certified coal miners:

> A. Well, it was total amazement to me that someone could get in this underground mine carrying this here exhibit here on the far right there on their belt, and (1), not knowing why they're carrying it; (2) not knowing what is in it; and most importantly, how this man was ever in this mine without this training was unbelievable. I just – I couldn't fathom that. I wasn't used to anything like that.
> Q. Approximately when did that happen? Can you recall?
> A. We were in the Southwest district, because when it was brought up to me, the whole crew was stopped at the C-1 Main intersection. And I proceeded to give a demonstration about the W65 and its use and when to wear it, and how to don the apparatus, and that kind of a procedure, but I was more interested in getting to the surface to find out who the man was that gave him this W65 and nothing else to go with it.
> Q. And did you . . .
> A. I certainly did that. I had approached Mr Roger Parry.
> Q. Tell me about it.
> A. Well, he was in the understanding that Mr Karasiuk had – this man didn't know the self-rescuer and that maybe he was pulling your leg. I said "Well, he may have been, but there was others on that crew that admitted that they had no knowledge of this W-65 either." And I believe there was four people on that crew that didn't know why they were carrying that on their belt.
> Q. Something that basic?
> A. Not that basic. Your life depends on that little box.[90]

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86 Steven Cyr told the Inquiry about an incident in March 1992, while he and some other Westray employees were waiting to be tested for their miner certification: "Romeo Short was there, and it kind of surprised me because he came up and he asked what this thing does and he was shaking his self-rescuer. And I said, 'That's your self-rescuer.' He said, 'I know . . . but what does it do?' I told him" (Hearing transcript, vol. 25, p. 5116).

87 Doyle had been talking to Bob Burchell, the United Mine Workers organizer (Hearing transcript, vol. 44, p. 9642).

88 Hearing transcript, vol. 31, p. 6681.

89 Hearing transcript, vol. 23, pp. 4435–36.

90 Hearing transcript, vol. 38, pp. 8403–04. Tom MacKay had been given a certificate of competency in May 1991, before being hired on by Westray. He had underground experience but was never trained in using the self-rescuer. He finally saw one opened up "around Christmas time" (vol. 32, pp. 7005–10).

Classroom Training

Westray's training proposal identified appropriate amounts of classroom training for workers with varied work experience, in addition to the two days of classroom orientation to be given to every new worker before underground deployment. Total amounts were to range from 6.5 days of classroom training for experienced coal miners to 11.5 days for former hard-rock miners, to 16.5 days for new employees with no underground experience (see table 4.2).

According to the company's training summaries, classroom training after workers had started their underground assignments consisted of a single short session on the company's approach to ground control, a WHMIS session for a few workers, and courses for mine rescue trainees or new supervisors.[91] Few of the classroom hours outlined in the proposal ever happened. Some workers had a four-hour session on conveyor belt repair, and tradesmen had training sessions on the repair and maintenance of equipment. Fire-fighting and fire prevention training, described in the training proposal as 16 classroom hours and a half-day of close personal supervision, was actually a one-hour surface demonstration of fire extinguishers.[92]

Electrical and Mechanical Trades Training

Electrical and mechanical tradespeople had their trades training programs, but they were not given adequate training on the requirements for safe performance of their trades underground. Harvey Martin had no underground experience when he signed on with Westray as an electrician. Allen Karasiuk led him to believe that he "would be trained in all aspectsof underground coal mining."[93] Mechanic Wayne Cheverie, then an apprentice, described his preparation for the underground:

> Q. So what direction – or what guidelines were you provided before you went underground?
>
> A. None whatsoever. I was given manuals for the mining equipment that I would be responsible to look after, told to go home and read them over for three or four days and that I would be the shift mechanic in four days' time on night shift.[94]

Although electricians and mechanics were given some workshops on maintenance and repair of particular pieces of the underground equipment, they did not get any more general orientation than the miners did. Cheverie was left to acquire information on special risks in the coal mine from other mine workers "only as things came up in conversation or in our

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91 Exhibit 119.281–88.

92 Ed Estabrooks described this minimal "fire training" (Hearing transcript, vol. 24, p. 4867). Steven Cyr was one of the "three or four of us . . . out of . . . probably 20 or 25 guys there" to extinguish a sample fire (vol. 25, pp. 5108–09).

93 Hearing transcript, vol. 23, pp. 4431–32.

94 Hearing transcript, vol. 20, p. 3926.

Table 4.2 Proposed Training Times by Level of Experience, Mine Operations, in Days

Previous level of experience	Classroom training	Close personal supervision	Total
Underground coal experience			
Core modules only	6.5	2.0	8.5
Underground hard-rock mining experience			
Core modules	6.5	2.0	8.5
Supplementary modules			
7 mine gases	1.0	0.5	1.5
8 fires and explosives	1.0	0.5	1.5
10 electrical hazards	1.0	1.0	2.0
11 coal haulage	2.0	5.0	7.0
Total	11.5	9.0	20.5
No underground experience			
Core modules	6.5	2.0	8.5
Supplementary modules (6–13)	10.0	24.0	34.0
Total	16.5	26.0	42.5

Source: Westray Coal Training Proposal draft, 26 June 1990, Table IV (Exhibit 119.045).

situations."[95] Cheverie recalled that he had first learned about the prohibition of electrical jumper cables underground only by a chance meeting with experienced coal miners as he was carrying a set of cables to use down in the mine – as he had been directed to do by the maintenance superintendent.[96] Franks described the electricians' dependence on advice from co-workers in lieu of training, and the lack of guidance by his supervisors:

> A. I found that if you went and talked to the supervisors, they'd just ridicule you for not knowing what was going on. And after a while you got sick of being ridiculed so you'd go talk to . . . the miners, you know, and they'd set you straight usually.
> Q. Well, how would they expect you to know what was going [on]? What to do.
> A. My impression of it they didn't want you to know what was going on; they wanted to keep you in the dark.[97]

Martin's experience was much the same:

> A. [T]he carry on was that if you didn't work for the British Coal Board or work in a coal mine before that you were – he [Brian Palmer, the electrical foreman] always told us we worked in a panty hose factory.
> Q. A what?
> A. A panty hose factory.
> Q. Why would he tell you that?

95 Hearing transcript, vol. 21, p. 4077.
96 Hearing transcript, vol. 20, p. 3981.
97 Hearing transcript, vol. 21, pp. 4114–15.

A. Oh, we just brushed it off as a joke, but . . . to me it was more or less an insinuation that we had no experience and just – you know, grab onto his apron and follow him around type of thing.
Q. Did you find Mr Palmer safety conscious?
A. No, not really. Not to what . . . my experience was working in other industry for safety practices. We never did have any lockout systems like as what I knew as a lockout system. We had no lockout procedures and . . . I always thought "Well, I never worked in an underground coal mine. Maybe this is the way they do things." You know, I figured well, these guys have been working in this stuff for years. Maybe they know what they're doing.
Q. But the safety procedures in place didn't seem to square with your previous industry experience?
A. No, not as far as locking out stuff before you'd work on it or anything like that. It didn't seem to . . . be what I had experienced before. [98]

Journeymen with no mine experience and apprentices with very little work experience of any sort were sent into sections of the mine on their own.[99] Martin was called in at 11 pm one night to cover a shift by himself, although he had never worked underground alone before. Despite his uneasiness, Martin agreed to do it to relieve his supervisor, who had been on duty for 15 hours and needed someone to relieve him: "Yeah, well . . . I told him [Brian Palmer] on the phone that I didn't want to come in because I was by myself and I . . . was nervous being there by myself because if something went wrong, I didn't know really what to do."[100]

The attitude of management and the rush for production had an adverse effect on the training of tradesmen; it also hampered the development of any program for consistent reinforcement of workplace safety. The tradesmen were required to fill out daily reports on their work and the condition of the equipment, but safety concerns noted were not addressed in a timely fashion.[101] According to Franks, when electricians and mechanics reported problems such as communications failures in the environmental monitoring system, a cable slowly burning on the main conveyor drive, or a slow leak causing a compressor to overheat, no attempt was made to find a solution:

> So Bob's [Bob Parry, maintenance superintendent] answer to the [compressor] situation was get a bunch of rock dust, throw rock dust under it to soak up the oil, get some fire extinguishers, put three fire extinguishers on the wall and set up a water hose just – well, I assumed in case she went on fire. I mean, he never used those words. But to repair it – they never did repair it.
>
> Wayne and I used to go back . . . every set of shifts and add oil to it . . . It was never repaired. It was just – instead of shutting the compressor down and repairing it – it was only a gasket that was blown, they'd rather just

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98 Hearing transcript, vol. 23, pp. 4472–73.

99 Bardauskas (Hearing transcript, vol. 23 p. 4576); Franks (vol. 21, p. 4100).

100 Hearing transcript, vol. 23, p. 4445.

101 Franks suggested the reports were never read. Larry James had even written a shift report in Welsh that went through the system unnoticed by his supervisors (Hearing transcript, vol. 21, p. 4120).

keep it running and prepare for a fire was my idea of the way he was doing it anyway. That was Bob's way of running things.[102]

Practical Training Underground

Workers on training crews were shown what they needed to know to complete their current assignments in roof support or belt conveyor maintenance, but they were not systematically instructed in mine hazards, safety requirements such as stonedusting and ventilation, or emergency response.[103] Novice miner Ted Deane described his bolting crew's response to smoke from an overheated conveyor belt roller: After senior miners had told them to "head out and go down to the fresh air," they were confused about which way to go – they were not sure where the fresh air route was.[104] A worker with no previous mining experience might be assigned to the working face within weeks of hiring on, if underground management was satisfied with his attitude and work habits, or if the press of work demanded more workers than were qualified.[105] New miner Lorne McLean described his assignment to clean-up work after a roof fall in the Southeast section:

A. . . . we just drove in and – actually, that was the day they had a little bit of roof fall down in southeast. And then Bryce took the other trainee and I – I think it was the fifth day we worked there, the sixth day maybe. It was in our second set. And he took us down there to help weld arches together at the roof fall, which I thought was a little strange to have two guys there with five days experience at a roof fall bolting arches together. We were beyond terrified. Nelson LeDrew took off running and I just slapped the guy to get on with me and it was right on his heels.
Q. Why did you take off?
A. I just took off because Nelson did. I figured he was an experience[d] miner and I was right on his heels.
Q. And why did Nelson take off?
A. There was rock fall behind us and he . . . explained to us, you don't want to be in the middle, which makes perfect sense sitting here around the table. But when you're down there and we just heard some rock fall, and me and the other guy were just, you know, "Wow, there's more coming down." But Nelson caught on really quickly. And like I say, we were like the three musketeers, just zoom, gone. But that was, you know – we had no idea. And Bryce had said he would be there with us. He would be personally responsible. Nelson would be with us all the time we were there, he told Aaron.
Q. . . . was Bryce there?
A. No, I have no idea where he went after that. He was personally responsible for us, I guess.[106]

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102 Hearing transcript, vol. 21, pp. 4117, 4129–30.

103 Jay Dooley, referring to the "non-existent" training on the bolter, miner, and shuttle car, said: "But . . . we had no facility that trained people in those areas" (Hearing transcript, vol. 38, p. 8399).

104 Hearing transcript, vol. 26, pp. 5409–10.

105 Bryce Capstick (Hearing transcript, vol. 42, pp. 9340–41).

106 Exhibit 116.1A, pp. 116–17.

Some of the foremen were concerned about the assignment of inexperienced miners. Fraser Agnew explained at the Inquiry:

> Q. Did you feel that men were receiving proper training before being deployed to a production crew?
>
> A. No. I don't think they were, a lot of the young fellows. Some of them were young guys that never had any mining experience at all.
>
> And then there was guys that had hard rock experience. At least somebody with hard rock experience, if they didn't have the methane and knowing what methane is about, at least they had the roof conditions down that they knew enough to get out of the way of a piece of falling rock or whatever.
>
> But when you've got a green boy off the street, and he's down in the North Mains, and he's setting arches for a few weeks, and he's at the face, I don't think that's very fair to put him there.[107]

Initially, an experienced coal miner was put in charge of the training crew, but as mine conditions deteriorated and the original trainer moved to a different job, the training crew became an arching and labour crew.[108] Even with the first leaders, training beyond the fundamental skills for the work at hand consisted of an informal collection of anecdotes and conversations.[109]

By 1992, the leadhands responsible for training new employees on the belt crews included workers who had only their Westray experience to draw on. Belt crew leadhand Aaron Conklin described how he had learned from the men he was supposed to be training that the flashing lights on the environmental monitoring system were meant to warn of hazardous gas levels:

> I didn't know that, so the trainee told me. . . . four new trainees . . . were told some safety stuff and they had films and what not, eh? And Joey Fenton, I believe, or Ron told me what this flashing light was. I didn't know what it was. I thought it was something the engineers had there flashing to figure out how much movement there was . . . he said I hear the CO, the methane tester started flashing, you were to get out of there. I didn't let on I didn't know, mind you.[110]

Conklin, who had no mining experience except at Westray, explained that trainees got nothing from him regarding mine safety: "As far as what I was teaching them about the belts, I feel competent that what I was teaching them was good. But . . . I wasn't doing coal mining, so I couldn't . . . teach them anything about coal mining."[111]

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107 Hearing transcript, vol. 35, p. 7671.

108 Don Dooley had definite opinions on the "training crew": "It was just a farce" (Hearing transcript, vol. 36, p. 7760). "It was a labour crew . . . Once we started setting arches, that was mainly what the training crew did" (vol. 37, pp. 8230–31).

109 Steven Cyr worked on John Bates's training crew for a month: "No, he never taught us that stuff [about methane and coal dust] . . . there was no training or anything, no" (Hearing transcript, vol. 25; p. 5096).

110 Pre-hearing interview, 6 August 1992 (Exhibit 115.1, p. 145).

111 Hearing transcript, vol. 28, p. 6009.

Close Personal Supervision

Gerald Phillips attended a meeting of the board of examiners on 10 April 1992. He informed the members that initial practical training from six weeks to three months was provided, always "under close supervision." Later training for work at the face was also said to be followed by six months of close supervision.[112] After classroom training, workers were supposed to work with qualified coal miners to observe and practise safe mining under the guidance of more experienced co-workers. Andrew Liney described the British version:

> I had to spend 20 days underground on what's called "close personal supervision" which means I wasn't allowed to do any task on my own. I had to move within arm's reach of an approved person who signed for me on a daily basis. So I did what he did. He showed me how to do it, then he let me do it, but . . . I was never doing it on my own.[113]

This practice was not followed at Westray. New workers were not consistently deployed under the close supervision of experienced coal miners. Inexperienced and inadequately trained workers were given work in the mine that should have been assigned to qualified miners, sometimes without the benefit of working alongside more experienced co-workers. There were too few qualified coal miners to provide adequate close supervision of the new worker. This may not always have been the case, but, as the mine expanded and split into several separate working sections, inexperienced workers were advanced to complete the crews at the face.

Section 50(2) of the *Coal Mines Regulation Act* requires that "no person shall be employed at any work at a working face in a coal mine" unless certified as a coal miner, under the control and direction of a certified miner, or employed at a working face approved by the minister as a training place. The April 1991 designation of the entire Westray mine as a training place may well have permitted Westray management to avoid the more stringent requirements for close supervision of uncertified workers, although that would certainly not have been the original purpose of that provision in the act. Generally accepted industry standards, the company's own representations, and good safety common sense would dictate that novice miners learn their skills under the supervision of experienced coal miners. The fact is, there were not enough experienced underground coal miners to fulfil this mandate, and inexperienced underground workers were left to learn what they could from experience – with little or no safety indoctrination at the face.[114]

Hard-rock miner Wyman Gosbee worked from November 1991 to March 1992 on a bolting crew without a certified miner, until he and

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[112] Exhibit 76.17.064.

[113] Hearing transcript, vol. 18, pp. 3267–68.

[114] Jay Dooley told the Inquiry about the problems of mining with inexperienced people. Even *before* the mine was split into two working sections, with nine people in a crew, "you know that four of these people are certified coal miners. You know that the other five . . . are not certified coal miners" (Hearing transcript, vol. 38, p. 8396).

others hired at the same time became eligible for certification themselves. During a shift working under difficult roof conditions, he complained to his foreman, Arnie Smith:

> A. And I had told him, I said, "by law . . . we're not even supposed to be in here bolting . . . none of us are certified." And then he had come back with the answer that, "Well, I'm certified and I'm in here all the time with you."
> Q. And was Mr Smith in there all the time with you?
> A. No . . . [115]

Certification as a Competent Coal Miner

During the rock tunnel driveage, Westray had been given an exemption from the *Coal Mines Regulation Act* requirements for certified miners. Once the mine got into coal, the requirement was reinstated.

Overman Jay Dooley estimated that, even as late as the spring of 1992, one in ten workers underground were properly trained coal miners.[116] Bryce Capstick reported that he had only one experienced coal miner working on his crew, along with a few hard-rock miners, and that the balance had no mining experience before Westray.[117] Neither Dooley nor Capstick considered that those who received their training and certification at Westray were properly trained and qualified.

Westray workers said that the testing of miners for Nova Scotian certification often consisted of only one or two questions, sometimes not even related to mining. John Lanceleve described his testing for certification as a coal miner:

> Q. And what did the test consist of?
> A. Two questions that I recall.
> Q. And what were they?
> A. What would you do in the case of an underground fire? And I just told him [Albert McLean] I would put on my self-rescuer. And he asked me what way I would escape or evacuate the mine. I told him up the fresh air.
> Q. And were those the only two questions?
> A. The third one was do you have $20.[118]

This superficiality was in stark contrast with descriptions of certification tests in other Canadian jurisdictions. In Alberta, Doug MacLeod, for example, had undergone lengthy oral questioning conducted by a panel of management, inspectorate, and labour representatives, covering all aspects of underground coal mining. He was even required to demonstrate proper

115 Hearing transcript, vol. 25, pp. 4967–68.

116 Hearing transcript, vol. 38, p. 8399.

117 Hearing transcript, vol. 42, p. 9340.

118 Hearing transcript, vol. 27, p. 5535. Westray miner Normand Lavigne related a possibly apocryphal tale about a certificate applicant who was asked, " 'where you from, Bud?' He said, 'Cape Breton.' Then the guy said that's good enough for me and he got his ticket" (Statement to RCMP, 9 June 1992, p. 6).

ventilation of a five-road system on a mine plan. In Nova Scotia, he was asked one question.[119]

Albert McLean, the Department of Labour mine safety officer who administered coal miner certification, said that Nova Scotia regulations do not require the testing of candidates for certification at the coal miner level. The work history on the application form and the supervisor's signature were sufficient to satisfy the requirements of the act. His cursory testing was merely "doing a favour," asking a few questions that he thought "might have been [of] some interest to the miners." He was not aware of any requirements for establishing that candidates under the six-month rule actually received systematic training.[120] He did not believe that any inspectors examined training logs, and could not say when he had learned of the board requirement for training logs to be submitted for review:

> Q. But did you know that this was the way it was supposed to be operating?
> A. I – right offhand, I don't – I can't recall it. It might have been discussed somewhere, but I never got a copy of this letter to the Board.
> Q. But if it's possible that it might have been discussed so that you knew it, why didn't you or somebody check to see if it was being complied with?
> A. Sir, I was under the impression the same thing, conditions at Westray was what took place at Donkin Mine.
> Q. And was that the same condition?
> A. That's – six months, the application would be filled out by the management and said the man, person, worked that and was given a certificate.[121]

Nova Scotian certification "testing" did not confirm any appropriate level of knowledge in the candidates. The process did not verify that candidates had the minimum work experience or training. Many of the miners certified at Westray did not meet basic conditions of length and type of work history necessary for certification. The testing did not detect these deficiencies. It does not appear that there was confirmation by the inspectorate of the information in miner candidates' application forms. The inspectorate did not confirm with the candidates that they had received the training or worked the reduced six months. The application forms had been prepared by the company from drafts filled out by the miners. There were indications that some forms had been adjusted to bolster the credentials of applicants. They were signed by senior management rather than by the direct supervisors. The applications were not scrutinized to detect such inconsistencies as Aaron Conklin's supposed work history of 24 months as a "trainer as belt man" at Westray when he had started there only eight months prior to the certification application

119 Hearing transcript, vol. 27, pp. 5625–28. Randy Facette (vol. 33, pp. 7226–27) and Rick Mitchell (vol. 31, pp. 6667–70) also testified to the rigorous testing they went through in Alberta and BC.

120 Inquiry interview, 13 December 1995 (Exhibit 86.1, pp. 131–35).

121 Hearing transcript, vol. 57, pp. 12495–96.

date. Phillips had signed the verification of work experience.[122] Evidence of deficiencies was not pursued. Lanceleve, for example, was asked how long he had worked underground and responded that he had five years in hard-rock mining. He was not asked about his time in coal mining. At that point, he had been employed by Westray for only 25 days and had worked about 12 shifts in whatever coal was encountered during the Westray tunnel driveage to 8 May 1991.[123]

William MacCulloch, the Westray training officer, had no mining experience and did no underground training. He regarded himself as a training "administrator." He kept no records about underground training beyond certification application forms. He knew little of what took place in the mine other than the program description Westray had sent to the Department of Labour.[124] He could not name the three persons characterized as underground trainers in that program description.[125] He claimed it was the underground supervisors' job to train the workers, the workers' responsibility to ensure that certification applications accurately represented their training and experience, and the inspectors' function to test the workers.[126]

The underground supervisors understood that their job was to oversee coal production. They were critical of the trainees' inadequate preparation for production work. They regarded that preparation as the responsibility of the so-called training crews, or the training officer. The training crew supervisors taught the conveyor maintenance and ground support work, and in some cases did not have the work background necessary for training others in coal mining safety.

Many applicants placed little value on the certificates. Aaron Conklin was certified even though he had minimal experience at a working face. He was asked a single question, "What would you do in case of a fire?"[127] He spoke of his lack of regard for the certification process:

> Well, I was told before that the test wasn't that hard. And I can't remember who had told me, but it was more or less relayed to me through the miners that even if I did get that – when I got that paper, as far as they were concerned, it didn't mean squat. I still had a lot to learn. . . . I never placed any big emphasis on that certificate, except the fact that it meant the company was going to give me a raise. It was a piece of red tape, as far as the government was concerned.[128]

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122 Hearing transcript, vol. 28, pp. 5955–57. Conklin was a trainer for the belt crew within months of his being hired as a complete newcomer to mining himself, and well before his own certification.

123 Hearing transcript, vol. 27, pp. 5536–37.

124 Hearing transcript, vol. 40, pp. 9018–31. This program description was in the 5 March 1992 letter from Parry to Albert McLean (Exhibit 119.116). MacCulloch made an interesting attempt to use this letter, which he had drafted himself from Parry's information, as support for his contention that underground training must have happened as described.

125 Hearing transcript, vol. 41, p. 9227.

126 Hearing transcript, vol. 40, pp. 9028–29. **Comment** I wonder, in light of all this delegation of responsibilities, what the "training administrator" actually did.

127 Hearing transcript, vol. 28, p. 5960.

128 Hearing transcript, vol. 28, p. 6014.

Many applicants were not aware of the requirements for certification, or of any false or misleading information in the final version of their applications. Little effort was made to correct misleading information. The inspectors gave approval for certification, assuming that the company training proposal had been implemented. The test administered by the inspector was a farce. The Department of Labour relied on the company acting according to its own proposals and representations.

Doug MacLeod had worked as a surface labourer for CMD and had about a month of underground experience by the time Westray hired him on 1 April 1991. Within two weeks, he was second operator on the Dosco Roadheader. On 17 April 1991, he received his certificate of competency as a coal miner. He understood this rapid promotion reflected the company's need for a certain percentage of certified miners. His application form contained misleading information, inflating his CMD underground work to a year and omitting to mention that his two years' previous mining experience had been in a surface gold mine. The form had been signed by both Phillips and Parry, and by MacLeod himself. He could not recall if he had read the final version before signing.[129] His coal mining experience consisted of 12 shifts in whatever coal had been encountered in the tunnel driveage during March and the first half of April 1991. He was tested by a single question addressed to a group of six candidates:

> Q. And what did the test consist of?
> A. He asked me – I believe it was one question. It was about ventilation. I don't know if I answered it or not. And he said "Good."
> Q. What do you mean you don't know if you answered it or not?
> A. I think I said "yeah," or because I didn't know nothing about ventilation after, what, eight days in a coal mine. I know if you get air, you're all right, you know, by that time.
>
> . . .
>
> Q. When you were in this room with Mr Parry and Mr McLean and the other individuals, did Mr McLean ask you anything at all about what your background was as far as coal mining went?
> A. I believe he said something about "Did you ever work in a coal mine before?" And Roger Parry answered that for me. He said "Yes."
> Q. Roger Parry answered the question?
> A. Yes, he did, yes.
> Q. Do you remember that, as you're sitting here today?
> A. I remember that as I'm sitting here today because I just looked at him and didn't say a word.
> Q. Why didn't you say anything? Why didn't you correct him?
> A. Oh, I don't really know that, why I didn't correct him. It was just that I got a piece of paper for nothing.[130]

There was an effort to increase the percentage of workers with certification. In an Inquiry interview, miner Rick Mitchell described how

[129] Hearing transcript, vol. 27, pp. 5610–15.

[130] Hearing transcript, vol. 27, pp. 5616–18.

he had looked for a certified miner to represent the North mains crews on the safety committee:

A. . . . anyway, we found one in the southwest section, Ferris' crew, Trevor. Well, we worked out west with him. But we went down there [in the North mains] and there wasn't one black tag in both sections.
Q. So there were two sections working and there wasn't a qualified miner in the whole crew?
A. But when we told Roger, all of a sudden the black tags were coming out like Rice Krispies, you know.[131]

The certification process did not monitor for the improper assignment of new employees or check directly on the actual experience of trainees. At Westray, an increase in the percentage of certified miners did not mean an improvement in the qualifications of the workforce.

Claude White suggested to the Inquiry that an improved process for verifying the existence and effectiveness of company training programs was one of the major ways in which the performance of the inspectorate could be improved. He suggested that inspectors sit in on training sessions to audit the program and that this classroom contact would open the possibility for more frequent and better communications with the workers.[132] The certification testing process could be made into a more reliable demonstration of candidates' knowledge and skills. The checking of qualifications could be more rigorous than the few oral questions asked of applicants for miner's papers.[133]

To White's list should be added the review of qualifications necessary for the various jobs in a coal mine so as to make certification more reflective of the knowledge and skills necessary in modern mining. The certification process did little to ensure that Westray miners had the training and experience necessary to perform their jobs safely.

Training for Mining Equipment

Pay scales in the mine were tied to the underground manager's assessment of workers' abilities to operate the three major pieces of equipment – the continuous miner, the shuttle car, and the roof bolter.[134] Assignments that gave the opportunity to learn from crew mates and to practise on this machinery were largely made by the underground manager, based on his

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131 Exhibit 115.1, pp. 155–56. "Black tag" is the miners' term for the certificate of competency as a coal miner.

132 Hearing transcript, vol. 63, pp. 13808–09.

133 **Comment** These suggestions are a startling commentary coming from *the* man whose responsibility it was to ensure safety in the mine. White was, after all, a mining engineer and had been director of mine safety since 1988, after wide experience in mining, including a term as instructor in mining at the University College of Cape Breton. His suggestions seem to have been offered as though they were new ideas aimed at improving the qualifications of miners. It was always within White's power and indeed was *his* responsibility, to ensure that *his* inspectorate, at *his* direction, was enforcing conformity with the certification requirements of the *Coal Mines Regulation Act*. My impression is that White viewed his job as seeing that the system worked and that others were discharging their responsibilities. White's comments at this time and in this context suggest nothing more than a shallow attempt to deflect attention from the grossly incompetent performance of the inspectorate he directed.

134 Photographs 1–7 in Reference illustrate the large equipment in use at the mine.

assessment of ability and on the production schedule. Opportunities to acquire these skills were an additional enticement to work overtime. Setting the pay scale in this fashion provided an incentive to learn new skills quickly – skills perhaps not consistent with safe practice.

In some Canadian mining jurisdictions, everyone must participate in an extensive training and testing program before being permitted to use the equipment at a mine site. Bryce Capstick explained one system that he was familiar with:

> Every mine, even every contractor that goes onto a mine site has to go through an orientation as to . . . occupational health and safety, what their regulations are on site, fire regulations, what safety equipment is being used.
>
> And a lot of the mines now, you have to have what's called a common-core ticket. And a common-core ticket is an extensive program in which you have a licence, it's like a driver's licence, for everything . . . you're to do in that mine. If you were to use a drill to drill a hole, you had to have a licence to operate that drill. To operate any piece of equipment, for that particular piece of equipment you must have a driver's licence. And there's no grandfather clauses. In other words, if you have 20 years' experience around that equipment, nothing's rubber stamped. You've got to take the course the same as a new fellow. You've got to prove that you can operate that equipment. You've got to prove it in order to get a driver's licence.[135]

Westray did not have such a program to prepare and test operators. Practical training for bolting or for operating coal production equipment consisted of opportunities to observe while others performed the tasks, and then to perform the work while those others offered comments and suggestions. There was no standardized program of instruction and testing by qualified trainers. As miner Wayne MacPhee said in an Inquiry interview:

> When I mentioned training, well, the men were sent down to take on a job, to train or whatever. But nobody, nobody was a qualified instructor as such. . . . they just sent this gentleman down with me and said "Okay. He's going on the bolter with you." I was never ever certified or checked out by anybody to say, okay, this man's a qualified instructor. If I got bad habits, I'm going to pass them on to him. You know what I mean? And this was the system. You know what I mean? You were left at the pity of some other poor bugger that was trying to do his job, you know? And the attitude, to me, was well, "You get this bolted and you get it done now as fast as you can to get into the other heading." Right? So . . . this gentleman here with me would pick up my habits. And it's the same thing on the miner. There was no particular person that went about the mine, checking guys out on the equipment, saying, "Okay. You are certified to operate this piece of equipment." Or, "You are certified to train personnel on this equipment." There was no such thing.[136]

There was little training for experienced miners from other mines, new to the layout and equipment at Westray. Experienced continuous miner operator Buddy Robinson testified that, on his first day at Westray, he was

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[135] Hearing transcript, vol. 42, pp. 9343–44.

[136] Exhibit 116.1(A), pp. 21–22.

assigned to unfamiliar and dangerous work from the bucket of a "much bigger" Scooptram than he was used to.[137] Miner Randy Facette, who had been out of the industry for several years, was put to work on a roof bolting crew. He had done similar work before, but described Westray's unfamiliar bolters as "quite the monsters; they were huge compared to what I was used to."[138] Miner Ed Estabrooks, who had also been out of mining for many years, was roof bolting within days of his arrival at the mine. The other men working the bolter trained him; as he described it, "They just proceeded to say this is the way it's done and showed me how it was done and that was it."[139] Hard-rock miner Carl Guptill found himself digging a hole in the floor of the mine when he had just been trying to level it with a Scooptram. The dusty air obscuring vision and the soft roadway material turned a familiar task into something for which he was not prepared.[140] David Sample talked to his supervisors about his discomfort with his assignment as first operator on a continuous miner when he had no depillaring experience.[141] He was given the job despite his misgivings. Hard-rock miner Lenny Bonner described his instruction on the use of the shuttle car:

> Well, I was told what made it go forward and backward. I was told: "This is the brake." I was told not to let off on, I guess you could call it the "gas pedal" because the machine would free-wheel. And that's basically all I was told, "Give it a try."[142]

In early 1991, some shuttle car training had apparently been done on surface.[143] As the mine enlarged, the cars and other equipment were required for production work, and surface training ceased. The shuttle car was tricky to handle, and learning on the job meant that both men and machines were at risk of collision. Lanceleve had never driven a shuttle car before Westray. He described his training:

> A. Well, I was showed how to start the pump, and I was showed high tram, low tram, . . . how to run the conveyor and release the brake. And Glyn Jones was my fire boss at the time. He jumped in the car and said "Go ahead, drive it down to the miner" and that was it, I was gone from there.
> Q. How did you find it driving that car, Mr Lanceleve?
> A. Pretty hairy at times, starting out.[144]

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137 Hearing transcript, vol. 30, pp. 6292–93. Robinson told his foreman that "that's my last trip up there."

138 Hearing transcript, vol. 33, pp. 7152–53.

139 Hearing transcript, vol. 24, p. 4871.

140 Hearing transcript, vol. 29, p. 6167.

141 Hearing transcript, vol. 30, pp. 6480–81. Sample had spent about 2½ months under the tutelage of Robinson and knew that he was not yet experienced enough.

142 Hearing transcript, vol. 24, p. 4724.

143 According to Sample, "that was what I had considered the only formal training I had received" (Hearing transcript, vol. 30, p. 6515).

144 Hearing transcript, vol. 27, p. 5464.

Another concern was the number of electrical cables pinched and sparking as the shuttle cars moved along the roadways. The combination of big cars, sensitive controls, steep slopes, tight corners, and inexperienced drivers made cable damage and similar perils inevitable. Westray miner Kenny Evans told of teasing an inexperienced shuttle car driver who held a record for the number of electrical cables damaged at one time.[145] Malcolm McPherson commented on inadequate equipment training and consequent cable damage as a potential ignition source for a coal mine explosion.[146] Other equipment offered similar risks to ill-trained operators.

Training for Mobile Diesel-powered Equipment

Operators of mobile diesel-powered equipment, such as the Scooptram, got similar training – a few minutes of demonstration of controls, a practice run, and then to work.[147] There was no systematic training in the use of some of the mobile equipment, most notably the farm tractors, which were only to be operated subject to special permits that restricted their use. These vehicles were to be equipped with specified safety features. They were not to be used in return air, in air containing more than 0.25 per cent methane, on roadways with more than 15 per cent combustible matter in the dust, past the last open cross-cut, or within 100 m of the working face.[148] The safety features and restrictions on operation were key to the level of danger they created in the mine.

The inspectorate assumed that workers would be informed about the conditions, would always know which was return air, and would be able to assess 85 per cent non-combustible levels by visual inspection. The company gave assurances that the diesels would be used properly, that workers would be informed about the conditions, that supervisors would insist on strict adherence to the rules, and that signs would be posted at the limit of permitted use. Testimony from the miners largely contradicts those assurances and assumptions.[149]

Operators had a limited or erroneous knowledge of the conditions. Miner Wyman Gosbee testified to the only restriction he had known:

> No, no . . . the only condition that I know of was my shift boss had told me when you supply the bolter, don't leave the tractor in the heading with the

145 "I seen a guy pile into five cables at once. Just about welded a car to the arch" (Exhibit 113.1, pp. 48–49).

146 Hearing transcript, vol. 9, pp. 1702–03.

147 Steven Cyr got "just a couple of minutes" of training on the boom truck from Aaron Conklin, who "wasn't very good at it himself" (Hearing transcript, vol. 25, p. 5098). Cyr, in turn, showed Ted Deane how to operate the boom truck, "so to speak," over the course of one or two shifts (vol. 26, p. 5347).

148 Exhibit 69b.173. This subject is covered in detail in Chapter 5, Working Underground at Westray, and Chapter 12, Department of Labour.

149 See Chapter 5, Working Underground at Westray, and Chapter 12, Department of Labour, for complete discussion.

> bolter. Take it back out to the first open crosscut in the intake side . . . And leave it parked there.[150]

Other drivers had been given similar and inadequate instructions. Jonathan Knock had been directed in April 1992 by Glyn Jones and Jay Dooley not to take the boom truck into the Southwest without a methane check by the foreman, but they didn't tell him why.[151] A sign had been posted at the limit of approved use of the non-flameproof diesels – at the last open cross-cut during development of the main slopes – but only for a few weeks about a year before the explosion. The drivers had not been told all the conditions for use of the mobile equipment, nor had they been given the background to appreciate the reasons for the restrictions. Liney commented on the need to prepare operators:

> Well, assuming that training was given to the operators in a normal, routine way, both when they first joined the mine and when they were trained to be vehicle drivers, obviously, I would have trained them, to some extent, on the importance and the significance of why they were being asked to keep out of the returns. Because I feel that people who came from, probably, rock mining backgrounds probably thought it was a relatively arbitrary distinction. I mean, it doesn't look any different. There's no sudden place you come to in the mine that suddenly looks like a dangerous place compared to the place you've just been.[152]

Workers could not have detected some instances of unacceptable use of tractors, since many lacked the expertise to recognize when they were in return air, particularly in the Southwest ventilation route. Knock, for example, had known he was not supposed to take the tractors in return air, but only learned of the return air route in the Southwest during the Inquiry hearings.[153] Electricians who used a tractor to retrieve gear during the retreat from Southwest 1 had not appreciated the risks. Michael Franks recalled at the Inquiry:

> A. Oh, yeah. I remember we . . . didn't know whether to take the tractor in or not, but we were never told that there was high gas there. So we kind of decided between ourselves to take the tractor in. We probably thought it was kind of a stupid move, but we took it in anyway. And when we got in there, Roger Parry came busting through the stoppings and shouted at us . . . "What are you guys, a bunch of fucking brain-dead cocksuckers" . . . And he said, "We've got a serious concern in here." So – and then he went raving on a little bit longer, and then he just stormed off and went about his business. So we got the tractor out of there pretty quick.
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> Q. Now did you have any . . . idea that you were in an area of high gas?

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150 Hearing transcript, vol. 25, p. 5009.

151 Hearing transcript, vol. 26, pp. 5242–45. According to Knock, his foreman subsequently allowed him to drive the truck in an area where he had taken a reading of 1 per cent methane.

152 Hearing transcript, vol. 19, pp. 3609–10.

153 Hearing transcript, vol. 26, p. 5249.

A. Well, there was stoppings between where we figured they had a concern. So we felt we were okay. We were more or less in the fresh air we thought.[154]

Some employees were severely chastised for unwitting improper use of vehicles, even when it was done on the instruction of supervisors. Underground labourer Lorne McLean related one such incident:

A. Now, I wasn't really familiar enough with the roads to know where we were. But at one – I think it was probably on our last set in, Glyn instructed us to go down here about 1 East and . . . retrieve our belt equipment.
Q. That's in the southeast section.
A. That's in the southeast section, because we had to do a stitch up on the No. 2 belt I think it was. And we took the tractor – it was Aaron Conklin and the other trainee and I. We took a tractor through one of those canvas stoppings they had that hung down. And we just drove right through it like it was a . . . driveway. We didn't know any better. Bryce Capstick was down there. And Bryce was a little upset. Asked us if we had checked the gas before we went in there with the tractor. Nobody. We didn't know. He got pretty upset. Told us not to do it again. And again . . . Aaron was training us, and Aaron didn't know enough to have the gas readings checked before we went in there. By the same token, Glyn had told us to do it and hadn't said, "Get the readings checked or anything like that." And like I say, we just whipped down through like it was a driveway and gathered up our gear. And . . . it was when we were leaving, Bryce gaffled onto us and pretty much read us the riot act about not to do it again, which was great. I mean, we knew then and we wouldn't do it again.
Q. What did he tell you? Did he tell you any reason why you shouldn't do it again?
A. Well, it was just your basic farm tractor. It was not to be in there with it . . . I assume, the purpose of having that temporary stopping hanging there was to . . . keep the gas behind it, I would assume. I don't know.[155]

Training for the operation of mobile vehicles was inadequate. Operators got information from co-workers that was incomplete or inaccurate. Management did not reinforce standards by example. They set work schedules that could not be met with proper use of equipment. Workers were reprimanded at times for practices that were condoned or even required at other times. It was not a training that would establish and promote safe mining practices.

Finding

The miners, supervisors, and underground tradesmen at Westray were not provided with adequate training in safe underground work practices. They went into the mine with little or no safety orientation.

154 Hearing transcript, vol. 22, p. 4202.

155 Inquiry interview transcript, undated (Exhibit 116.1(A), pp. 114–15).

Finding

Lacking a proper appreciation for the special dangers inherent in underground coal mining, many of the tradesmen were prone to accede to directions to perform unsafe tasks or to take dangerous shortcuts in their work.

Occupational Health and Safety Training

Miners were not, in most cases, given copies of the *Coal Mines Regulation Act* and the *Occupational Health and Safety Act*; nor were their legal rights explained. Though management did seek workers to serve as representatives on the safety committee, it did not set up an effective committee or inform the members about their rights, roles, or responsibilities. The inspectorate quite properly raised these requirements in discussions with company management and provided the company with copies of the relevant acts. The Department of Labour did not directly confirm that miners received and understood the information, however, or that company practices conformed with the law. Nor did the department provide the safety committee with training or organizational assistance. Neither management nor the inspectorate sought input from the underground workers in decisions affecting safety, and they did not invite worker representatives to participate in the inspection tours conducted by inspectors. The company responded to legitimate concerns raised by the safety committee after its inspections with excuses, denial, or at most a selective clean-up of small problems with quick solutions. Inspectors did not adequately address complaints brought by the committee or by individuals. These matters have been addressed at greater length elsewhere in this Report, but it is worth repeating that this important aspect of safety training was neglected at Westray.

1993 Draft Training Proposal

In 1993, Westray management produced a draft training proposal that covered all aspects of work in a coal mine.[156] It called for:

1 introduction to the statutory rights of miners and their representatives, lines of authority and responsibility, introduction to operator's rules, and reporting hazards;
2 training in the use of respiratory devices, including practice in donning the units for all new employees, regardless of experience;
3 rules and controls for transportation and communications, including warning signals, the tagboard, and conditions for use of vehicles;
4 underground tours, with explanations of the work and the safety precautions;
5 review of the mine plan, locations of abandoned areas, instruction in the emergency evacuation plan, fire fighting, and barricading methods;

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156 Exhibit 79.05.001.

6 introduction to and instruction on the ground control plan and the ventilation plan;
7 instruction on health hazards such as dust and noise, the WHMIS, and first aid;
8 instruction on purpose and procedures for company stonedusting;
9 recognition and avoidance of hazards in the mine, with special instruction on detection and avoidance of the hazard associated with mine gases; and
10 instruction in the health and safety aspects of tasks to be assigned, safe work procedures, and the mandatory health and safety standards related to them.

Testimony from the witnesses revealed serious deficiencies in all aspects of training during the pre-explosion operation of the mine. This post-explosion draft proposal provides a catalogue of what was not done before May 1992.

The key to any successful regulatory regime is compliance, and the key to compliance is enforcement. As has been so graphically illustrated in the Westray experience, regulations, no matter how effective on paper, are worthless when they are ignored or trivialized by management and when their enforcement is largely ineffectual.

RECOMMENDATIONS

3 One regulatory organization (such as the Department of Labour or a board of examiners) should be responsible for certifying workers in underground coal mines in Nova Scotia.

4 Before approving the start-up of any underground coal mine, the regulator should review and amend the standards of certification to ensure the following:

(a) Standards of certification fit the mining methods and technology of the proposed mine.
(b) All positions in the mining operation are filled by people with the qualifications and experience necessary to do their jobs safely.
(c) The system of certification applies to every person required to work underground. Categories of certification should include (at a minimum) coal miner, electrical tradesperson, mechanical tradesperson, surveyor, engineer, mine rescue person, and the various levels of supervisors and managers.
(d) Trainers have the necessary qualifications and experience.

5 The regulator should establish a model curriculum consistent with established standards and practices in the coal mining industry.

6 **The mine operator should be required to have in place a training program, approved by the regulator, for every position in the workplace. The mine operator's training proposal must:**

(a) conform to or be more rigorous than the model curriculum;
(b) show when, how, and what training will be done;
(c) incorporate annual refresher training and safety education;
(d) provide for adequate orientation to the mine for all new employees, including those with experience in coal mines; and
(e) include complete and sufficient training for operators of individual pieces of mining equipment prior to their being assigned operating positions.

7 **The mine operator should be required to keep training and work history records for applicants for certification. The regulator should:**

(a) check applicants' records, making sure that training is taking place; and
(b) test applicants for certification in a manner that establishes whether underground workers are trained sufficiently to work safely.

8 **The mine's joint occupational health and safety committee should periodically review training standards, policies, and programs to make sure that they adequately reflect changing technology and mining conditions and practice within the mine.**

These recommendations merely present a minimal outline of the basics to ensure that workers are "safety trained." They are neither innovative nor unique, but they do reflect the kind of program that I have observed in operation. Jim Walter Resources, Inc. in Brookwood, Alabama, has a structured training and retraining program for its underground workers, and Devco has modular training programs for the various classes of underground workers. The National Mine Health and Safety Academy at Beckley, West Virginia, offers periodic training for miners [157]

[157] The Inquiry library has copies of the JWR Annual Refresher Training manuals as well as similar material from Devco. Course outlines and other materials from the Beckley Academy are also in the library.

5 Working Underground at Westray

To inquire into . . .

(c) whether any neglect caused or contributed to the occurrence;

(d) whether there was any defect in or about the Mine or the modes of working the Mine

It is almost axiomatic that the development of a safety mentality in the workplace must start at the top. It is the responsibility of management at all levels through its actions and its example to instil a strong safety ethic in its workforce.[1] In the case of Westray, management undeniably failed to do so. Instead, management created a workplace that fostered a disregard for worker safety. Westray management either dismissed fundamental safety hazards for those working underground in the mine – including roof, dust, and gas conditions – or addressed them inadequately. In the preface to this Report, we state that "safety and production . . . must be so harmonized that they can coexist without doing violence to one another." Westray is a stark example of an operation where production demands violated basic and fundamental tenets of safe mining practice. As this chapter will reveal, management's drive for production, together with its disdain for safety, played a key role in the devastation of the Westray mine.

The Absence of a Safety Mentality

A strong safety mentality must by necessity start with the most senior official and filter down through all levels of management to the workforce. Colin Benner, who had been president of Westray Coal for only a month at the time of the explosion, commented on this very issue during his testimony at the hearings of this Inquiry. His evidence was insightful, reasonable, and well founded:

> Q. . . . How important is it to establish . . . a "safety mentality"?
>
> A. Oh, I think it's critical. It's crucial. It's – safety is a state of mind, whether it's at the workplace or it's at home or it's out in the recreational activity. It's a state of mind. You know, it has to be established, and I think there's fundamentals that go along with establishing that and I think, first and foremost, would be the involvement or the role of people such as myself, top management, if you will.
>
> *Management has to establish a policy, and it has to promote that policy* and it has to promote its thoughts with respect to how it wants its operations managed from a safety standpoint. And then [at] the next level down, which is mid-management or site management, there's a responsibility to reinforce that policy and to enforce the regulations . . . as they are working under. And in this case, for example, it would be the coal regulations and the OSHA [*Occupational Health and Safety Act*] of Nova Scotia. And the next level down is front line management. *And by the way, it all has to be done by way of demonstration through behaviour and attitude.* And then the next level down is front line

[1] Throughout the course of this Inquiry, this message has been reinforced over and over. It is perhaps best expressed in the Burkett Report, *Towards Safe Production.*

> supervision who have to ensure that the safety policies and the regulations are practised in the workplace, that they're conveyed to the workers and that the workers are in point of fact aware of and educated in that sort of thing. And then the next level down, of course, is the workers, and they have to accept the responsibility of taking on these assignments in a safe manner and in following the regulations.[2]

Benner agreed with the view that safety is integral to production – you cannot sustain production without safety.[3]

As articulated by Benner, it is incumbent on management *both* to "establish a policy" and to "promote that policy" through its behaviour and attitudes. Simply put, a company policy that advocates safe working procedures is rendered futile if management proceeds to ignore the policy, to violate its procedures, and to trivialize the very safety issues it addresses. Westray's policies and procedures were set out in detail in its Operations and Maintenance Employee Handbook, which we will return to at various points in this chapter. As we shall see, management did not follow the policies and procedures it laid out. The safety policy purportedly established by Westray was merely formulated; it was never promoted or enforced.

Westray's Health and Safety Philosophy

On 29 October 1991, mine manager Gerald Phillips sent a memorandum to all Westray Coal employees along with an excerpt from Westray's Operations and Maintenance Employee Handbook, entitled Health and Safety Philosophy.[4] The memorandum was prompted by media attention, which focused on safety problems underground at Westray. Phillips commented as follows to his employees:

> I would like to stress to all employees that Westray considers, first and foremost, the safety of its employees its number one priority, and emphasizes safe work practices and safe work environments..
>
> . . .
>
> Westray Coal, its consulting engineers . . . and the Nova Scotia Department of Labour, continuously monitor and evaluate the underground conditions. Whenever we feel it is necessary to provide additional support, it is always done without hesitation or any questions being asked regarding loss of productivity or costs, again stressing safety is our number one priority.
>
> We have been open to discussions with you on safety . . . and this policy of consultation and response will continue to be a commitment on my part.
>
> Beyond our regular formal meetings, *I would like to stress that Westray has an open door policy whereby you, individually, have avenues to air your views at any time. We encourage you, as employees, to feel free to raise your legitimate concerns whether it is with respect to safety, working conditions or any other subject* related to your employment. I cannot

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2 Hearing transcript, vol. 73, pp. 16005–06. Emphasis added.

3 Hearing transcript, vol. 74, pp. 16175–76.

4 Exhibit 120.301–305.

> promise the moon, however, I can promise to listen to and respect those matters which are of legitimate concern to you. I am committed to this open dialogue.
>
> . . .
>
> Westray Coal will strive to always work towards a safe operation. Your personal safety will always be our number one concern. [Emphasis added.]

The Health and Safety Philosophy developed by Westray set out the responsibilities of each member of the management team, of supervisors, and of employees. In effect, it theorized about the development of a safety ethic that would start with management and filter down to the supervisors and employees. It advocated the implementation of safe and productive work procedures, proper education and training for workers, high standards for housekeeping, high standards for the development and maintenance of equipment and underground work areas, and accident prevention. It concluded with the slogan "Protection – People – Production."[5] *In theory* at least, management accepted the view that safety was integral to production. In fact, Phillips would employ similar slogans in writing memoranda to Westray employees: "Safety And Production Go Hand In Hand,"[6] "Please Work Safely and Productively,"[7] and "Always work safely because a safe operation is a productive operation."[8] To the detriment of underground workers, Westray's *practice* bore no resemblance to its *theory*.

The evidence before this Inquiry unequivocally paints a picture of a coal mining environment that stressed production and was devoid of any safety mentality. Don Mitchell, a coal mining expert, commented on Westray's general approach to safety, and his words were absolute: "There was none. Or if there was any, it . . . [did not] add up to a hill of beans."[9]

The absence of a safety ethic at Westray manifested itself through every facet of the operation – the hazardous dust, gas, and roof conditions, the multitude of illegal practices, the ineffective environmental monitoring system, the lack of proper safety equipment for miners, the state of housekeeping in the mine, and the human relations issues such as management-worker relations and the ineffectiveness of the joint occupational health and safety committee. We will explore each of these facets in this chapter, as well as the effect of the production incentive bonus.

Dust, Gas, and Roof Conditions

The evidence before this Inquiry relating to the dust, gas, and roof conditions at Westray is unequivocal. The accumulations of both dust and gas and the state of the roof were extremely hazardous and menacing for

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5 Exhibit 120.304–305.

6 7 November 1991 (Exhibit 15.135).

7 12 March 1992 (Exhibit 120.034).

8 9 April 1992 (Exhibit 120.319).

9 Hearing transcript, vol. 16, p. 2944.

all of Westray's short life. The underground hazards at Westray are addressed throughout this Report, particularly in Chapters 7 to 10, Ventilation, Methane, Dust, and Ground Control. For this reason, the following review is by no means exhaustive. Rather, we will concentrate on management's apparent refusal to alleviate obviously hazardous conditions. It provides a striking illustration of the absence of any safety ethic at Westray.

Dust Conditions

Although reports of coal dust underground vary in detail, one thing is clear: coal dust accumulations underground at Westray exceeded safe levels in almost every part of the mine. In Chapter 9, we explore in detail the accumulations, the reluctance to clear dust out of the mine, the insufficient controls to suppress airborne dust, the serious lack of stonedusting, and the absence of a sampling program. The evidence compels us to conclude that management considered coal dust to be, at worst, a nuisance to be shoved aside and ignored – not the lethal hazard it turned out to be.

Section 70(1) of the *Coal Mines Regulation Act* requires that, "[u]nless the floor, roof and sides of the road and working places in a mine are naturally wet throughout, they shall be systematically cleared so as to prevent, as far as practicable, the accumulation of coal dust, and systematic steps either by way of watering or otherwise shall be taken to prevent explosions of coal dust occurring." The company ignored its legal obligations under the act – as it ignored its own Safe Operating Procedures.

Mine geologist Arden Thompson shared his own observations of the stonedusting, or lack thereof, at Westray. His testimony is clear and insightful. Thompson believed that the amount of stonedust being spread was inadequate. There was no systematic stonedusting and, as far as Thompson knew, there was no equipment available for such dusting.[10] Recalling the only incident in which he saw stonedusting being done, he testified that the workers were using round-mouthed shovels to spread the dust and that they had as much on themselves as on the rib:

> [O]ne of the fellows on the bolter made a comment to me. . . . "Arden," he said, "there must be somebody coming." And I knew what he meant but I just played along, I said "Well, what do you mean?" And he said, "Well," he says, "look at the stone dust we're putting on." . . . *I knew that the stone dust was just cosmetic.*[11]

Thompson explained that a day or two later he noted a tractor-load of people who, to the best of his knowledge, were considering investing money in the project. Shortly thereafter, Clifford Frame and then-Premier Donald Cameron were to visit the mine.

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10 There were in fact two devices used sporadically for stonedusting (see Chapter 9, Dust).

11 Hearing transcript, vol. 40, pp. 8806–07. Emphasis added. Thompson stopped going underground in December 1991 (p. 8796).

Thompson described stonedusting at Westray as "cosmetic." It appears that Westray management was only concerned with stonedusting prior to an inspection by the Department of Labour or a visit by someone management hoped to impress.

In what seems to be a transcript of a conversation between underground manager Roger Parry and president Marvin Pelley regarding Westray's safety committee, Parry made the following comments about stonedusting underground:

> **Roger** My impression of the visit was that the inspectors was that we had stone dust throughout the belt road and they requested more stone dust in the working areas. *When they would finish that visit and expressed their concern about the dust we'd start moving stone dust in that very same day and the night shift next morning stayed over and started spreading the stone dust for the next four shifts between shifts spreading stone dust in the Southwest section and Main belt lines discolith.* The belt crew more stone dust down to number five cross-cut and they spread stone dust throughout the belt line from the back and down number eleven cross-cut. The air velocities there carried the stone dust all the way through the tunnels. To give you a fixed outcome more or less they have three men working overtime between shifts stone dusting in the discolith.[12]

The date of this conversation is not known, but Parry's comments on stonedusting suggest that Westray management was quick to respond to the inspectorate's concerns or orders to clean up dust. The evidence before this Inquiry flatly contradicts any such proposition.

Finding

There is no question that management was aware that coal-dust accumulations underground at Westray were at hazardous levels. There is no question that management was aware, or ought to have been aware, that safe mining practice – as well as section 70(1) of the *Coal Mines Regulation Act* – requires operators to clear or treat coal dust to render it non-explosive. Notwithstanding the legislative requirement and the fact that management was cognizant of the hazard, management failed to order and enforce sufficient and systematic stonedusting underground at Westray.

Gas Conditions

Methane conditions encountered underground at Westray were unacceptable. The miners who testified at this Inquiry recounted numerous incidents of men becoming faint, dizzy, and numb while working in the mine. Management must have been aware of the severity of the situation

[12] Exhibit 120.244–45. Emphasis added. The circumstances of this transcript, entitled Safety Committee, are unknown to the Inquiry. It comprises five pages of conversation between Roger [Parry] and Marvin [Pelley] and is undated but is clearly post-explosion. Parry's language here is clearly ungrammatical; the oddities may result from poor transcription. Despite language problems, I chose to quote from this source because it offers a rare glimpse into his own thinking. Parry's use of the term "discolith" is curious; the word is a legitimate geological term – referring to a tiny inclusion in sedimentary rock – but has nothing to do with coal mining.

and the unsafe conditions workers were exposed to, yet chose to ignore the hazardous reality of the underground.

Chapter 8 documents in detail the hazards of methane, the regulatory requirements for dealing with the gas, and the actual conditions in the Westray mine. The evidence points to a serious hazard that was neglected and underrated by management. Methane is dangerous in two respects. First, in concentrations of 5 to 15 per cent by volume in air, it is explosive. Second, although not physiologically harmful itself, methane displaces oxygen, which is necessary to sustain life. This deplacement of oxygen explains the fainting, dizziness, and numbness experienced by underground workers. Furthermore, since methane is lighter than air, it tends to accumulate at the roof and in roof cavities if ventilation air currents are insufficient to move it. In evidence to the Inquiry, witnesses demonstrated over and over again that methane regularly occurred and gathered in dangerous concentrations throughout the Westray mine. It becomes clear through the witnesses' stories that management was, by turns, indifferent to or contemptuous of the workers' legitimate concerns about gas.

Westray management was aware of the excessive levels of methane gas underground. Lenny Bonner testified that, while working with Ed Estabrooks in the North Mains installing chock blocks and steel sheathing, he suddenly found himself on his knees. A moment later, Estabrooks attempted to put up another chock and "he came down like a ton of bricks" and "his eyes were rolled up in his head." Bonner grabbed him by the shirt and shook him until his eyes focused; he was evidently unharmed. Following the incident, Bonner advised Roger Parry to get some ventilation up above those arches. Bonner testified that Parry replied: " 'I find that fucking hard to believe. I was just down there and it was only 0.5 [per cent methane].' "[13] Parry's response is telling and indicative of management's general response to workers' legitimate safety concerns.

The existence of serious and excessive gas levels underground was routine and recurring. Section 72 of the *Coal Mines Regulation Act* sets out the responsibility of "the person in charge of a mine or any part thereof." This section provides that, where the percentage of flammable gas in the general body of air is 2.5 per cent or more, "*every worker shall be withdrawn from the mine or such part thereof as is so found dangerous*" [emphasis added]. Management's duty is absolute. Management was aware that conditions underground were bad; workers who had experienced symptoms consistent with high concentrations of methane had expressed their concerns *directly* to management. Notwithstanding its responsibility, management responded by trivializing these potentially lethal conditions and bullying the miners into working despite the conditions – a singularly callous reaction.

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[13] Hearing transcript, vol. 24, pp. 4733–35.

Finding

There is no question that management knew that the levels of methane underground at Westray were hazardous. Management was aware, or ought to have been aware, that, under section 72 of the *Coal Mines Regulation Act*, such conditions mandated the withdrawal of workers from the affected area.

Roof Conditions

The severity of the roof problems at Westray is beyond dispute. Experts, management, miners, and government representatives recognized and focused much attention on the issue. Chapter 10 of this Report details the serious ground control problems faced by Westray. Although it is true that the precarious roof conditions underground at Westray did not play a *direct* role in the cause of the explosion, they were, in many ways, integral to the disaster. The evidence suggests that Westray's preoccupation with roof conditions diverted attention from other critical safety issues, including gas and dust accumulations, which *did* play a direct role in this disaster.

Again, the evidence is overwhelming that Westray employees were expected to work in hazardous conditions, and that production and the safety of equipment took precedence over the well-being of the workforce. Westray management was preoccupied with ground control problems and, as a result, ignored and trivialized other safety concerns. Jay Dooley expressed the view that "there was too much concentration on trying to hold up the ground as opposed to the [stone]dusting."[14] Don Dooley also testified to the decline in the amount of stonedusting owing to Westray's preoccupation with ground problems: "The last three or four months, every minute of overtime was spent setting steel. We had unbelievable roof conditions and problems. . . . you were preoccupied with your roof. Like, that roof was imminent death right there in front of you."[15] Randy Facette expressed concern that someone would be killed by a roof fall. He went on to say that the roof was Westray's primary focus, which took away from other problems in the mine.[16] Dr Malcolm McPherson made some insightful comments from the perspective of a mining engineer on this concentration of attention on the problems of roof control at the expense of other safety issues.

> You have already heard of the severe problems of roof control/ground control, the falls of roof, and this was a major, major concern to the mine management. This was a major concern to the mine management, I would hope, from the point of view of the safety of the miners. There is another factor, however.
>
> Falls of roof inhibit the mining process itself. If you have falls of roof, then you cannot get your coal out; you cannot get your men and materials

[14] Hearing transcript, vol. 38, p. 8401.

[15] Hearing transcript, vol. 36, p. 7793.

[16] Hearing transcript, vol. 33, p. 7228.

> and equipment in. A fall of roof in part of that infrastructure of the mine will cause a cessation of min[ing] because, physically, you cannot get the equipment, the people in. *So not only is this a matter of safety, it also results in cessation of production in that part of the mine.*
>
> Problems associated with poor ventilation do not necessarily do that. If you have poor ventilation, then you can keep mining, as, indeed, happened at Westray. So although it is equally a matter of safety and health, as the falls of roof are, it does not immediately prevent production. It will inevitably do so in the long term, sometimes with tragic consequences, as we've seen at Westray.[17]

McPherson's comments take us back to the opening paragraph of this chapter – and the harmonization of safety and production.

Finding

Westray management was preoccupied by problems of ground control. Management focused only on those safety issues, such as ground control, that directly interfered with immediate production of coal. Management's drive to produce and its failure to advocate safety in the workplace rendered any harmonization of production and safety difficult. Thus, Westray failed both to meet production demands and to address safety concerns.

Hazardous and Illegal Practices

A coal mining operation that functions without any safety ethic will inevitably violate the principles of safe operation. The *Coal Mines Regulation Act* sets out many basic principles of safe mining practice. Although Westray itself acknowledged such principles in its Health and Safety Regulations for Employees,[18] it then ignored and abused safe operational procedures and provincial regulations. Some of these issues are addressed in this chapter. Others are addressed in other parts of this Report. This is not an exhaustive catalogue of all the unsafe practices reported at Westray. The purpose here is to illustrate the breadth of the hazards encountered underground. Westray underground workers were faced with serious safety concerns that touched on every underground coal mining practice.

Finding

The many instances of hazardous and illegal practices encouraged or condoned by Westray management demonstrate its failure to fulfil its legislated responsibility to provide a safe work environment for its workforce. Management avoided any safety ethic and apparently did so out of concern for production imperatives.

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17 Hearing transcript, vol. 9, pp. 1705–06. Emphasis added.

18 Exhibit 119, p. 191.

Twelve-Hour Shifts

Section 128(1) of the *Coal Mines Regulation Act* sets out the length of shifts for underground workers:

> **Length of shift**
> Subject to this Act, a worker *shall not* be employed at his working place below ground in a mine for the purpose of his work for more than eight hours during any consecutive twenty-four hours. [Emphasis added.]

By working 12-hour shifts, Westray was in violation of section 128. Some workers at Westray were not averse to working 12-hour shifts, since they received four days off.[19] Many others felt it was too arduous. McPherson summarized the problems associated with 12-hour shifts:

> 12 hours in the arduous conditions of any underground mine as a routine and continuous procedure is much too long. Normal period, of course, is eight hours. Many mines use seven hours. Some mines in the world have now gone to four shifts working six hours, Mr Commissioner. *12 hours is excessive.* Not only from the point of view of the human aspects of working 12 hours at a time, but also *because of the inevitable loss of attention* that can result and has resulted all too often in accidents and deaths occurring in mine. You are very reliant for your safety, not only on yourself, but also on the guy next to you. And if you've been working for 12 hours, that attention is going to slip.[20]

Bryce Capstick agreed that a 12-hour shift is too hard on the workers: "[T]heir body gets tired. Their brain gets tired. They're more apt to become dangerous [to] themselves and the ones around them."[21] Shaun Comish agreed that, when the end of his shift was approaching, he would be thinking less about safety and more about "getting out of there."[22] Doug MacLeod said that after 8 or 9 hours underground "you're accidental [*sic*] prone."[23] While Don Dooley did not object to 12-hour shifts, he could not deny that a worker could be less safety conscious towards the end of a 12-hour shift.[24]

The situation was exacerbated by the fact that there were no regularly scheduled lunch breaks at Westray. Management apparently felt that such breaks would interfere with production. Comish testified that management did not like the workers taking breaks. He recounted that on a few occasions the miners saw a light approaching while they were eating their lunch and "they would all just scramble like rats, go back to work" in case it was Roger Parry. Depending on Parry's mood, he would either

19 Rick Mitchell liked the 12-hour shifts (Hearing transcript, vol. 31, p. 6828). Ron MacDonnell testified that the 12-hour shifts were not bad, since he got to go home for four days (vol. 29, p. 6121). Aaron Conklin testified that he had no problem with 12-hour shifts (vol. 28, p. 6016).

20 Hearing transcript, vol. 9, p. 1705. Emphasis added.

21 Hearing transcript, vol. 42, p. 9389.

22 Hearing transcript, vol. 28, p. 5847.

23 Hearing transcript, vol. 27, p. 5706.

24 Hearing transcript, vol. 36, p. 7962.

"start hollering" or sit and chat for a while.[25] Harvey Martin related an incident when, about three hours into a shift, he and Roger Ellis were sitting down having tea, and Phillips appeared. Martin recalled Phillips saying: " 'You guys are sitting down on your ass while everybody else is fucking working their guts out.' "[26] Tom MacKay testified that, some days, the workers on the bolter would rotate jobs to give one another an opportunity to take a break. Other days, he would not get a lunch break. MacKay explained that management did not want them taking a break together; work was to be ongoing.[27] Wayne Cheverie testified that, on the odd occasion, he would not take any breaks during his shift. He explained that you would grab lunch whenever it was possible, that is, whenever it would not hold up production.[28]

Finding

Shifts at Westray for underground workers were 12 hours in length. In scheduling these shifts, Westray was in violation of section 128(1) of the *Coal Mines Regulation Act.* Twelve-hour shifts increase the risk of injury and accident to the workers because of their mental and physical fatigue.

Tagging System

Practically speaking, there was no tag-in, tag-out system at Westray. Coal mining expert Tom Smales described for the Inquiry the conventional procedures employed in underground mining. He explained that there should be two systems operating in a mine to monitor who is underground at any given time. First, in the tag board system, each miner is assigned an identification disk, which the miner places on "in" when going underground and on "out" after leaving the underground. Second, at the same time, the miner should speak to his foreman, who then identifies the miner by recording his presence underground in a register. Smales went on to describe the importance of such a system to an underground operation. In the event of a disaster, it is essential to know who is underground. As well, it is important to be able to locate an injured worker. In a properly run mine, there should be little confusion about who is underground and where they are.[29]

Bonner referred to the tagging system at Gays River.[30] He said that it had been strictly enforced – an underground worker was not allowed to

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25 Hearing transcript, vol. 28, pp. 5807–08.

26 Hearing transcript, vol. 23, p. 4476.

27 Hearing transcript, vol. 32, pp. 7026–27.

28 Hearing transcript, vol. 21, p. 4003.

29 Hearing transcript, vol. 2, pp. 321–22. In addition, each miner should be assigned a specific cap lamp. Its presence or absence from the charging rack provides yet another check of the miner's whereabouts.

30 A number of Westray employees had worked at Gays River, another Nova Scotia underground mine that closed shortly after Westray started up.

leave the property until tagging out. Bonner remembered a time he had forgotten to tag out:

> There was one instance where I had to drive back to the mine at Gays River and remove my tag. . . . My shift boss had to stay until I got back to the mine and remove my tag. Even though he [had] seen me leaving, and I said goodbye to him, he still had to stay there and call me back to the mine site to remove my tag from that board.[31]

This was not the situation at Westray. In fact, when the Westray mine exploded on 9 May 1992, management was not sure who was working underground.[32]

Jay Dooley said that the tag system at Westray fell into disuse as the development of the mine progressed. He did not see the absence of a tagging system as a threat to his safety; he testified that he became complacent.[33] Don Dooley explained that, for the first few months, he did use the tagging system. He did not continue because he felt that no one else was committed to the system and no one monitored it.[34] Wayne Cheverie testified that workers were never instructed or encouraged to use the tag system.[35] Clive Bardauskas said that he had assigned himself a tag that corresponded with his lamp number. He was not directed to do so by management or the supervisors. Bardauskas tagged in and out for a few weeks until his tag disappeared.[36] John Lanceleve spoke about the tagging system at Westray as follows:

> Q. Did it strike you as odd that you and a few others were using it and others weren't?
> A. Yes.
> Q. Did you ever speak with anybody about that?
> A. Well, we joked around about it amongst the crew, amongst the guys.
> Q. What did you joke around about?
> A. That they can't even run a tag board system. Like, it was never enforced.
> Q. It was never enforced?
> A. No.
> Q. By the management?
> A. No.
> Q. By the shift bosses?
> A. No.[37]

The evidence is clear that, although the tagging system was set up and used to a limited degree by a few workers in the early development of the Westray mine, underground workers soon stopped using the system, and management and supervisors failed to police it.

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31 Hearing transcript, vol. 24, pp. 4744–45.

32 Dave Matthews was one of the first on the scene. He told the Inquiry that "we didn't know who was underground at the time" (Hearing transcript, vol. 31, p. 6628).

33 Hearing transcript, vol. 39, p. 8685.

34 Hearing transcript, vol. 36, p. 7965.

35 Hearing transcript, vol. 21, p. 4057.

36 Hearing transcript, vol. 23, pp. 4606–07.

37 Hearing transcript, vol. 27, pp. 5539–40.

Finding

No effective system existed at Westray to keep track of the whereabouts of people underground. Management and supervisors failed to set up and enforce the use of an appropriate system for keeping track of who was underground and where they were.

Storing Fuel and Refuelling Vehicles Underground

Section 69(6) of the *Coal Mines Regulation Act* addresses the storage of flammable material:

> No oil, grease, canvas or other inflammable material shall be stored below ground in any mine except in a fireproof receptacle or chamber.

Westray's Codes of Practice for Non-flameproof Diesel Equipment further provided that non-flameproof diesel equipment "be fuelled on surface only with the engine turned off or at specifically designed and approved underground filling stations."[38] Like other Westray safety rules, this one was more honoured in its breach by Westray management than by enforcement.

The record shows that fuel was illegally stored underground at Westray and that equipment was improperly refuelled in violation of these provisions. Wayne Cheverie testified that fuel was taken underground at Westray regularly after December 1991. There was an order that the 5-gallon containers (jerry cans) be taken to No. 10 Cross-cut; Cheverie presumed the order came from Roger Parry. As well, a 45-gallon drum with a barrel pump was set up at No. 10 Cross-cut. Either the workers would bring the vehicles to this cross-cut to be refuelled or the jerry cans were transported to the vehicles on the back of a non-flameproof tractor. Cheverie described this process:

> A. Sometimes the plugs or caps for the cans would be missing and they'd be sloshing around in the back of the tractor and spilling out on the ground as you went underground. We carried them on the back end of the tractor because most of the tractors had the exhaust built into a bumper that went on the front of the tractor, therefore, keeping them as far away from anything hot as you – or a spark, as you could.
> Q. When the fuel would spill out, would someone clean it up?
> A. Definitely . . . not.
> Q. You never did it?
> A. No.[39]

Clive Bardauskas described the manner in which vehicles were refuelled underground. He said that sometimes fuel was poured from a jerry can into the machine without a funnel while the vehicle was running, and with no lighting other than the worker's cap lamp.[40]

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38 Exhibit 69b.004.

39 Hearing transcript, vol. 20, pp. 3974–75.

40 Hearing transcript, vol. 23, p. 4619. Bardauskas had done this himself on occasion when a Scooptram for some reason or another couldn't be taken to the fuel station at No. 10 Cross-cut.

Jay Dooley said that he was concerned about fuel underground at Westray. In fact, he asked Roger Parry about acquiring a flameproof building to house these materials. Parry advised Dooley that he planned to use No. 11 Cross-cut as the storage for underground fuels when the cross-cut was complete. The plan never materialized.[41] Dooley further confirmed that there were both jerry cans and 45-gallon drums improperly stored at No. 10 Cross-cut. Management had ordered him to take the 45-gallon drum underground, he testified, and he had done so, but he was aware that it was an improper practice. Dooley testified that there was nothing to prevent an inspector from seeing the 45-gallon drum.[42]

There is evidence that workers were ordered to conceal fuel from mine inspectors. Harvey Martin recalled being underground with maintenance foreman Roger Ellis when mine manager Phillips instructed Ellis to hide the diesel fuel at No. 10 Cross-cut because an inspector was to tour the mine that day. Martin said that Ellis hid one 5-gallon jerry can in his personal tool box, but he wasn't sure what was done with the others.[43]

Bardauskas explained that managers encouraged storing fuel and refuelling underground because they did not want the mechanics coming out of the mine to get fuel: "They wanted the guys down there the full twelve hours."[44] Although Jay Dooley said that the Scooptrams were refuelled underground so that roof support crews wouldn't lose any time, he agreed that this in fact indirectly improved production.[45]

Finding

Westray management instructed that fuel be stored underground and that vehicles be refuelled underground. In so doing, Westray management acted in violation of section 69(6) of the *Coal Mines Regulation Act* and of its own codes of practice. These fuel storage and refuelling practices were illegal and hazardous.

Torches Underground

Section 88 of the *Coal Mines Regulation Act* addresses the use of torches underground and mandates that permission be sought from an inspector. Section 88(1) provides:

> An inspector may permit the use, under the constant supervision of an official carrying a locked flame safety lamp or a gas tester of a type approved by the Minister, of an electric welder, acetylene torch or heating unit in main trolley roads, pump rooms or engine rooms, if these places are ventilated by a split of fresh air from the main intake airway.

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41 Hearing transcript, vol. 39, pp. 8672–73.

42 Hearing transcript, vol. 38, pp. 8440–41.

43 Hearing transcript, vol. 23, pp. 4486–87.

44 Hearing transcript, vol. 23, pp. 4618–19.

45 Hearing transcript, vol. 38, pp. 8440–41.

There are numerous accounts of the unauthorized use of acetylene torches at Westray. Fraser Agnew agreed that it was commonplace for torches to be used underground. He said that Roger Parry would tell him when a "burn" was to take place and that he was to supervise it.[46] Underground mechanic Wayne Cheverie also testified that torches were brought into the mine regularly to facilitate repairs to equipment.[47] The record is clear that the Department of Labour inspectorate did not authorize the use of torches underground on each of these occasions (see Chapter 12, Department of Labour).

It is not unusual in the coal mining industry for an inspector to grant such permission on condition that specified safety precautions – including the use of stonedust, fire extinguishers, and fire hoses – are followed. Putting aside for a moment the fact that Westray did not have any authority to use torches underground, I note that, when torches *were* used underground, the company routinely failed to follow any such safety precautions. Randy Facette said that, on several occasions, torches were used underground without the proper safety procedures in place. Facette referred to one incident at No. 5 Cross-cut when he, Rick Mitchell, and Jay Dooley were setting steel supports, and the holes and bolts would not line up properly. Dooley brought down cutting gear to cut the plates and the steel legs to match up the holes. Facette went on to say:

> And I believe it was Rick that mentioned to Jay, you know, "Where is your extinguishers, your rock dust, your charged hose and all this, eh?" And Jay's response was basically, "No, we don't need that, we're in the in-take air." I think what he did, there was a little pile of sand there, and he had us throw some sand on the ground . . . underneath where he would be cutting, and that was the extent of what he did. Me and Rick just walked away shaking our heads more or less.[48]

Mitchell, a member of the Westray safety committee, said that he told mine inspector Albert McLean about this incident and the lack of safety procedures employed while welding underground.[49]

Facette testified to another incident when steel work was being done at the intersection of No. 2 Main and 3 North Main. He noted acetylene torches against the rib in his crew's work area. Facette stated he was against the use of cutting equipment in that part of the mine, particularly when they could have prefabbed the material on the surface. At that point, he advised Jay Dooley that he was a safety committee member and that he required that the proper safety precautions be taken – that the area be stonedusted and wetted down, and that the charged hose, extinguisher, and a supply of stonedust be on hand. Facette recalled Dooley's response to his safety concerns: "And he told me if I wanted it, basically to do it myself, so that's what I did." Facette went on to say that, as he was throwing the

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46 Hearing transcript, vol. 35, p. 7725.

47 Hearing transcript, vol. 20, p. 3949. Cheverie said that, when he asked maintenance superintendent Bob Parry about permits, Parry replied, " 'We do have permits.' " (p. 3951).

48 Hearing transcript, vol. 33, p. 7157.

49 Hearing transcript, vol. 31, p. 6727.

stonedust, there was gas coming up from the floor that ignited the full length of a 20-foot I-beam. "Fortunately, it was extinguished right away, but it scared the hell out of me."[50]

Dooley, however, testified that he had taken safety precautions when using torches, including the use of stonedust and fire extinguishers.[51] He said that torches were used underground in his presence at least four or five times. He had been advised by Roger Parry that Westray had an "open permit" to burn underground, provided that the necessary precautions were followed.[52]

Management ordered workers to use torches underground and would not tolerate workers who defied orders. Don Dooley testified that he had heard that Stephen Lilley was suspended for leaving the mine because he did not feel the use of torches was a safe practice.[53] Wayne Cheverie also testified to this incident. He recalled Lilley's telling him that he had been suspended for refusing to stay in the mine while torches were being used. Cheverie told the Inquiry about the effect this episode had on the workers:

> And that sent a real clear message to all the other workers that were there that either put up with the torches going underground or . . . you'll be suspended or fired or whatever.
>
> . . .
>
> If you refused unsafe work, you were threatened with your job or intimidated into submission.[54]

Clive Bardauskas explained that he used torches underground as a result of the Lilley episode. Bardauskas once commented to Bob Parry that he never saw torches being used underground in the United Kingdom. He testified that Parry's response was: "'You're no longer in the U.K.; you're in Canada now.'"[55] Bardauskas interpreted this to mean "Keep your mouth shut." He felt that he had been asked to do work at Westray in a manner that compromised safety.

Finding

The unsafe use of torches underground was a common practice at Westray. Management was aware of the practice, condoned the practice, and reprimanded those who condemned it. In so doing, management sent a clear message to the underground workers. Management's *unsafe* mentality was, in effect, filtering down to the Westray workforce.

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50 Hearing transcript, vol. 33, pp. 7158–59.

51 Hearing transcript, vol. 39, pp. 8648–50. There is evidence that some miners took measures, such as wetting down and stonedusting areas in which burning was being done.

52 Hearing transcript, vol. 39, p. 8643. No such "open permit" had in fact been granted to Westray Coal.

53 Hearing transcript, vol. 37, p. 8142.

54 Hearing transcript, vol. 21, pp. 3996–97.

55 Hearing transcript, vol. 23, pp. 4626–27. Bardauskas and Parry both had UK coal mining experience.

Methane Detection Equipment

The evidence supports the fact that methane detection equipment at Westray was improperly and illegally defeated in the interests of production. Westray's Health and Safety Regulations for Employees plainly forbade the deactivation of, removal of, or interference with any protective device on any machinery.[56] Again, management failed to enforce its own regulations. Some workers – aware of the prohibition – nevertheless engaged in such practices under the instruction of supervisors and management. Other workers were uninformed and unaware of the existence of any such health and safety regulations. As a result, the safety guidelines and procedures put in place by the management team were breached on a regular basis.[57]

Many instances of methanometer misuse, disuse, and tampering are documented in Chapters 6 to 8, The Explosion, Ventilation, and Methane. The tampering with methane detection equipment in the mine showed complete disregard for a basic safety practice in the coal mining industry. It subordinated worker safety to production – a practice all too commonplace at Westray.

Finding

Methane detection equipment at Westray was illegally foiled in the interests of production.

Lockout System

There was no proper system – integral to safety – for locking out the conveyor belts at Westray. Jeff Yeo, Westray's electrical engineer-in-training, defined a "true lock-out" as a physical lock requiring a key or other such method to re-energize the conveyor. He agreed that such a method "is the appropriate and sort of industry standard so far as lock-outs are concerned." Yeo testified that there was no such feature on Westray's conveyors.[58] Electrician Harvey Martin supported Yeo's testimony. Martin said that the safety lockout procedures at Westray did not seem to square with his previous industry experience.[59] According to Mick Franks, the lockout system at Westray could be defeated. He recalled that, on instruction from his supervisor, he had "jumped out" the main belt in order to override the lockout system, which had become damaged. As a result, the main belt could not be shut down between the surface and No. 5 Cross-

56 Exhibit 119.194.

57 This breaching of safety guidelines and procedures happened despite the fact that every employee was required to sign a statement acknowledging having received, read, and understood the company health and safety handbook (Exhibit 119.199).

58 Hearing transcript, vol. 45, p. 9862.

59 "Any place that I've ever worked, lockout systems have been to cut the actual power to a device" (Hearing transcript, vol. 23, p. 4504).

cut, leaving that segment completely without any safety protection for the underground worker.[60]

The lack of a proper lockout system at Westray resulted in serious injury to one underground worker. Matthew Sears testified that he had been instructed to replace a worn roller on the main conveyor. His supervisor, Ralph Melanson, told him and his co-worker, Gordon Walsh, that the conveyor belt was locked out and that they could proceed to work. Sears told the Inquiry how they lifted the belt, got the roller out, and replaced it with a new one. As they were finishing, the conveyor started without the usual warning. Both Sears and Walsh were standing on the belt at the time. Sears testified that his supervisor attempted to pull the safety cable running alongside the belt to stop it. Walsh managed to jump off the belt. Sears was not so fortunate:

> I fell down and I tried to roll off the conveyor belt to get off it and I did. But as I did, my body got tangled up . . . on the return conveyor belt that was going back to a large roller . . . And I was pulled – when I was first on the conveyor belt, I would have been pulled away from the roller, but as I rolled off, there was a belt underneath and it pulled me back.

Sears then fell between the conveyor and a nearby chain-link fence. His leg was caught in the large roller and jammed in beside it. Sears held on to the fence to keep himself from being further pulled into the roller. Walsh was also holding on to him. Melanson was still trying to stop the conveyor belt, but each time he pulled the safety cable the belt would restart. Melanson then went for help. The conveyor belt eventually got up to full speed, the roller slid away from Sears, and he managed to free his leg.[61] Sears was taken to hospital. He was off work for four months before returning to light duties. Although the electrical foreman, Brian Palmer, had called him to apologize for having restarted the conveyor, Sears did not receive any explanation from the company about what had occurred. Walsh had heard "rumblings" that the accident was basically Sears's own fault.[62] In a pre-hearing interview, electrician Terry Regular said that he had been working on the surface with Palmer that day when they noticed that the conveyor belt had stopped:

> And of course when the belt stopped, it was just, geez, the belt is down. Let's go, run, run, go get a belt going. And . . . Brian and I, we went to the top of the breaker station. The belt was stopped. We looked at . . . the indicator . . . There was no lockout on the thing and the belt was stopped. So Brian started the belt . . . We were stopped again. We started again, stopped again. It kept stopping.[63]

Harvey Martin said that he had spoken to Palmer about the accident. Martin explained that the lockout system had been improperly hooked into a timer instead of an actual lockout device. Even though it looked as if it

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60 Hearing transcript, vol. 21, p. 4170.

61 Hearing transcript, vol. 29, pp. 6056–59.

62 Hearing transcript, vol. 29, pp. 6060–63.

63 Pre-hearing interview with Terry Regular and Greg Palmer, 11 June 1992, p. 75.

was locked out, the belt could still be started.[64] The main power feed to the belt was simply not shut down, as it would have been with a proper lockout procedure in place.

As a result of the incident, Sears underwent three operations to his left knee and foot. He lost the feeling in his foot and in the lower portion of his ankle; at the time of his testimony, he did not have full use of his leg.[65] Matthew Sears's accident was preventable.[66] It would not have occurred had a standard lockout system been in place – a routine matter in any normal underground coal mining operation.

Finding

No true system was in place at Westray for locking out the main conveyor belt, a standard procedure in underground coal mine operation.

Unqualified Underground Personnel

Westray sent workers and foremen underground without proper training or underground experience.[67] As the issue of training has been addressed in Chapter 4, the following evidence is offered to document further management's lack of concern for the well-being of its workforce.

Steven Cyr said that, although he was on a training crew with John Bates for about a month, it was more of a labour crew than a training crew. There was no instruction about the hazards of methane or coal dust. There was no demonstration of how a self-rescuer was used. The crew was simply shown the bolter and put to work setting steel and laying pipes.[68]

The evidence suggests that the foremen at Westray also lacked the training and experience appropriate for their assigned roles. Bryce Capstick testified that the only coal mining experience he had was the development of the roadways, which involved some mining through coal. He did not have any experience with the actual production of coal.[69] In testifying, Capstick discussed whether he was qualified to hold the position of shift foreman at Westray. He felt qualified as far as the production of coal was concerned. He felt less qualified about ensuring that the operation was run properly:

> [W]hen I was there I relied on the mine inspectors, and I relied on upper

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64 Hearing transcript, vol. 23, p. 4504.

65 Exhibit 112.1B.9–10.

66 Yeo testified that, had a true lockout system existed at Westray, it would have been "extremely unlikely" that the Matthew Sears accident would have occurred (Hearing transcript, vol. 45, p. 9863).

67 As noted in Chapter 2, front-line supervisors are variously referred to by witnesses as foremen, shift foremen, shift bosses, shifters, and fire bosses. The terminology varies from mine to mine. Except in quotations, we will attempt to simplify things by referring to this class of supervisor as foremen. To further confuse matters, most underground foremen at Westray were also mine examiners by default.

68 "But there was no training or anything, no" (Hearing transcript, vol. 25, pp. 5094–96.)

69 Hearing transcript, vol. 42, pp. 9284–85.

> management as far as the actual operation of the mine was concerned. . . . If any regulation was being violated, I expected them to know about it.
>
> And as far as work goes, work is work. . . . and as long as you carried out certain duties, you know, that aspect would be covered. But apparently, I guess, I was kind of misled because nobody kept an eye on anything. Upper management, they just connived to break every rule and regulation and when the inspectors came in, they just rubber-stamped everything.[70]

Capstick went on to say that, with the exception of Arnie Smith and Jay Dooley, he did not feel that the rest of the shift foremen had had enough underground coal mining experience.[71]

Cyr recalled a conversation he had had with Chester Taje, a miner who had come to Westray from Alberta with the expectation of becoming a foreman. Taje told Cyr he hadn't been made a foreman "because of his safety standard." According to Cyr, Taje thought that the Westray foremen were "a bunch of donkeys and weren't qualified to be shifters."[72] Buddy Robinson, a coal miner with 30 years' underground experience, was of a similar mind. In his opinion, Owen McNeil, Ray Roberts, Bryce Capstick, and Angus MacNeil were not qualified to be foremen. Robinson did not think that they had sufficient coal mining experience.[73]

Finding

Westray management sent underground both foremen with little or no coal mining experience and novice miners who were untrained and inadequately supervised. This practice can only be construed as a further example of Westray management's laxity in applying basic principles of coal mining safety.

Non-flameproof Equipment Underground

There are instances in which workers, supervisors, and management at Westray employed non-flameproof equipment underground in violation of the regulatory conditions for its use.[74] Westray did receive exemptions for non-flameproof mobile equipment. Each exemption carried with it a set of conditions to be followed for that specific piece of equipment. The following conditions were common to the exempted non-flameproof mobile equipment:

- the equipment was not to be used in the return air
- the equipment was not to be used beyond the last open cross-cut

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70 Hearing transcript, vol. 42, p. 9314. With this brief comment, Capstick seems to have aptly summarized the roles of management and the inspectorate at the Westray mine.

71 Hearing transcript, vol. 42, p. 9329.

72 Hearing transcript, vol. 25, p. 5168.

73 Hearing transcript, vol. 30, pp. 6408–09. It is significant to note that Robinson declined more than once to be a shift foreman at Westray. He testified that he was unwilling to instruct miners to work in conditions that he himself would find hazardous (pp. 6410–11).

74 The *Coal Mines Regulation Act* was outdated to the extent that it made no provisions for the use of diesel equipment other than diesel locomotives. Instead, the director of mine safety granted each piece of equipment a permit subject to written conditions for its use.

- the equipment was not to be used within 300 feet of the working faces
- the equipment was not to be used in air containing more than 0.25 per cent methane measured in the general body of air
- the equipment was not to be used on roadways with more than 15 per cent combustible matter.[75]

As well, Westray's own code of safe practice for non-flameproof equipment provided that such vehicles "shall only be operated in intake airways and shall not pass the last open cross-cut."[76]

The evidence of underground workers at Westray shows that these conditions were simply not met. Ron MacDonnell testified that he observed Jay Dooley, an experienced coal miner and a foreman, operating a non-flameproof bulldozer "right at the face."[77] Dooley confirmed this himself. He explained that he was advised by Roger Parry that the non-flameproof diesel equipment was not permitted in any area with more than 0.25 per cent methane in the air. This was the only condition Dooley was aware of prior to the explosion. Dooley went on to say that he recalled seeing such equipment being operated within 5 or 10 feet of the face. It was a regular occurrence for the non-flameproof boom truck to be at the face.[78] Wayne Cheverie said that he was not made aware of the conditions governing the use of non-flameproof equipment in the mine. He said that maintenance superintendent Bob Parry advised him that the non-flameproof tractors were not to go past the last fresh-air cross-cut – the only condition he was aware of prior to the explosion. Cheverie explained that he could not always abide by the restrictions applicable to the tractor:

> There were certain things that were expected of you . . . in the mine that could only be done with a vehicle of some sort and by times everyone in the mine abused the equipment that was exempted.[79]

Cheverie went on to provide examples of prohibited actions. The non-flameproof vehicles were used to transport hydraulic oil and bolting supplies to the face, and to stock the bolter with roof bolts, bolt plates, screen, and resin. This was done at the request of the foremen. Cheverie also recalled driving the tractor in the return air. He believed that foremen and mine management must have been aware of such practices.[80] Cheverie reminded the Inquiry that the only vehicle access to the Southwest 2 section was via a return airway.

There is evidence establishing that both Roger Parry and Phillips engaged in such unsafe and illegal practices. Estabrooks said that he saw Phillips and Parry drive a non-flameproof tractor down 2 East in the

75 Exhibit 73.12.003. This is from the schedule of conditions for the Jeffrey Dresser dozer used underground. Similar approvals were on file for the Massey-Ferguson tractors and a boom truck. Certified flameproof vehicles such as the Wagner Scooptrams were subject to some of the same restrictions (Exhibit 69a).

76 Exhibit 69b.004.

77 Hearing transcript, vol. 29, p. 6089.

78 Hearing transcript, vol. 39, pp. 8663–65, 8669.

79 Hearing transcript, vol. 20, pp. 3968–70.

80 Hearing transcript, vol. 20, pp. 3970–72.

Southeast section of the mine just days before the explosion. He also testified that Albert McLean, the mine inspector, rode a tractor with Parry to within 30 feet of the North A Road face.[81] Don Dooley witnessed Parry driving a non-flameproof tractor in the North mains return air.[82] Clive Bardauskas said that he saw Bryce Capstick operating a Scooptram with the scrubber "spragged" – that is, with the float-scrubber safety system that dilutes noxious gases and prevents sparking disabled. On this occasion, both he and Jay Dooley saw sparks flying out of the exhaust. At that point, according to Bardauskas, Dooley ordered the machine shut down, and the scrubber was filled with water – a safety procedure that took only a few minutes.[83]

In a pre-hearing interview, Lenny Bonner recounted an episode involving the use of non-flameproof equipment underground in SW1-3 Cross-cut. Bonner testified that he was sitting in the front of the tractor while attempts were made to back it up the hill:

> [W]e were backing up there and they had a fan pulling the air out of one of the other sections and it was exhausting right on the slope . . . and we were backing up the tractor and it just started to – it looked like you were putting a grinder to a piece of steel, it was sparks that came out of the exhaust. It kind of scared the shit out of us and we shut the tractor down right there and Chester Taje was standing on the corner and he seen it and he was just white as a ghost because the dust that was getting kicked up from the exhaust of the tractor and the wheels and the fan blowing on us exhausting gas out on us and coal dust and mixing it all up and all them sparks flying out and they were big sparks – they looked as big as the tip of your finger, they did.[84]

During the mine rescue operation, those same non-flameproof tractors were taken underground as far as the fresh-air station. Clive Bardauskas testified that he noted the exhaust of the tractor was sparking underground. When asked how that made him feel, Bardauskas responded simply: "Sick. That even during the rescue that we'd have situations where tractors were still producing sparks."[85]

The careless and haphazard use of non-flameproof equipment in a coal mine is a serious safety issue.

Finding

Westray management failed to provide adequate instruction on the use, and the limitations imposed on that use, of non-flameproof equipment. By its example, Westray management condoned, and even encouraged, illegal use of this equipment underground.

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81 Hearing transcript, vol. 24, pp. 4891–94. It is likely that 2 East in May 1992 met *none* of the conditions required for operating the tractor.

82 Hearing transcript, vol. 36, p. 7933.

83 Hearing transcript, vol. 23, pp. 4596–98.

84 Exhibit 92.1.81–82.

85 Hearing transcript, vol. 23, pp. 4702–03.

Cable Damage

The evidence shows that the maintenance of electrical cables at Westray violated section 85(2), rule 75, of the *Coal Mines Regulation Act*:

> Trailing cables shall be examined for defects or damage at least once each shift by the machine operator, and once each week by the chief electrician or one of his assistants. *If found damaged or defective, they shall be sent to the surface for permanent vulcanized repair, and shall be replaced by spare cables in good condition.* [Emphasis added.]

Malcolm McPherson testified to the seriousness of cable damage from the perspective of safety:

> We do not have any evidence that cable damage was the cause of this particular ignition, but reflecting your statement that this is an indication of perhaps less than adequate training of the miners in handling those cables. And, indeed, if that had continued, this would have been, and indeed it was, a possible source of ignition.[86]

The evidence of electricians Mick Franks and Harvey Martin shows the improper, yet common, manner in which cables were repaired at Westray. Franks said that the *Coal Mines Regulation Act* permits tape repair of damaged cables during and until the end of a shift, provided that the inside pilot cable is undamaged. It then requires removal of the cable to surface for vulcanization. He was advised of this policy when he first began work with Westray. Franks said that the policy was never implemented. He made his first report of cable damage to Brian Palmer, but the cable was never removed from the mine for servicing. Franks estimated that approximately eight or nine cables may have been removed properly. He testified that there was a lot of cable damage and no vulcanizing kits to repair them. He saw only one kit prior to the explosion; as far as he knew, it was never used. Franks remarked that the practice employed at Westray was merely to tape the cables and use them in that state.[87] Martin's testimony is consistent with that of Franks. He stated that at one time he was advised that damaged cables were to be repaired for the remainder of a shift and then removed from the mine and vulcanized. Martin never saw any cables removed from the Westray mine to be repaired properly.[88]

The improper repair of cables would have been quite evident to mine management – and to the inspectorate – since some cables showed numerous and obvious "tape jobs." Nevertheless, Westray electricians were never instructed to repair the cables properly, nor were they given the necessary materials to make such repairs.

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86 Hearing transcript, vol. 9, p. 1702.

87 Hearing transcript, vol. 21, pp. 4143–44.

88 Hearing transcript, vol. 23, p. 4534.

Finding

Westray management seemed to condone the dangerous and haphazard practice of allowing temporary cable repairs to remain as permanent repairs. In so doing, management was in violation of section 85(2), rule 75, of the *Coal Mines Regulation Act*, which requires that such cables be properly vulcanized.

Main Ventilation Fan

There are accounts of the main ventilation fan having been shut down at Westray – a blatantly unsafe and illegal practice whenever workers are underground.[89] Clive Bardauskas questioned Westray's rationale for having positioned the main ventilation fan directly above the conveyor belt. Debris and dust were sucked into the fan, partly blocking the mesh cover on the main fan intake. To clear the problem, the fan was simply turned off and the mesh was cleaned.[90] Bardauskas referred to one incident in No. 5 Cross-cut, where a new belt drive was being installed. As one of the welders proceeded to burn, the torch suddenly turned "a funny colour blue."[91] Bardauskas said that maintenance foreman Roman Schule tested for gas, went off to determine what had happened, and returned to advise that the main fan had been turned off. Bardauskas found this unbelievable because "you just don't turn the main fan off when there's men underground, and especially you don't turn it off when you're doing burning or welding like that."

Matthew Sears, who worked a total of 12 shifts underground at Westray, testified that he was aware of the main fan being shut down on at least two occasions to clean out debris that had collected in the fan. Ralph Melanson, his foreman, had told him to do it; he didn't know who would have instructed Melanson to take that course of action. Sears went on to say that the fan was shut down for "approximately 15 to 21 minutes" on each occasion. He doubted that mining was ongoing the first time, but thought it was "more than likely that mining was going on" the second time.[92]

Finding

The main ventilation fan in any mine is fundamental to the safe operation of that mine and the safety of its underground workers. Notwithstanding, Westray management failed to instil any understanding of this fact in its workforce. On the contrary, workers were instructed to shut the fan down for maintenance without any provision for the safety of the workers.

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89 Section 71(4) of the *Coal Mines Regulation Act* requires that "[w]hen the fan is stopped for any reason, the workers shall be removed from their working places to a place of safety . . . and the workers shall not return to their working places until the mine has been declared safe." Turning off the main fan interrupts the flow of respirable air to underground workers and promotes the formation of methane layers at the roof.

90 Hearing transcript, vol. 23, pp. 4628–29.

91 Hearing transcript, vol. 23, p. 4623. Methane burns with a characteristic blue flame.

92 Hearing transcript, vol. 29, pp. 6052–53.

The evidence is clear that the underground workers were well aware of the dangers they were regularly exposed to. Professor Gerald Wilde at my request identified several of the safety concerns which, by their own account, prompted experienced miners, as well as novices, to quit Westray:

- presence and accumulation of coal dust
- presence of methane, the methanometer not working or being deliberately set at a higher than prescribed level
- sparks from electrical equipment, torches taken underground
- poor ventilation
- frequent cave-ins of the roof structure
- poor level of training of the workforce and of safety training in particular.[93]

Environmental Monitoring System

Although Nova Scotia's *Coal Mines Regulation Act* makes no mention of atmospheric monitoring systems (AMS), such systems have become commonplace and reliable. The ability to monitor continuously the quality of mine air in designated locations is important to underground mine safety.[94] Westray had such a system, but it was neither installed nor operated properly. Unfortunately, management's disregard for this key safety feature effectively disabled an early warning system for the kind of conditions that resulted in the explosion of 9 May 1992.

Underground mine monitoring systems are used in two separate but related ways: to control and monitor the operation of mechanized equipment, and to observe the condition of the mine atmosphere. The most common airborne pollutants monitored in coal mines are methane and either carbon monoxide or smoke. Air velocity transducers are also being used increasingly.[95] Some systems may also track the concentration of oxygen and carbon dioxide as well as temperature, humidity, and pressure differentials across fans, doors, or stoppings. With these systems, alarms can be set off when preset levels of the monitored conditions are exceeded. The control centre, usually at a surface location, houses the computer and associated equipment that manages the system and records the information received from remote monitors.

The system at Westray monitored and controlled the belt conveyors in the main slopes and equipment in the coal preparation plant, where the control centre was situated. The six environmental monitoring stations in the mine – all of them in, or close to, the main slopes – measured carbon

[93] Gerald J.S. Wilde, "Risk Awareness and Risk Acceptance at the Westray Coal Mine: An Attempt to Understand Miners' Perceptions, Motivations, and Actions prior to the Accident," report to the Westray Mine Public Inquiry (Kingston, April 1997), 2. Professor Wilde is a member of the Department of Psychology, Queen's University, Kingston, Ont.

[94] U.S. coal mining regulations require an AMS under certain ventilating circumstances or as an alternative to regular hand testing (see 30 CFR 75.351).

[95] A transducer is a device that converts a non-electrical signal, such as the speed of rotation of an anemometer, into an electrical signal.

monoxide and methane. It was a new and modern system, but it had a history of intermittent operation and unreliability. The recordings made prior to the explosion gave no definitive warning of impending danger and they offer no assistance in establishing the cause or behaviour of the explosion. It is by no means certain that the system, as installed, could have detected any progressive indications of unsafe conditions in the Southwest sections of the mine. Two questions arise: Why was the environmental monitoring system so unreliable? and How suitable were the numbers and locations of the monitoring stations?

Description

The monitoring system at Westray was manufactured by Davis Derby Limited (later Senior Davis Derby), a long-established British firm with an admirable reputation in the British coal mining industry. It used transducers made by another British company, Trolex Limited. The Canadian distributor, Minelec Limited, first supplied a carbon monoxide detection system to Canadian Mine Development, the Westray mining contractor, in January 1990. The first conveyor control was shipped in May 1991, and Westray received the main mine monitoring system in July 1991. Alan Blevins, president of Minelec, conducted training sessions for Westray personnel during the weeks of 13 May, 24 July, 22 October, and 9 December 1991.[96]

At the time of the explosion, six environmental monitoring stations had been established for carbon monoxide and methane. Four of the stations communicated with the surface control centre, as indicated in table 5.1. The two other local stations, with flashing beacons, monitored the electrical power centre in No. 5 Cross-cut and the compressor in No. 10 Cross-cut. Their trip-point levels were set at 12 parts per million carbon monoxide and 0.25 per cent methane.[97]

Low-voltage electrical signals were transmitted between the control centre and monitoring points via electrical "outstations." The principle of operation was that every few seconds a signal was sent from the surface control to each transducer, or sensor, to check that it was connected and operating correctly. Signals sent from the transducers to the control centre indicated the concentration of gas detected. When that concentration exceeded the preset limits, audio and visual alarms would be activated at the corresponding locations. The incoming signals could be inspected visually via computer monitor screens at the control centre. In addition, two forms of records were made. One, known as the rolling log, maintained information on the two-way signals, including whether an alarm condition was detected, but did not record the actual

96 Alan Blevins summarized this information in a 12 June 1992 letter to Shelley Gray, an occupational hygienist with the Nova Scotia Department of Labour (Inquiry file, DOL Box6 33).

97 Exhibit 45.11.

Table 5.1 Underground Monitoring for Carbon Monoxide (CO) and Methane (CH_4)

Station	Underground Alarm Setting		Surface Alarm Setting	
	CO (ppm)	CH_4 (%)	CO (ppm)	CH_4 (%)
No. 1 Environment (Intake) NW1 Cross-cut between North B & D Roads	12	0.75	12	1.25
No. 2 Environment (Exhaust) 2 North Main at North D Road		0.75		1.25
No. 3 Conveyor No. 2 Main between Nos. 10 & 11 Cross-cuts	12		20	
No. 2 Conveyor No. 2 Main between Nos. 4 & 5 Cross-cuts	25	1.25	20	0.8

Source: Exhibit 45.11.

concentrations.[98] The second (archived) form of record did, indeed, give actual concentrations, but averaged over periods of 10 minutes.

Signals Recorded Prior to the Explosion

The person charged with maintaining the monitoring system at Westray was a young electrical engineer-in-training, Jeff Yeo. Yeo testified that he had had no experience in underground coal mining; nor had he had any formal training in mine electrical procedures.[99]

At the time of the 9 May 1992 explosion, the environmental monitoring system was not working reliably. Dr McPherson reported that it is not unusual for a new electronic surveillance system at an underground mine to have a settling-in or debugging period when initial site-specific problems are resolved, and operators and maintenance personnel become trained and fully conversant with the system. At Westray, there were several reasons why that period was prolonged, in addition to Yeo's lack of experience. At an early stage of installing the environmental monitoring system, lengths of underground telephone cable were installed instead of the type of cable specified by the manufacturer.[100] Surges of electrical current on power lines, as occur when equipment is switched on or off, could cause transient responses and produce false alarms.[101] The system would be especially susceptible to such effects because of the incorrect cable that was used. A control circuit card was suspected of malfunction and was replaced, Yeo testified, but without any perceptible improvement.[102] There was no schedule in place for calibration

98 Exhibit 33.

99 Hearing transcript, vol. 45, pp. 9800, 9890–91.

100 Hearing transcript, vol. 45, pp. 9840–42.

101 Hearing transcript, vol. 45, p. 9855.

102 Hearing transcript, vol. 45, pp. 9891–92. Yeo thought that initially the new card might have helped, "but over time we started to have doubts as to whether that really made much difference at all."

of the sensors.[103] False alarms occurred so frequently that operators in the control room were instructed to ignore them.[104] Yeo told the Inquiry that the primary concern of the control room operators was "to run a prep plant, and they had other things to do."[105]

A further factor that delayed the development of a reliable environmental monitoring system, and which also had a parallel with mine ventilation, was that Yeo had duties related to mine production, which took priority over matters of safety. The former included the monitoring system for the conveyors.[106]

The rolling log for the period 20 April to 9 May 1992 indicates that few meaningful signals were received from environmental monitors during that period. It was within the context of this virtually useless environmental surveillance system (as installed) that mine personnel and engineers of Senior Davis Derby tried to glean information from signals recorded shortly before the explosion.[107] The signals transmitted in the early hours of 9 May 1992 were recorded on the rolling log and as archived data, and these data were analysed by Senior Davis Derby.[108] Table 5.2 combines in summary form the two sets of records for the northern intake (No. 1 Environment station) and nearby exhaust monitoring points. The intermittent nature of the signals and the short-lived alarms, unconfirmed by the archived data, suggest strongly that the records reflect transients that could have been caused by electrical fluctuations, by switching the system on or off, or by faults in the transmission links.

Had any abnormal quantities of gas been emitted from the Southwest section into the main slopes, they might have been detected at the No. 2 Conveyor monitoring station. No such abnormalities were recorded. Between midnight and loss of transmission on 9 May 1992, the carbon monoxide fluctuated at low levels between 0.78 and 1.57 parts per million, while the methane concentrations ranged from 0.29 to 0.35 per cent.

Locations of Monitoring Stations

McPherson examined the locations of the monitoring stations and reported to me subsequent to the hearings. The stations along the main conveyors were sited appropriately for detecting abnormal gas emissions from the

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103 Hearing transcript, vol. 45, pp. 9901–02. The Trolex Installation and Operating Data booklet for the TX3261 methane sensor used in the system recommended recalibration and other regular servicing every two weeks (Inquiry file, DOL Box 6 32).

104 Hearing transcript, vol. 45, pp. 9837–38.

105 Hearing transcript, vol. 45, p. 9884.

106 Hearing transcript, vol. 45, p. 9861. Yeo was the system administrator for the company's minicomputer (p. 9799). He commented, regarding the environmental monitoring system: "I would say I didn't have as much time to work on it as I would have liked to" (p. 9846).

107 Yeo was asked, post-explosion, to do "a very hurried analysis"; this analysis was inconclusive (Hearing transcript, vol. 45, pp. 9856–57). Alan Blevins arranged for analysis of the data by the system manufacturer, by this time known as Senior Davis Derby.

108 The rolling log is in Exhibit 33.3. The 14 September 1992 report of Senior Davis Derby is in Exhibit 37a.176–79.

Table 5.2 Environmental Monitoring at No. 1 Environment Station, 9 May 1992

Time (hr:min:sec)	Signal
04:24:20	• Communication established with monitors after having been off since 7 May at 01:41:13
04:24:22	• Intake methane and carbon monoxide monitors both operational • 10-minute average concentrations: Carbon monoxide 3.92 to 3.53 ppm; methane 0.16 per cent • Exhaust methane monitor not operational
04:45:20	• Intake: carbon monoxide detected. This was a short-lived alarm – 10-minute average: 2.35 to 1.96 ppm • Methane alarm for a very short transient period – 10-minute average concentration: 0.16 to 0.2 per cent
04:45:26	• No signals for 3 seconds
04:45:31	• Intake carbon monoxide monitor showing a fault • Intake methane monitor operational • Return methane monitor showing a fault
04:45:45	• Intake methane alarm for a period of less than three seconds – 10-minute average concentration: 0.2 per cent
04:46:30	• Intake carbon monoxide monitor operational – 10-minute average until loss of transmission: 2.35 to 1.96 ppm
05:18:51	• Off air

Source: Exhibits 33.3, 37a.176–79.

working sections into the main return. Similarly, the carbon monoxide monitors, had they been maintained in continuous operation, would have provided a means of detecting a fire along the main belt lines. It was also appropriate to locate an environmental monitoring station at the inbye end of the north workings, although he thought it unclear why two such stations were positioned so close to each other.[109]

The purpose of environmental electronic surveillance in an underground mine is to provide warning of actual or impending dangerous atmospheres. Therefore, when deciding where to locate such stations, it is important to consider where such conditions are most likely to arise. This is not always an easy decision, since air quality in a mine can vary with respect to both time and location. There are, however, some guidelines that offer assistance. First, in coal mines, inadequately mixed methane will migrate towards the roof. Similarly, in the case of an underground fire, thermal stratification will cause the products of combustion, including carbon monoxide, to rise. It is therefore prudent to locate gas monitoring sensors at, or close to, roof level.

Second, the geometry of the mining layout will indicate appropriate monitoring locations. McPherson thought that at Westray it would have

[109] The locations of the monitoring stations are shown on maps 5, 6, and 7 in Reference.

been prudent to site a monitoring station in the return airway from the Southeast section. In his estimation, there should have been two stations in the Southwest, one in SW2-A Road, the return airway from the Southwest 2 section, and, from the time that the Southwest 1 section was developed, one in the SW1-B Road. Had there been such a station anywhere between the SW1-B Road stopping inbye SW1-3 Cross-cut and the entrance to the SW2-B Road, and had it been located at roof level, and had it been kept operational, the methane layer emerging from the abandoned Southwest 1 workings would have been detected at an early stage.[110]

Any system of controlled partial recirculation of ventilation in a mine should be carefully designed and engineered. As a part of the design, and before permission for its use is granted by a regulatory authority, continuous monitoring of the quality and quantity of the recirculated air should be maintained by means of transducers for air velocity and carbon monoxide or smoke. In a coal mine, a methane monitor should also be provided. At Westray therefore, despite the stations in the main return, there should have been an environmental monitoring station located in the surface recirculation duct.

Finding

The environmental monitoring system at Westray was not effective. Its problems were inherent not in the equipment, but in the manner in which it was installed and maintained. They can be summarized as follows:

- **Equipment was installed improperly and an incorrect transmission cable was used.**
- **Initial difficulties were not resolved and the system was inoperative most of the time.**
- **Maintenance and resolution of faults in the system were left to an engineer-in-training with no previous experience in coal mines or with this type of equipment.**
- **That same engineer was allocated duties that conflicted between mine production and safety.**
- **There were not sufficient monitoring stations in strategic locations, especially in the Southwest sections.**
- **There was no scheduled maintenance or recalibration of gas sensors.**

Equipment

The inadequacy of the equipment provided to underground workers further supports the view that Westray management trivialized safety issues. The unacceptable standards at Westray in effect deprived miners of the very basics in underground coal mining – there was no system in place to ensure that equipment was properly outfitted, issued, or maintained.

[110] See Chapter 7, Ventilation, for details about the Southwest 1 methane layer.

Equipment Maintenance

Preventive maintenance of equipment is fundamental to both worker safety and production. Regular maintenance enhances the efficiency and the life of production equipment and thereby enhances production itself. Westray management blatantly ignored any maintenance schedules it had put in place. Equipment maintenance at Westray was simply not performed with the rigour and regularity dictated by good mining practice.

Underground mechanic Wayne Cheverie's evidence on this point is clear and credible. He testified that, although a preventive maintenance program had been established, there was no scheduled downtime; maintenance was permitted only when machines were not in production. He said that it was extremely difficult to service the continuous miners, the main production machines, since management did not like them out of production for any reason.[111] In such cases, underground workers attempted to complete whatever preventive maintenance they could while the continuous miner was inactive. Any opportunity to service the equipment simply came to an end when the production side of the crew was set to recommence mining.[112]

Harvey Martin, a shift electrician, testified that it was not always possible for him to complete scheduled preventive maintenance work. In the event that a crew was beginning or in the middle of a cut, he was not likely to have the opportunity to service that piece of machinery that day. Martin went on to identify production as the top consideration when it came to the servicing of equipment: "*Anything that had to do with production fell ahead of any preventative maintenance.*"[113] A broken-down continuous miner would take precedence over a roof bolter scheduled for preventive maintenance. Initially, Martin had thought that the company would take maintenance seriously, since a schedule had been put in place. He soon learned, however, that repair and maintenance jobs that directly affected production would inevitably take precedence over the duties assigned to him.

Mick Franks testified that it was "pretty well impossible" to complete any preventive maintenance checks on the continuous miner – there was never any downtime scheduled. According to Franks, the situation became even worse during the couple of months leading up to the explosion, when "they wouldn't shut it down at all."[114]

The underground workers assigned to the maintenance of conveyor belts were faced with similar difficulties. Franks testified that management did not permit the belt to be shut down for any reason:

> No, you could never shut the main belt down. *The main belt was totally taboo*, you know, like, Gerald [Phillips] had them install a yellow light on top of the main belt so that he could see it from his house, like a revolving

111 Hearing transcript, vol. 21, p. 3998.

112 Hearing transcript, vol. 21, pp. 4045–46.

113 Hearing transcript, vol. 23, pp. 4447–49. Emphasis added.

114 Hearing transcript, vol. 21, pp. 4127–28.

> light, you know. So that if that light went out, he knew that the belt was down and then he'd get on the phone and find out why the belt was down. Even if there was no mining going on, even if they were doing a power move in the North Mains and the Southwest was shut down for some reason, they still had to keep that belt running for some reason. It was just – I don't know, a big bugbear with him. They just always had to keep that belt running.[115]

As a result, underground workers were left with little choice but to perform maintenance and repair work while the belt was running. According to Franks, the only time the belt was shut down was when it broke down.

Westray's mine maintenance month-end reports show that scheduled preventive maintenance work was routinely not completed. For November 1991, preventive maintenance work for the underground mechanical equipment, underground electrical equipment, underground tractors, and underground Scooptrams was 52, 29, 85, and 25 per cent, completed respectively.[116] For March 1992, preventive maintenance work completed for underground mechanical equipment, underground electrical equipment, and underground diesel equipment, was 63, 72, and 89 per cent, respectively.[117] (It should be noted that the percentage of preventive maintenance work completed on surface was higher. Maintenance work completed in the preparation plant for November 1991 and March 1992 was at 80 and 100 per cent, respectively.)

Evidence heard respecting the practice of routine preventive maintenance in other mines contrasts with the practice at Westray. Cheverie testified that at Grande Cache there was scheduled maintenance *and* downtime within which to complete such maintenance. The mechanics and electricians were expected to service the equipment every morning. When the production crew was set to mine, the machine would be released for production *if possible.* In addition, a half-hour was allotted during the shift for further maintenance work.[118] Harvey Martin contrasted his experiences at Westray and Faro. Martin explained that, on receiving a work order for routine maintenance at Faro, he always found the equipment available so that servicing could be completed. Such was not the case at Westray.[119]

Cap Lamps

There was no proper procedure for issuing cap lamps to underground

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115 Hearing transcript, vol. 21, pp. 4134–35. Emphasis added.

116 "Mine Maintenance Month end for November" (12 December 1991) (Inquiry file, West Room27 11).

117 "Mine Maintenance Month end for March 1992" (2 April 1992) (Inquiry file, West Room27 11).

118 Hearing transcript, vol. 21, p. 4002.

119 Hearing transcript, vol. 23, p. 4448. Faro was the site of Curragh's base metals mine in Yukon.

workers at Westray. Mick Franks testified about the problems he encountered:

> Q. Was that a common occurrence for your cap lamp lights to go dim?
> A. . . . [I]t . . . used to be a common occurrence, definitely, yeah. Because people would be just grabbing anybody's lamp and you might have somebody . . . using your lamp on your days off. And then you come in and . . . it might last two or three hours and it's gone.[120]

Tom MacKay experienced similar problems. He explained that one was not always assured of receiving the same lamp each shift. There were times when MacKay would just make it underground and his light would go out.[121]

This problem was exacerbated by the fact that the workers' cap lamps were not suitable for 12-hour shifts. The lamps were intended for the 8-hour shift. Accordingly, the lights would frequently begin to dim before the end of the workers' shift – clearly constituting a safety hazard.[122] Westray management was aware of this problem, but ignored it. Management's indifference is apparent from the testimony of Carl Guptill, who recounted the episode that led to his being injured.[123] Guptill had agreed to switch lamps with Wayne Conway, who was roof bolting when his lamp went dim. Rather than arrange for a replacement lamp, their foreman instructed Guptill to work in the dark, using only the light from nearby workers. Guptill tripped while carrying a heavy arch and was injured.

The mine inspectors were also aware of the safety hazard. The electrical/mechanical inspector, John Smith, had apparently been surprised to learn about the 12-hour shifts:

> I thought, "Well, surely to God there's not going to be all these guys running around every shift with a dim light after eight hours or nine hours." Well, they [the cap lamps] were new. I suppose you might squeeze 10 or 11 hours out of it if it was new and in good shape. But towards the end of each 12-hour shift, you wouldn't have a very good light, if you had a light at all. . . . So that was the thing that I was concerned about, it was a – well, it wasn't a purely electrical thing, but it was a safety thing. [124]

The inspectorate was fully aware of this safety concern yet failed to address the issue.

Methanometers

The workers responsible for calibrating methanometers testified that proper supplies for doing so were not always readily available at Westray. Harvey Martin testified that, on many occasions, the bottled 2.5 per cent methane gas required to calibrate was not available, nor was the "zero

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120 Hearing transcript, vol. 21, pp. 4181–82.

121 Hearing transcript, vol. 32, p. 7029.

122 Equipment and materials expert John Bossert agreed in testimony that the cap lamps used at Westray lose up to 40 per cent of their light output after 10 hours of continuous discharge (Hearing transcript, vol. 12, pp. 2200–01).

123 More fully described in the section on Carl Guptill in Chapter 12, Department of Labour.

124 Hearing transcript, vol. 59, pp. 12868–69.

gas."[125] Zero gas was requested but, to his knowledge, never received. As a result, Martin was not confident that the methanometers were being calibrated accurately. Mick Franks testified that, despite repeated requests, he was unable to acquire "lab air" to calibrate the methanometers properly.[126] Rick Mitchell recalled operating the continuous miner with a hand-held methanometer (see photo 10 in Reference) when there was no gas available to calibrate the on-board methanometer.[127]

Apparently, no methanometer extensions were available to the workforce at Westray. As a result, underground workers were unable to test for gas and gas pockets close to the roof or in roof cavities, which often reached a height of 4 m and higher. Rather, gas checks were confined to the height any given underground worker could reach with a standard hand-held methanometer – perhaps 2.1 m. (Sometimes workers would stand on equipment to get more height.) Harvey Martin said that he never saw any type of extension or mechanism at Westray that could be used to test for a layer of gas at the roof.[128] Trevor Eagles said that, although he had access to a methanometer with an extension in April 1992, he didn't see it after that.[129]

Management was aware that roof bolting crews were working in high methane. Underground workers repeatedly requested that the roof bolters have methanometers installed even though they are not required by the *Coal Mines Regulation Act*. The practical and safe solution to high methane concentrations would be adequate ventilation.[130] The inadequacies of the Westray ventilation system are addressed in Chapter 7, Ventilation.

Don Dooley was adamant that there should have been methanometers on the bolters. Dooley, other members of the bolting crews, and many other underground workers requested methanometers. Management's response was simple and clear: they were not required.[131] Wyman Gosbee recalled asking that the bolters be outfitted with methanometers. His foreman gave him two reasons why this would not be done: first, it would be difficult to find a safe place on the bolter to place the methanometer; and second, "you'd never get anything done because it would always be shutting down."[132] Gosbee was not satisfied by the response he received

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125 Hearing transcript, vol. 23, pp. 4452–54. "Zero gas" is bottled air with no methane, used for calibrating the zero point of the methanometer.

126 "It just didn't seem like an issue to Brian [Palmer, electrical foreman]" (Hearing transcript, vol. 21, pp. 4140–41).

127 Hearing transcript, vol. 31, p. 6805.

128 Hearing transcript, vol. 23, pp. 4543–44.

129 Hearing transcript, vol. 76, pp. 16618–19.

130 Equipping roof bolters with methanometers does not seem to be common industry practice. Perhaps the question arises only in mines such as Westray, in which the ventilation system was so inadequate that methane layering at the roof was commonplace. When mining at the face is complete, the area must be ventilated to clear any methane before the roof bolters start to work. Inquiry coal mining consultant Roy MacLean confirmed that this is the appropriate, and standard, approach.

131 Hearing transcript, vol. 36, p. 7876.

132 Hearing transcript, vol. 25, pp. 4996–97.

from his shift boss. He went on to explain that a methanometer on a bolter would automatically shut the bolter down at the standard 1.25 per cent methane. He was accustomed, however, to working in methane concentrations as high as 3.75 per cent.[133]

Finding

Roof bolting in conditions such as those experienced at Westray clearly jeopardized the health of the workers who were "gassing out" on a continual basis. The issue of methanometers on roof bolters leads us directly to the adequacy of ventilation in mining headings. If the ventilation of the headings had been adequate, methane would be cleared before bolting began. Westray management's trivialization of methane in working areas illustrates a serious disregard for or a misunderstanding of proper ventilation.

There is ample evidence from which to conclude that the underground equipment at Westray was not being properly and routinely serviced, that the underground workers' cap lamps were inadequate for their 12-hour shifts, that methane monitoring was insufficient, and that miners were being subjected to hazardous concentrations of gas. Experienced mine bosses Gerald Phillips and Roger Parry knew, or ought to have known, that these conditions constituted an immediate and serious hazard to the underground workers at Westray. If they knew and did nothing, they exhibited a startling degree of laxity in respect to the essentials of safety. If they did not know, they were simply incompetent.

Finding

Westray management failed to provide properly maintained and appropriate equipment. Management thus failed in its fundamental and overriding responsibility to ensure that underground workers were able to do their work in a safe environment.

Housekeeping Underground

The state of housekeeping in an underground coal mine is indicative of the existence or absence of a safety ethic. Colin Benner expressed his view:

> Oh, they're an automatic indicator. Housekeeping is . . . an indicator of an attitude. . . . The workplace, if it's kept in the right order, will be safe. If the housekeeping is good, things are put in place where they . . . belong, then usually you're not going to have a high frequency of accidents. It's just an indicator, I think, that *housekeeping, by all studies done by all safety experts and by all industrial engineering experts has always been one of the prominent features in developing a good safety program* in a mine or in any

[133] Gosbee reckoned that he started feeling the effects of oxygen deprivation at about 5 per cent methane (Hearing transcript, vol. 25, p. 4998).

industrial setting, for that matter. A lot of accidents occur as a result of poor housekeeping.[134]

The record is replete with references to the poor state of housekeeping underground at Westray. Benner testified to the standard of housekeeping that he observed underground on 5 April 1992: "[T]here was a lot of debris in various areas, like timber lying around, steel lying around, garbage papers, lunch papers, orange peels."[135]

The mine workers generally held the view that the state of housekeeping underground left much to be desired. Lenny Bonner described housekeeping at Westray as "terrible."[136] He commented on "water jugs lying in the drift, boxes of resin cartridges . . . rock bolts . . . and Dywidags buried in coal dust. . . . lunch can wrappers . . . half eaten food" and similar items thrown on the ground. Bryce Capstick believed that housekeeping was always an "inconvenience problem" in the workplace.[137] He went on to say that it could become a "safety problem" in the event that you had to work in a poorly kept area of the mine and "there's something to trip over or cause injury."

The evidence suggests that housekeeping became a priority only when Westray management had to make a positive impression on visitors to the underground. Gosbee testified that, as a rule, management knew when an inspector would tour the mine. He commented that "[y]ou were always informed the day before to brush up on your housecleaning" and keep things in order.[138] The poor state of housekeeping underground is indicative of management's lenient approach towards safety at Westray. On those few occasions when management did exhibit an *apparent* concern for safety, it was for the benefit of officials or inspectors who were expected to visit the mine. The health and safety of the workers was, at best, a peripheral concern for Westray management.

Other Factors

Conditions for those working underground at Westray were also affected by a number of other factors, some of which are essentially human relations issues.

There is no doubt that those working underground perceived the risks in their situation. Workers spoke in testimony and interviews about the dangers and their fears. The reasons they continued working at Westray, despite conditions they saw as unsafe, also emerge from their words. Professor Wilde reviewed the evidence to try to offer some insight into the miners' perceptions of risk and their reactions to it. He reported that certain factors "contributed to the employee perceptions of accident risk" and that there was a general feeling among the underground workforce that

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134 Hearing transcript, vol. 73, pp. 15842–43. Emphasis added.

135 Hearing transcript, vol. 73, p. 15834.

136 Hearing transcript, vol. 24, pp. 4740–41.

137 Hearing transcript, vol. 42, p. 9472.

138 Hearing transcript, vol. 25, p. 5005.

a serious accident was a strong probability. Wilde attributed the miners' willingness to accept high levels of danger to the operation of various factors, in particular economic pressures and incentives. The incentive bonus plan introduced by management at Westray in early 1992 did not help the situation, but rather, in Professor Wilde's view, made it worse:

> Mine management, rather than putting in place a safety-incentive programme of a type known to significantly improve cautious and accident-free performance, instituted instead a remuneration schedule that appears to have exacerbated risk acceptance and the frequency of imprudent practices among the miners.[139]

Professor Wilde has identified some 13 reasons given by Westray workers for accepting the risky working conditions:

- wanting the pay cheque
- wanting production bonuses
- having no prospect of alternative employment in the region
- anticipating promotion and long-term advancement through the ranks; hoping for long-term job security
- hoping working conditions would improve with time; hoping to survive through skill and experience
- not having the necessary data to confront management or to take Westray to court
- fearing reprisals; fearing being fired for complaining to management about unsafe conditions
- feeling intimidated by management
- feeling powerless; feeling that government may support mine management, that inspectorate would refuse to assist miners; fearing that complaining to the mine inspector might lead to being fired
- fearing unemployment insurance penalties; anticipating problems leaving work without sufficient cause or without UI eligibility; fearing delay in arrival of UI cheque
- being bribed to hide a lost-time injury from Workers' Compensation
- feeling loyal to colleagues working under dangerous conditions
- identifying with the mine; "having mining in the blood."

Management-Worker Relations

To understand the working environment at Westray, we need to appreciate the dynamics among management, supervisors, and underground workers. In testifying at this Inquiry, Colin Benner identified workplace dynamics – how people conduct themselves and relate with others in the workplace – as a good indicator of the existence or absence of a safety mentality.[140] The relationships at Westray are particularly telling.

On 5 May, just days before the Westray mine exploded, Lenny Bonner testified that he was putting chock blocks above the arches with Ed

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[139] Wilde, "Risk Awareness," p. 1.

[140] Hearing transcript, vol. 73, p. 16006.

Estabrooks near the face of SW2-A Road. Arnie Smith, their foreman, had sent them there and told them not to do any work until he returned, at which time he would operate the Scooptram. Bonner and Estabrooks waited for about a half-hour, but Smith did not appear. They began working without him. At this point, Bonner stated, Gerald Phillips, Roger Parry, and Smith arrived on the scene, and a heated confrontation ensued. Parry referred to Estabrooks and Bonner as "a bunch of dog fuckers." Bonner, agitated by this remark, jumped down out of the arches and made a few comments to Parry: "I threw my gloves off and I told him for a nickel that I would gut him."[141] Bonner then became confrontational with Phillips:

> And I called him an asshole for allowing Mr. Parry to go on the way that he went on in the mine. I told him to his face he wasn't much of a manager to allow this to happen and stand there and let him belittle us like that. So he walked away.[142]

Bonner was ordered to report immediately to the surface to speak with Phillips, who arrived about three hours later. Bonner told Phillips that he was not impressed with him as manager or with Roger Parry as underground mine manager. He said he was disgusted by the manner in which men were belittled and spoken to. He commented on the difficulties he and the other men were experiencing underground, including the bad roof, gas, and dust conditions. Bonner further advised Phillips that worker morale was low:

> I told him I wasn't particularly happy about coming into a workplace that made me scared to death. I told him on top of being scared to death, men have to come in here and be harassed and being called brain dead and everything else, right? Like, I mean, you don't come to work for that, you know.[143]

According to Bonner, Phillips said he agreed with most of the issues raised by Bonner, and he attempted to lay the blame on Parry. When Bonner spoke with Parry that same afternoon, the episode quickly deteriorated into an abusive confrontation:

> [Roger] came across . . . his desk. He was pounding on the desk and pointing his finger almost touching me. And I had a pin on that said, "I'm an organizer" . . . And he was spitting chewing tobacco over himself and he was quite upset and pounding on his desk and he said, "You're fucking lucky you have that or you'd be gone."[144]

Estabrooks, too, had been told to report to Parry in his office. Estabrooks described Parry's state of mind:

> And Mr. Parry was quite agitated. The veins in the side of the neck when he started ranting and raving in the mine would bulge out and kind of in and out like – a feature in his face would turn red and so on.

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141 Hearing transcript, vol. 24, p. 4781.

142 Hearing transcript, vol. 24, pp. 4770–73.

143 Hearing transcript, vol. 24, pp. 4774–78.

144 Hearing transcript, vol. 24, pp. 4778–80. Bonner was helping to organize the union membership drive.

Estabrooks felt that he and Bonner had been set up that morning because they were involved with the union drive.[145]

Section 9 of Westray's employee handbook encouraged employees to discuss issues and problems with their supervisors. It further invited employees to discuss issues with progressively higher levels of management up to and including the vice-president and general manager (Gerald Phillips), should issues remain unresolved.[146] Phillips, in his 29 October 1991 memorandum, referred to early in this chapter, had stressed Westray's commitment to open communication and "an open-door policy." This commitment amounted to nothing more than mere puffery. Contrary to the company's published position, management-worker relations were largely confrontational and founded on intimidation and bullying. Both Wyman Gosbee and Wayne Cheverie recalled experiences with Westray's open-door policy. Cheverie believed that "the door was only open if you were saying what they wanted to hear. If you said things that management didn't want to hear, then they would reprimand you; they would intimidate you and you would have to submit."[147] Gosbee shared those sentiments, but put them in a different light:

> A. But my understanding of that was that open door policy, that door only went one way. Meaning that if you had a problem and brought it up, their answer would be, well, there's 200 or 2,000 applications on my desk, if you don't like it, there's the door.
> Q. And the door was open?
> A. And the door was open.[148]

Bonner described the general attitude exhibited by management towards underground workers who expressed safety concerns:

> I was under the impression that if you complained too much, you were in hot water with the company, so to speak, so your job was at stake. And things went much smoother if you just kept your mouth shut and went along with the game plan, right? And besides, management's attitude towards things like that, like if you would have something that you wanted to discuss, you would be talked to like, *'Well, do you have a problem with that? Maybe you'd like to pack your fucking lunch can.' And this is how you would be responded to if you had a legitimate safety concern.* If you went to Roger Parry, that's how you would be talked back to.[149]

There are numerous accounts of underground workers and supervisors who expressed safety concerns or refused to perform unsafe work at Westray. The underground worker in fact has a *right* to refuse work under certain conditions as set out in section 22(1) of Nova Scotia's *Occupational Health and Safety Act*:[150]

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145 Hearing transcript, vol. 24, pp. 4906–08.

146 Exhibit 119.162.

147 Hearing transcript, vol. 21, pp. 3997–98.

148 Hearing transcript, vol. 25, pp. 5035–36.

149 Hearing transcript, vol. 24, p. 4762. Emphasis added.

150 RSNS 1989, c. 320.

> Any employee may refuse to do any act at his place of employment where he has reasonable grounds for believing that the act is likely to endanger his health or safety or the health or safety of any other employees until:
>
> (a) the employer has taken remedial action to the satisfaction of the employee;
> (b) the committee, if there is one, has investigated the matter and unanimously advised the employee to return to work; or
> (c) an officer in consultation with the Director has investigated the matter and has advised the employee to return to work.

In a transcript of a dialogue between Roger Parry and Marvin Pelley, Parry spoke about a worker's right to refuse unsafe work:

> **Marvin** So were the men ever forced to go into a place that they felt was unnecessary or did we find other work for them?
>
> **Roger** We always give it time to settle down and find other work so that that miner was not forced to go into the mine to do something they didn't want to do and any questions or concerns they would report back so that the foreman would get a hold of me whether it were day or night and I'd be back at the mine and check it out for myself.[151]

The evidence contradicts Roger Parry. Management's response to workers' concerns and refusals to perform unsafe work violated their rights under the *Occupational Health and Safety Act*. Management's response to any such refusals was invariably the same – it was management's mine, and if the underground workers did not like the way it was operated, there was simply no place for them at Westray.

Cheverie witnessed a face-to-face argument between Parry and Roy Pasemko, one of the miners. Parry ordered Pasemko to go in and roof bolt a cut; Pasemko flatly refused because of the unsafe condition of the heading:

> At the time – I remember very clearly Roy saying, "I'm not going in there. You're fucking going to kill somebody here and you don't care." And Roger's answer to that was: *"Roy, either you go in there and bolt that fucking heading or you can fucking take your lunch can and go up the drift; you're fired."*[152]

At that point, the foreman stepped in, spoke to Pasemko, and convinced him it was not worth losing his job over. Pasemko bolted another heading until he completed his shift.

Management style at Westray was consistent. Gerald Phillips, the man with primary on-site responsibility to instil and promote a safe work ethic, had a management style at times not unlike Parry's. Cheverie testified about an incident between Phillips and Aaron Conklin, a new member to the Westray crew. Following a bad roof fall, Conklin took the initiative to speak to Phillips about his concern:

> He walked over to Gerald, 8 or 10 feet from where I was standing, very meekly said "Gerald, do you think it's safe to go underground this

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151 Exhibit 120.244. As described above in note 12, the circumstances behind this five-page transcript are unknown; it is undated but is post-explosion.

152 Hearing transcript, vol. 21, p. 3991. Emphasis added.

> morning?" And Gerald Phillips turned around to him and loud enough so everyone in deployment that . . . could hear would hear, told him: "Aaron, either you fucking go underground or you fucking go home" and turned around and walked away.[153]

Conklin went underground and worked his shift.

Management's attitudes clearly shaped the manner in which the workplace functioned at Westray. The persistent trivializing of safety issues filtered down through the workforce. Ted Deane, a miner and bolter at Westray, recalled overhearing Phillips yelling and screaming at John Bates, Jay Dooley, and a few other night shift supervisors. Deane didn't know why they were being reprimanded, but Phillips's message was clear: "[H]e informed them that this was his mine and that they had better do things the way that they're told to do it."[154] Deane went on to explain how such intimidation on the part of management influenced safety attitudes and the way work was done at Westray:

> [A]t that time when I heard that conversation, and Gerald telling them that this was my mine, and you better do it the way I tell you to do it . . . I understood why John and maybe some of the other foremen did things the way . . . that they did. Why, if the regulations book said we weren't allowed to do it, why we actually did do it. Like, taking cutting torches in the mine and that. I understood the reason why.[155]

Carl Guptill said that he did things underground that he knew were unsafe. The reason was simple – he was intimidated by Roger Parry:

> Q. You don't seem to be a man who would easily be intimidated by someone. You had had a management position in other mines?
> A. I never met anyone like him before
> . . .
>
> He was rough. He had a crazy streak in him. Like, if he got really mad at you – I, at times, prepared for him to attack me.
> Q. Physically?
> A. Yes.[156]

The demeaning and abusive language used by Westray management had to be intimidating to Westray supervisors and underground workers. Although the use of rough language is not unusual in underground mining environments, the language used by Westray management went far beyond the norm. John Lanceleve said of the manner in which the men were spoken to at Westray, "Well, there's coarse language in . . . every mine I ever worked in. But it's not like cursing each other down; it's just the way some of the guys talk."[157] Lanceleve went on to contrast the Westray experience with his experience at Grand Cache in Alberta. At Grand Cache, there was no bad-mouthing of the men or public display of anger; the underground mine manager and supervisors did not use coarse

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153 Hearing transcript, vol. 21, pp. 3994–95.
154 Hearing transcript, vol. 26, pp. 5382–83.
155 Hearing transcript, vol. 26, p. 5384.
156 Hearing transcript, vol. 29, p. 6175.
157 Hearing transcript, vol. 27, p. 5564.

language to communicate with the men; the foremen were not run down by the underground manager; and miners could readily express their safety concerns. Fraser Agnew, who had also worked at Grand Cache, said that Roger Parry would call the underground workers some pretty miserable names – something he would never have heard at Grand Cache. Agnew recalled an incident at Grand Cache when someone spoke to a co-worker inappropriately, and it caused an uproar, eventually leading to a retraction. Agnew testified that the crude language at Westray was new to him:

> Q. And that wasn't something [crude language] that you were used to?
> A. No. I mean . . . you can carry on . . . we use some pretty bad language underground, all of us, you know, but it was in fun, most of it . . . but you would never go up to a man on a bolter, "Why haven't you got that bolt in there you stupid son-of-so-and-so."
> Q. And is that the way Mr. Parry . . . communicated with the men?
> A. In a lot of the ways, yes.[158]

Colin Benner was also critical of the language used by Westray management. Benner said that his criticism of the underground manager was based on language used in referring to the underground workers – "language that I wouldn't use even in a hard rock or soft rock mining industry where . . . it's quite commonly known that the workers' language is pretty coarse on occasion." Having heard how Parry spoke of the men in his presence, Benner wondered how he spoke to the employees when senior Curragh officials were *not* present: "But the fact that the candour [*sic*] was so coarse, then it led me to conclude that it might be even rougher when senior people weren't around."[159]

There is no question that management's manner of speaking to employees was harsh and demeaning. Deane testified to an incident in which Parry was calling Robbie Doyle "slow, stupid, good for nothing, demeaning him, over . . . to me, no reason."[160] Cheverie quoted Parry as once calling a few of the crew a "fucking bunch of brain-dead dummies."[161] Estabrooks testified that he overheard Phillips tell John Bates: "This is my fucking mine, and I'll run it my fucking way."[162] When Bryce Capstick became a shift foreman at Westray after qualifying as a mine examiner, Parry told him what his job was.

> Q. What did Mr. Parry say to you with respect to what he wanted you to do?
> A. After a day or so, it was very bluntly put to me what the duties of a foreman was going to be at that mine
>
> . . .
>
> He told me, he said, "You fellows are nothing but working fucking foremens [*sic*] . . . You will go down, you will train the men, you will show the men what to do, you will work with them. That's all you'll

158 Hearing transcript, vol. 35, p. 7688.
159 Hearing transcript, vol. 73, pp. 15893–94.
160 Hearing transcript, vol. 26, p. 5416.
161 Hearing transcript, vol. 20, p. 3967.
162 Hearing transcript, vol. 24, p. 4903.

> fucking well do and that's it. So that threw the papers [certification] out the window."[163]

Capstick explained that "foreman" was just a title at Westray. He had to spend his time doing hands-on work and was provided no time to perform his mine examiner duties.

Finding

Westray managers not only failed to promote and nurture any kind of a safe work ethic but actually discouraged any meaningful dialogue on safety issues. Management did so through an aggressive and authoritarian attitude towards the employees, as well as by the use of offensive and abusive language. Westray workers quickly came to realize that their safety concerns fell on deaf ears and that management's open-door policy was mere window dressing.

The John T. Ryan Trophy

Westray management was concerned with the window dressing, however, and in early February 1992, in response to a suggestion from the managing director of the Chamber of Mineral Resources of Nova Scotia, Westray applied for the John T. Ryan safety trophy.[164] This award was first introduced in 1941 by Mine Safety Appliances Company of Canada Limited (now MSA Canada Inc.) to promote and "recognize notable achievement" in mine safety. The trophy was named in honour of the founder of the company and is administered by the Canadian Institute of Mining, Metallurgy, and Petroleum (CIM), through a committee comprising the chiefs of the provincial mine inspection branches and the heads of the various mining associations. The John T. Ryan trophy is a prestigious and much-sought-after award in the industry.[165] Eligibility is based on a calculation of the ratio between total number of hours worked at the mine site and the number of reportable injuries during the reporting period.[166]

Westray's entry form was prepared and certified by Allen Karasiuk, Westray's human resources supervisor, and signed by Gerald Phillips, vice-president and general manager.[167] It provided injury statistics for the competition year ending 31 December 1991, indicating 15 reportable injuries: 5 "lost time injuries" and 10 "modified work injuries." The company reported 221,357 hours worked for the year. The form named Claude White, P. Eng., as the regional representative, followed by the

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[163] Hearing transcript, vol. 42, pp. 9297–99.

[164] J.D.R. Smyth, managing director, Chamber of Mineral Resources of Nova Scotia, to Gerald Philips, 7 February 1992 (Exhibit 120.315).

[165] Both Bruce Campbell, past executive director of the Ontario Mining Association, and Ian Plummer, mining engineer and recently retired director of mine safety for the Ontario Department of Labour, told me about the importance of this award.

[166] This is somewhat of an oversimplification, but describes, in broad terms, the basis for qualification for the award. Terms and conditions for the award are in Exhibit 120.317.

[167] Exhibit 120.316.

statement, "This entry is certified as the leading entry for my Region," to be signed by the regional representative.

In a memorandum of 9 April 1992, Phillips announced to "All Westray Employees" that Westray had been awarded the John T. Ryan safety trophy. Phillips wrote, in part, that this "prestigious award is in recognition of the fact that Westray had the lowest frequency of injuries of all the underground coal mines in Canada in 1991." Phillips ended his memo with the following advice: "Always work safely because a safe operation is a productive operation." Phillips and Eugene Johnson (one of the miners who died in the explosion) journeyed to Montreal to attend the CIM annual institute dinner, at which the trophy was presented to them as representatives of Westray. The news, Phillips's memo, and the presentation all occurred within a month of the 9 May 1992 explosion.

This achievement is sadly ironic in light of all the other evidence of the unsafe, unhealthy, and oppressive environment in which the Westray miners worked. The award was based entirely on injury-related statistics provided by the company. The application was not subject to any third-party audit.[168] One may speculate that statistics do not always provide the total picture.

Occupational Health and Safety Committee

Section 18(1) of the *Occupational Health and Safety Act* requires the establishment of a joint occupational health and safety committee:

> At every workplace where twenty or more persons are regularly employed, *the employer shall establish and maintain* one joint occupational health and safety committee or, at the discretion of the employer, more than one such committee. [Emphasis added.]

As well, Westray's management team had made a *written* commitment to the efficient operation of a health and safety committee. Section 5 of Westray's Operations and Maintenance Employee Handbook begins: "The maintenance of a Safety and Health Committee is recognized by Westray Coal as an important component of a comprehensive accident prevention program."[169] Again, the written commitment to safety was a sham. Westray management was derelict in not fulfilling its legal responsibility required by the act.

Because of management's attitudes, some employees attempted to air their safety concerns through other channels, including the joint occupational health and safety committee. This effort proved frustrating, further eroding the safety mentality and the morale of the Westray

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168 Our research uncovered several possible discrepancies in the entry form, but it is not known if these would have altered the outcome. For instance, during 1991, miners were given "arching bonuses" for achievement in erecting arches. The bonus took the form of added hours of pay. It is impossible to determine whether these extra hours were included in the entry calculations and if that would have substantially distorted the total hours reported. It also appears that at least three "modified work" injuries (Mike Palmer on 7 May, James Doyle on 25 July, and Ferris Dewan on 19 August 1991) were omitted from the entry form. Again, it is not known whether this would have had any effect on the outcome of the award process.

169 Exhibit 119.158.

workers. An effective health and safety committee solicits, identifies, and addresses safety-related concerns in the workplace. The one at Westray failed to meet any such criteria. The reason for its failure is clear: management made no effort to ensure that Westray's health and safety committee would be an effective and meaningful tool.

Although the company did solicit workers to be safety representatives (three members were Randy Facette, Owen McNeil, and Rick Mitchell), it failed to inform committee members of their roles, their responsibilities, and their rights pursuant to the act. The company failed as well to respond to any of the safety concerns voiced by safety representatives. Instead, Westray management chose to ignore these concerns and make excuses for its inaction. The potential of the health and safety committee was never to be realized at Westray. In fact, management's superficial participation in the committee, management's intimidation of workers who brought safety issues to the committee, and the workers' fear of reprisal diminished any concept of a functioning safety committee at Westray.

It was the hope of workers that the joint occupational health and safety committee would become a useful mechanism at Westray. But it was not long before most workers lost faith in the committee. Carl Guptill testified that he had never been introduced to the committee members and that he had not been underground long before he "started hearing rumours that they were a waste of time, that they weren't doing their job."[170] Trevor Eagles, who spoke often with the miners, said that underground workers had no means to express their safety concerns – the committee was very ineffective and its recommendations were never implemented.[171] According to Bryce Capstick, Westray had "half of a safety committee" set up – the committee did not fully exercise its rights.[172] As well, he questioned whether the Department of Labour was kept apprised of safety concerns identified by the committee at Westray. It was his view that the committee failed to fulfil any meaningful role.[173]

Don Dooley told of an incident in which the Westray health and safety committee played a useful role, but he went on to explain the committee's short-lived effectiveness. Dooley's crew was going to set an arch when Shaun Comish informed Dooley that the roof was "working." Comish refused to continue under those conditions and asked that his safety committee representative, Owen McNeil, examine the area. McNeil arrived at the scene and the roof began to work once again, at which time McNeil and Dooley agreed with Comish that the area should be bolted. The committee therefore proved to be effective on this occasion. Dooley said that, after McNeil was promoted foreman, the committee did not appoint another representative to his crew.[174] The evidence suggests that

170 Hearing transcript, vol. 29, pp. 6176–77.

171 Hearing transcript, vol. 76, p. 16435.

172 Hearing transcript, vol. 42, p. 9360.

173 Hearing transcript, vol. 42, pp. 9385–87.

174 Hearing transcript, vol. 36, pp. 7981–84. McNeil was promoted foreman.

a successful occupational health and safety committee requires members who are aware of the workers' rights and who are able to assert those rights and insist on appropriate standards and conditions for the underground operation. Without such safety-minded and informed individuals, the committee was, for all intents and purposes, ineffectual.

There was a general feeling among the workforce that the committee and its underlying philosophy was, at best, taken lightly by Westray management. Capstick thought that the committee was merely established so that the mine could be viewed as having complied with the law.[175] Bonner told the Inquiry that the "health and safety committee was *going through the motions* of making it look like the company cared about safety."[176] Committee member Randy Facette shared their view – Westray management failed to respond to committee recommendations or to address obvious and visible safety problems:

> They would go on the walks with us just, I guess, make it look like we were actually participating in something, but other than that . . . I guess the biggest thing is that these people, like Roger Parry and Gerald Phillips, were seasoned, experienced miners with the know-how and the insight to see these problems but just chose to overlook them.[177]

Fraser Agnew understood that, at the beginning, the health and safety committee would be a mechanism by which the company and the workers could cooperatively make Westray a safer place. Agnew recalled that this was communicated by Phillips himself. Since the committee was formed around the same time as the union drive, Agnew was suspicious: "And I think it was more or less put into place because I believe the company . . . maybe figured if the safety committee got together and made a few changes that the union and the men would part ways."[178]

Not only did Westray management fail to regard the joint occupational health and safety committee as a constructive force, but management attempted to intimidate miners to prevent them from using the committee to voice their own safety concerns. Guptill said that he was hesitant to seek out committee members in the presence of Westray management:

> I didn't know anybody's name at that time or where I would go. I wouldn't do it above surface in deployment because either Roger or Gerald would be there watching me. And underground, I mean, it could take you hours to walk the mine asking, "Are you health and safety" and – I mean, as soon as you would ask the wrong person, it would have got back to them. But from what I know of occupational health and safety, it was non-existent at that mine.[179]

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175 Hearing transcript, vol. 42, p. 9384.

176 Hearing transcript, vol. 24, p. 4840. Emphasis added.

177 Hearing transcript, vol. 33, p. 7197.

178 Hearing transcript, vol. 35, p. 7730.

179 Hearing transcript, vol. 29, p. 6177.

Wayne Cheverie expressed similar concerns and feelings of distrust vis-à-vis Westray management:

> Some of the people who were appointed to the safety committee I felt I couldn't trust not to expose any concerns that I had about safety back to management, and therefore making me vulnerable to the tactics of management as far as intimidation and harassment.[180]

Wyman Gosbee tried to take his concerns about the lack of stonedusting to the committee. Despite his numerous complaints, Gosbee's concern was never addressed. He refused to take his complaint to Phillips or Parry for fear of being perceived and labelled a "complainer."[181]

The workforce was generally reluctant to approach the Westray committee, and workers were unwilling to approach Phillips or Parry directly. The evidence suggests also that underground workers were persistently discouraged by management from approaching the mine inspectors about safety violations underground. The Westray workforce had every right to speak directly with the inspectors. Section 29 of the *Occupational Health and Safety Act* provides as follows:

> **Accompaniment of officer during inspection**
>
> (1) Where an officer makes an inspection of a workplace pursuant to the powers conferred upon him pursuant to Section 28, *the employer shall give a committee member, or other person selected by the employees to represent them, the opportunity to accompany the officer* during his physical inspection of the workplace or any part or parts thereof.
>
> **Selection of employee by officer**
>
> (2) Where there is no committee member representing employees, the officer may select an employee or employees who shall accompany him during his physical inspection of the workplace or any part or parts thereof and during his physical inspection *the officer shall endeavour to consult with a reasonable number of employees*. [Emphasis added.]

In the transcript of the post-explosion dialogue between Roger Parry and Marvin Pelley referred to earlier in this chapter, Parry *claimed* to be in full support of direct contact between the inspectors and underground workers:

> **Roger** I purposely took the mines inspector on to each piece of equipment and then walked away. I left the mines inspector so he could talk himself because I never wanted it being said that people were being intimidated with me being there and felt that they couldn't talk to the mines inspector and I just left Albert [McLean] to talk with the guys which he did when he went down . . . He said I come down the mine and talk with the miners and nobody expresses concerns. Miners are very outspoken people and usually if they've got concerns it makes no difference whether you're there or I'm there or anybody else is there, if it needs to be said they'll say it but they

[180] Hearing transcript, vol. 21, p. 4093.

[181] "I knew people that had went to them and brought up issues, and they were treated unfairly because of it" (Hearing transcript, vol. 25, pp. 5011–13).

> just stuck it back in their mind and maybe there was some intimidation in me being there. That's why I left the inspector there.[182]

Contrary to Parry's claims, testimony shows that he interfered with the direct and open communication lawfully required between workers and inspectors. Buddy Robinson testified that on the four or five occasions he saw inspector Albert McLean underground, Parry was always with him. Robinson did not believe that McLean had spoken to any of the miners, except himself. And when he did attempt to speak to McLean, Parry was always within earshot.[183] John Lanceleve testified that he would not speak with McLean for fear of losing his job. He then recounted an episode that illustrates the relationship between Westray management and the underground workers:

> We were just coming on shift, and he [Parry] said "There's a safety concern I'd like to speak yous [*sic*] about. . . . Some fucker took it upon himself to go to Department of Labour and report unsafe practices at the mine site." And he said "This won't be tolerated." He said "You have a health and safety committee here to deal with safety concerns." And he more or less jumped all over us that if he got wind of anyone going to health and safety that we wouldn't be employed there any more.[184]

Some workers had approached the inspectorate, but their attempts were to no avail. The Carl Guptill saga, reviewed in Chapter 12, Department of Labour, demonstrates the inspectorate's inaction. Robinson said that, on four or five occasions, he expressed his concerns to McLean about the roof and dust conditions, the qualifications of the engineers, and the non-flameproof diesel equipment underground. McLean did not respond to Robinson's concerns.[185] Robinson recalled phoning McLean at his home in Glace Bay one evening to voice his worries about Westray's underground. Robinson explained that the initiative for the phone call had come from a discussion he had had with Tom Reid, another miner. Robinson explained that Westray was mining 30 feet lower than it should, owing to an error in planning. As a result, the roof had a tendency to break and "crack something terrible. You almost thought it was going to come in behind you." Robinson said that Reid had been extremely upset about having to work in the area, and he had come to Robinson. Robinson discussed the Reid situation – among others – with McLean during an hour's conversation. Robinson spoke to McLean about the manner in which the mine was being operated – including the lack of a clear plan for the development of the mine, the lack of engineering expertise, the improper use of diesel equipment underground, and the presence of high methane in the mine.[186]

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182 Exhibit 120.243. To accept Parry's claim, I would have to reject the evidence of other relevant witnesses, and I am not going to do that.

183 Hearing transcript, vol. 30, p. 6470.

184 Hearing transcript, vol. 27, pp. 5521–22.

185 Hearing transcript, vol. 30, pp. 6337–41.

186 Hearing transcript, vol. 30, pp. 6337–42.

> And I asked Albert is there anything you can possibly do to change the venue [*sic*] on what's going on here. Because if somebody doesn't, I don't know what we're going to do, because we had absolutely no power to do anything. The management wouldn't listen to the men. They just went their own merry way when they were doing things.
>
> So our only recourse was Albert. . . . He [McLean] said his hands were tied. . . . I understood from that that if his hands were tied, our necks were in a noose because who else are we going to turn to? . . . I assume from that, that his superiors were telling him to lay off [Westray].[187]

Joint occupational health and safety committee members Facette, McNeil, and Mitchell also sought the support and assistance of the inspectorate – but their safety concerns were ignored. Mitchell testified to a meeting that the three of them had with McLean. They discussed the illegal welding underground, lack of miner training, prohibited use of diesel equipment, ventilation in the Southwest area, inexperienced foremen, and lack of stonedusting. Mitchell asked McLean if he'd been reading the committee's safety walk reports, since the same concerns were repeatedly expressed, with no response from management or the department. McLean "said he would look into it."[188] Mitchell said that that had been the fourth time he personally spoke to McLean. Facette also testified to that meeting, which he remembered had been at McLean's request. It took place at the mine and lasted about 45 minutes. Like Mitchell, Facette recalled that they had discussed a multitude of safety issues with McLean and had been explicit about their concerns – they conveyed a sense of urgency to McLean. Facette recalled McLean advising that he would get back to them. Facette said that he did not hear from McLean or see him again until after the Westray mine exploded (more than three months later).[189]

McLean's failure to react to the concerns expressed by the safety committee members, Guptill, Robinson, and other underground workers sent a clear message to miners – any attempts to report safety concerns to the Department of Labour were futile. Don Dooley said that this was the message received. Dooley testified that he was aware of the *Occupational Health and Safety Act* and the rights afforded an individual who reports unsafe work practices to the Department of Labour. He went on to say that, following the Guptill incident, he did not feel that the act offered him any protection in the event that he went to the department. Dooley described the impact of the Guptill episode: "It totally, totally destroyed my confidence in Albert McLean and the Department of Labour to protect me or any other individual that worked at Westray Coal."[190]

[187] Hearing transcript, vol. 30. pp. 6347.

[188] Hearing transcript, vol. 31, pp. 6726–30.

[189] Hearing transcript, vol. 33, pp. 7207–14.

[190] Hearing transcript, vol. 36, p. 7979.

Finding

Westray's joint occupational health and safety committee was ineffective. It never functioned as the *Occupational Health and Safety Act* envisaged, and for that management must bear responsibility. Management actively discouraged a safety mentality on the part of the workforce and failed to respond to safety concerns raised by committee members.

The Union Drive

The hazardous underground conditions at Westray added impetus to the workers' attempt at unionization in January 1992. The union drive was unsuccessful. The testimony suggests two main reasons for the failure – intimidation by management and the inability to gain the support of surface workers.

On 3 January 1992, just days before the union vote was to take place, Gerald Phillips sent a memorandum to all Westray employees in relation to the certification drive. Phillips reminded employees of their right to vote and advised that the *Trade Union Act* afforded them protection from pressure and harassment by either employer or union. Phillips further advised: "The decision whether to unionize is to be made by the Employee without interference from the Employer."[191] Although Phillips's words may have been reasonable, sound, and fair, his actions flatly contradicted such an approach.

The testimony of Westray employees suggests that both Phillips and Parry attempted to intimidate workers who supported the United Mine Workers of America as their bargaining agent. Ed Estabrooks testified to a discussion with Phillips in which Phillips questioned him about his union activities on company time. According to Estabrooks, Phillips said, "'If this mine is unionized, I will shut this mine down . . . This mine will operate without a union.'"[192] Buddy Robinson commented on the reasons for the failure of the union drive. He testified that some employees simply did not want to be part of a union. He also spoke of intimidation by Westray management: "Roger Parry was telling some of the men that if they . . . got a union, the pay – whatever your pay level was, it would be cut. And I told the guys that whatever your pay level is now, that's where it stays; they can't cut your wages. It stays where it's at."[193]

The failure of the union drive at Westray eliminated another potential means by which Westray could have been made a safer place. A hazardous working environment, an ineffective health and safety committee, an unresponsive inspectorate, and a failed attempt at unionization clearly left the workers with few choices. One option for some workers was simply to walk out and leave Westray behind. For others, however, quitting the

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191 Exhibit 120.081.

192 Hearing transcript, vol. 24, pp. 4900–01. Although this discussion took place on 4 May 1992 during the second attempt at unionization, months after the January 1992 union drive, it is indicative of management's attitude towards the unionization of workers at Westray.

193 Hearing transcript, vol. 30, pp. 6432–33.

mine was not a financially viable option. The situation was exacerbated by the fact that workers who wished to leave Westray would be faced with yet another obstacle – the delay or denial of unemployment insurance.

Unemployment Insurance

Although this issue, in itself, is not fundamental to the Westray tragedy, it adds yet one more component to the predicament of underground workers at Westray. The evidence on this point is limited but clear – workers who intended to leave their employment at Westray would find no support in the unemployment insurance (UI) system.

Mike Wrice was employed by Westray from June to October 1991.[194] He quickly became concerned about the underground working environment, particularly the bad ground conditions and frequent rock falls. He expressed concerns about the accumulation of coal dust. In October 1991, he decided he could stay at Westray no longer. Wrice applied to collect unemployment insurance, explaining to the unemployment insurance office that he left Westray Coal owing to "unsafe conditions." In January 1992, Wrice appeared before the board of referees and again explained that he had been working in an unsafe environment, particularly in hazardous ground conditions. A representative of the company was also questioned by unemployment insurance officials and, as Wrice put it, "I guess between the company and myself they said that they more or less believed the company."[195] Wrice then attempted to contact the Department of Labour and gain its support. The department's response was that, as far as it was concerned, Westray Coal was meeting all provincial safety regulations. As a result, Wrice suffered a nine-week penalty period prior to receiving his first unemployment insurance cheque.

Bonner said that the conditions at Westray – "the gas, the dust, management's lax attitude toward safety, the roof falls. Generally everything"[196] – caused him to quit his job. When Bonner filed his unemployment insurance claim, however, he was told that he would be penalized for eight weeks. This was because Westray had just won a safety award, and a representative from the unemployment insurance office had toured the mine with Roger Parry and had determined it to be a safe workplace. The UI person had toured the mine in response to complaints of dangerous working conditions by numerous miners who wished to leave Westray. Following the UI office's assessment, Bonner decided to go back to Westray, hoping that conditions would improve. He felt this was his only choice, since he had relocated his family to New Glasgow, and no other employment opportunities were available.[197]

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194 It should be noted that Wrice worked at Westray Coal prior to June 1991 with Canadian Mine Development and Westray for a short time before returning in June.

195 Pre-hearing interview transcript (8 October 1992), p. 39.

196 Hearing transcript, vol. 24, pp. 4762–63.

197 Hearing transcript, vol. 24, pp. 4766–68.

Ed Estabrooks testified that, although he had considered quitting Westray, he was in a financial bind at the time:

Q. Was there ever a time when you considered quitting Westray?
A. Yes. I – from the day I went underground, I had a bad feeling of the mine itself. It would give me the willies to be underground. And every time I left deployment to proceed to the portal, I would say a prayer going down and "Amen" when I reached surface again.

. . .

Q. So did you ever contemplate quitting?
A. Yes. Yes, the last two months I would – I was having trouble sleeping with different odd nightmares and that of the place.
Q. This is while you were still working there?
A. Yes, it was.
Q. So why didn't you quit, Mr. Estabrooks?
A. I was in a financial bind at the time is the reason why I stayed.
Q. Did you have any other work to go to?
A. I did not.[198]

William MacCulloch, Westray's training officer, had answered inquiries from the UI office in relation to workers' complaints that Westray was unsafe. MacCulloch advised UI representatives that the underground workers' complaints had come from hard-rock miners who were not used to the conditions of an underground coal mine. He testified at the Inquiry:

Q. And what do you recall today that you responded?
A. That this was a natural reaction by hard rock miners who were used to much safer ground conditions than we had there.

. . .

Q. [Do] you recall getting inquiries from U.I.C., that men were saying they quit because the mine was not safe?
A. "Safe" by their definition, yes. And the explanation that I would identify is that what hard rock miners would consider safe and what a coal miner would consider safe are quite often two different –
Q. Was it only hard rock miners who were quitting?
A. Mostly.
Q. But there were coal miners who were quitting as well?
A. Were there? I don't –
Q. You don't know that?
A. I don't recall very many coal miners that quit, no.[199]

Clearly, his recollection did not reflect the situation. There were coal miners working underground at Westray who were aware that such conditions were not typical of a safe coal mine. Unfortunately, this was not accepted by the unemployment insurance office.

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198 Hearing transcript, vol. 24, pp. 4889–90.

199 Hearing transcript, vol. 41, pp. 9204–06. Despite his title, MacCulloch had no experience in coal mining. His job was strictly administrative, and he had few qualifications and next to no experience in training.

Production Bonus System

Westray management brought in a production bonus system effective 1 March 1992. Under this system, which involved different bonus percentages depending on work being done, workers could earn a bonus for average monthly production in excess of 500 tonnes per machine shift. Workers had a percentage of their bonus deducted if they missed work: a one-day absence meant a 25 per cent reduction; a two-day absence meant 50 per cent reduction. This bonus was in the end only paid for the month of March, since production in April did not reach the basic level required.

Workers had mixed reactions to the bonus, but for most the relationship to safety was clear. As Ted Deane commented, "[The] bonus system killed the safety."[200] When asked if the bonus system affected safety in the mine, Buddy Robinson commented: "[A]t the stage and the state that the mine was in, I don't think it made any difference"; he agreed that in his view safety conditions could not get worse.[201] Miner Tom MacKay spoke about the bonus system:

> A. I got one bonus cheque
> Q. What did you think of that?
> A. I wasn't too keen on that either because I figured the boys are going to start taking short cuts. . . . I figured the bonus that I got was that if I got out of there at night when my shift was over, if I got out of there –
> Q. That was your bonus.[202]

Professor Wilde analysed the financial effect of the bonus payments and reported that "as many as 14 of the 39 miners, who worked a minimum of 16 shifts in March 1992 and who were entitled to 100% of the bonus, received a productivity bonus in excess of $1000.00 over that month. For the same period of one month, the average bonus for employees who worked at least one shift and were no more than three days absent (i.e., 119 of 140 underground employees) amounted to $657.09."[203] Wilde commented that there is considerable literature on the effect of pay for production on safety, and that the reaction of Westray workers to the bonus system – rushing, taking shortcuts, not taking appropriate breaks – was not surprising. He was struck by the fact that the system implemented at Westray rewarded increased production at an accelerating rate. At the same time, the economic penalty in the bonus system created great pressure not to miss any shifts.

The picture that emerges from the testimony is one of a workforce taking great risks of workplace accidents as the result of three major factors acting in conjunction: the behaviour of management, the general economic conditions in the area, and the motivations of the miners themselves. Management was perceived by workers as focused on production at the expense of safety. The high rate of unemployment in the

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[200] Department of Labour interview transcript, 9 June 1992 (Exhibit 94.2, p. 42).

[201] Department of Labour interview transcript, 28 May 1992 (Exhibit 106.2, p. 38).

[202] Department of Labour interview transcript, 3 June 1992 (Exhibit 101.2, p. 28).

[203] Calculated from Exhibit 120.044, Wilde, "Risk Awareness," p. 6.

area meant that a miner quitting Westray faced the prospect of prolonged unemployment. According to Wilde, given these conditions, miners had two options in response to the risk of accident: stay with the mine, or resign. The miners clearly felt that these were the only two options because any attempt to change the views of management might get them fired. Similarly, workers perceived that expressing safety concerns to the mine inspector had no effect, and might also result in their being fired. In other words, any attempt to reduce the dangers of the job was felt to be ineffectual in reducing danger, as well as counterproductive in terms of employment. Thus, the benefits of acting in a safe way were perceived to be small and their potential costs high. Wilde reported that these conditions would be expected to lead to increased acceptance of risk. At the same time, the largely economic benefits of staying with the mine were high, and were enhanced by the introduction of the bonus system.

> Because of its nature, this scheme, which extended more than equal increases in income for equal increments in productivity, also led to an extraordinarily high level of accident risk acceptance.[204]

Colin Benner spoke critically of the bonus system at Westray and has made the point that safety issues have to be considered as part of any bonus system.[205] Various studies recently have examined the safety effects of various incentive systems for accident prevention and the benefits that ensued in terms of reduced days lost, lower workers' compensation insurance premiums, and, ultimately, increased production or profitability. Professor Wilde reported that experience shows that some of these programs have had greater success than others. The key ingredients in the successful programs seem to be: first, the incentive scheme has been developed in cooperation with the employees to whom it is addressed; second, both group safety performance and individual safety performance are rewarded; and third, all employees are included. If all employees, including management, take part, the safety culture in a company is enhanced.

Finding

It is clear from the evidence of the miners and from an outside expert's analysis of that evidence that the incentive bonus scheme based solely on productivity was not conducive to safety in the Westray workplace.

In the course of my research, including the several mine visits referred to elsewhere in this Report, it became obvious that safe mining is a critical element in productivity. Mine accidents cost dearly in productivity and it therefore follows that a safe mine is a more productive mine. This concept is also alluded to in the Burkett Report and in the title to that report, *Towards Safe Production*. It logically follows that incentives to promote

204 Wilde, "Accident Risk," p. 9.

205 Hearing transcript, vol. 73, pp. 15975–78.

safe production, in the mine or elsewhere, not only result in a safe work environment but also benefit productivity. Production incentives, on the other hand, might not have the desired results if they ignore safety considerations.

RECOMMENDATION

9 **Incentive bonuses based solely on productivity have no place in a hazardous working environment such as an underground coal mine. Such schemes should be replaced, where practical, by safety incentives that incorporate three principles:**

(a) The incentive plan should be developed cooperatively with the employees to whom it will be addressed.
(b) Both group safety performance and individual safety performance should be rewarded.
(c) All employees, whether underground or on surface – workers, supervisors, and middle managers – should be included.

If properly instituted, such a safety incentive plan may well have its own productivity rewards.

Conclusion

The evidence before this Inquiry compels but one conclusion – the Westray operation defied the fundamental rules and principles of safe mining practice. Regardless of the theories, philosophies, and procedures that management espoused on paper, most notably in its employee handbook, it clearly rejected industry standards, provincial regulations, codes of safe practice, and common sense in the operation of the Westray mine. Management failed to adopt and effectively promote a safety ethic underground. Instead, management, through its actions and attitudes, sent a different message – Westray was to produce coal at the expense of worker safety. Westray's illegal, hazardous, and improper practices were not confined to one area of operation or one isolated occasion. Rather, Westray's dismissal of safety concerns penetrated every facet of the operation on a daily basis. Simply put, Westray management did not truly recognize that the promotion of a safe ethic and the espousal of safe practices would not jeopardize coal production, but enhance it. And it is to the misfortune of all Nova Scotians and the coal mining industry that this was the case.

Finding

Westray management, from the chief executive officer, Clifford Frame, and the mine manager, Gerald Phillips, down to the line supervisor, had a fundamental duty to instil in the underground worker a respect for safety beyond other considerations. Management could do this through training, by example, and with continued monitoring at all levels. In trivializing and ignoring safety concerns, Westray management was significantly derelict in its duty to the workforce and seemed actively to promote a disdainful and reckless attitude towards safe mining practices.

PART TWO

The Explosion

An Analysis of Underground Conditions

6

The Explosion

To inquire into . . .

(c) whether any neglect caused or contributed to the occurrence;

(d) whether there was any defect in or about the Mine or the modes of working the Mine

The first of the terms of reference set out in the Order in Council that established this Inquiry deals with the direct cause of death of the 26 miners on 9 May 1992.[1] This Inquiry must address two main questions: How did those 26 miners die? And why did those 26 miners die? The "how" is relatively straightforward and will be answered, as best it can be, in this chapter. The "why" is decidedly more difficult and involves multifaceted considerations – of planning, development, supervision, management, and regulations – that take the balance of this Report to address and, as possible, to resolve. In my capacity both as a special examiner under the *Coal Mines Regulation Act* and as a Commissioner under the *Public Inquiries Act*, I feel it is incumbent on me to "inquire into and report" on the proximate and probable cause of the explosion.

I have relied to a considerable extent on the report and testimony of coal mine explosion expert Reg Brookes in compiling this chapter on the explosion. He has extensive and special expertise in underground coal mine fires and explosions. From 1960 until his retirement in 1987 he was involved in the investigation of all but one mine explosion in the United Kingdom, and he has written, alone or jointly, nine reports on the examination of mine explosions. He has done far-ranging research and has written extensively on the subject.[2] He came to the Westray mine in early June 1992, participated in the interviews of several mine officials, and went into the mine in the company of a team of draegermen (mine rescue personnel). I was most impressed with Brookes as a witness. He was generally understated in his commentary and gave freely of his expertise in answer to questions by counsel, without embellishment but with keen perception. His opinions and conclusions seemed to flow logically and dispassionately from an incisive grasp of the subject.

Brookes's testimony is not the only evidence on record to bear on the actual explosion. In reaching a conclusion about the probable source of ignition, we carefully examined all the related expert opinions and anecdotal evidence.[3] In addition, a wealth of material – such as research findings, other explosion reports, and commentary dealing with mine explosions – formed part of the inquiry into the immediate cause of the Westray explosion. It was important to examine the interrelationship of all the forces and factors at work, not only at the time of the ignition but also

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1 NS Order in Council 92-504, 15 May 1992.

2 Exhibit 53.1, Curriculum vitae for Reg Brookes.

3 My comments about Reg Brookes are in no way intended to denigrate the expertise of other expert witnesses. Although Brookes's expertise in explosion investigation is more closely focused on the subject of this chapter, I have relied extensively on the evidence of the other experts in matters germane to their areas of expertise. Of course, the facts on which the experts' opinions were based were drawn from the transcripts of miners' interviews, documentary evidence, and in some cases on the evidence of witnesses during the hearings.

leading up to that time. This is a useful exercise in that it illustrates how these seemingly unrelated components came together to create the fatal result. It further illustrates the importance of ventilation, methane detection and control, dust control, housekeeping, ground control, and equipment maintenance – and how each of these separate categories has an impact on mine safety in general. This is consistent with the closing comments of Dr Malcolm McPherson in his report of 28 February 1996:

> It was indicated earlier in the public hearings of the Inquiry that one of the purposes of these proceedings is to establish, as far as is possible, the sequence of events that took place in the Westray Mine on 9 May 1992. It is toward that end that rigorous examination of alternative hypotheses of the cause and behaviour of the explosion is directed. Nevertheless, I am in agreement with [Andrew] Liney and others who have commented that whatever the precise sequence of events, the conditions that were allowed to develop at Westray were such as to generate a very high probability that a major hazardous incident would occur early in the life of the mine.[4]

Brookes approached this question in a somewhat different manner when he replied to counsel for the Inquiry:

> Q. [W]hat do you say as to how significant it is that we may never be able to pinpoint the exact location?
>
> A. [I]t's nice to be able to answer the question and . . . from the investigator's point of view . . . being able to say that this was the point where it started and to explain it fully . . . but . . . in this case it's not a great deal of significance to actually know what the igniting source was. I think the point is that the igniting sources were there available and the fuel was there, was available. And those two produced a deadly mixture. You've got to have the two of them to produce the explosion.[5]

Basically, I interpret Brookes as saying that the conditions that were allowed to develop at Westray have greater significance than the actual source of ignition, since without those conditions any spark or other ignition source could not have propagated anything.

Sources of Ignition

A few cautionary comments may be helpful before continuing with the review of the evidence. Many of the facts and findings in this chapter are the subject of more detailed comment in other portions of this Report. For instance, a finding of excessive accumulations of methane will be more thoroughly reviewed in Chapter 7, Ventilation, so there is no need here to set out the background or the premises and scientific data on which those concepts and conclusions are based. By the same token, commentary on the matter of roof cavities and their propensity to trap methane will be discussed in both Chapter 8, Methane, and Chapter 10, Ground Control. Although this narrative is of considerable length and detail, we must bear in mind that the total occurrence, from the first ignition of the methane to

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4 Malcolm J. McPherson, A Review of the Testimony of Andrew D. Liney, 28 February 1996, p. 7.

5 Hearing transcript, vol. 11, p. 2031.

the surface blast through the main portal, probably lasted fewer than 20 seconds.[6]

A word of caution about the evidence of the draegermen and the miners who later accompanied the RCMP into the mine to assist in their investigation. When they went into the mine during the rescue operation, they were primarily interested in locating the missing miners. Their observations of the conditions would be peripheral to their main task – rescue. Their only source of light at these times would be their cap lamps, which are very directed. Areas of the mine not directly illuminated by the lamps would be in pitch darkness, and, for this reason, the witness's perspective as to distance and location would be somewhat limited. These comments are not meant as criticism of the work of the draegermen or other rescue workers, or to denigrate their evidence. I make these observations only to underline the extremely stressful conditions that draegermen had to contend with, and how that may affect the accuracy of their recollections. For these reasons, we may be faced with seemingly contradictory interpretations of the conditions existing in the post-explosion underground.

The Equipment

The various pieces of equipment referred to throughout this Report may be unfamiliar to the average reader. Some of the equipment is illustrated in Reference, and the following brief comments on their respective places in an underground mine may assist readers in understanding the narrative.[7]

Continuous miner Photo 1 in Reference shows a new continuous miner on the surface at Westray. This machine literally carves the coal from the working face of the mine. It is the producer and the key to room-and-pillar mining. A horizontally rotating drum is studded with picks, which chew the coal from the face (see photo 2). This cutting head is hydraulically raised and lowered to mine the coal. The resulting chunks of coal fall onto a chain conveyor that carries the coal to the rear of the machine. The continuous miner is powered by electricity and is self-propelled, moving on bulldozer-like tracks. Normally, two people operate and tend to the machine.

Shuttle car This box-shaped vehicle receives coal from the continuous miner and transports it to the feeder-breaker. The rubber-tired shuttle car is electrically powered and driven by one operator. A new shuttle car (without wheels) is illustrated in photo 3 in Reference.

Stamler feeder-breaker This machine, located at the tail end of a belt conveyor, takes coal from the shuttle car, breaks up the larger pieces, and

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[6] Brookes estimated the flame speed as it travelled out of the mine to be 150 m/s or 340 miles per hour. He agreed with the Commissioner's suggestion that, after developing into a coal dust explosion, "the entire event would have been over in less than 10 seconds . . ." (Hearing transcript, vol. 11, pp. 2027–28). Liney came to a similar conclusion about flame propagation speeds (vol. 18, p. 3318).

[7] These and other pieces of mining equipment are also defined in the glossary in Reference.

feeds the coal evenly onto the belt conveyor. See photo 4 in Reference. The feeder-breaker is not mobile and can operate unattended.

Roof bolter After the continuous miner finishes a "cut," this machine is brought into the heading. The roof bolter drills holes in the roof (and sometimes the ribs) and sets steel bolts in the holes with resin. The bolts hold the roof strata together to keep the roof from "caving," or falling apart. Screens and straps are then secured to the bolts with steel plates and nuts to keep small material from falling to the roadway. The roof bolter incorporates an automatic temporary roof support (ATRS) system to enable the bolting crew to work under otherwise unsupported roof. Like the continuous miner, the roof bolter moves on tracks and is electrically powered. A crew of three operated the double roof bolter used at Westray. Photo 6 in Reference shows a typical bolting operation underground at Westray.

Boom truck This rubber-tired diesel-powered utility vehicle transports materials to working areas of the mine. It is equipped with a hydraulic arm for lifting and moving heavy materials.

The Mining Cycle

It may be helpful to the reader to describe briefly the sequence – the "mining cycle" – in which this equipment is used. Graham Clow and John Smith gave succinct descriptions of the cycle – cut, support, clean up, and do it again.[8] The cycle commences with the continuous miner, which moves to the working face and cuts coal from floor to roof for about 6 m.[9] As the coal is cut, it is transported by a chain conveyor on the miner to a shuttle car parked at the rear of the miner. When loaded, the shuttle car takes the coal to a feeder-breaker, which breaks up any large pieces and feeds the coal onto a conveyor belt for transport to the surface. At Westray, the continuous miner normally operated with two shuttle cars taking turns, thus keeping the miner as productive as possible. Because of the width of the roadways at Westray, the continuous miner made two cuts into the working face for each mining cycle.

After completing a cut, the continuous miner is moved out of the heading and the roof is secured with roof bolts. When the entire cut has been adequately bolted, the roof bolter is removed. The newly mined and bolted heading is cleaned by gathering any loose coal and garbage with a Scooptram or other permissible equipment. The loose coal is moved to the face, where it will be picked up by the continuous miner on the next cut. When clean, the area is stonedusted to render any remaining coal dust non-explosive. The mining cycle is complete and will start again.

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8 Clow (Hearing transcript, vol. 74, p. 16201); Smith (vol. 58, p. 12772).

9 In underground coal mines, people are not permitted to work under unsupported roof. At Westray, the continuous miner operator sat at the controls on the machine, thus limiting the depth of cut to the distance from the cutting heads to the operator's position. Continuous miners at some mines (Jim Walter Resources in Brookwood, Alabama, for example) are operated by remote control; the operator stands to the rear of the machine, thereby allowing more advance per cut without exposing the operator to unsupported roof.

Westray commonly developed two headings together so that the continuous miner and the roof bolter could alternate positions. This practice increased productivity by minimizing downtime for the machines.

At the time of the explosion, there were three operating areas in the Westray mine (see map 1 in Reference):

- the Southwest 2 section, comprising SW2-1 Road, the Lefthander (a formal designation seems not to have been assigned to this roadway), and SW2-B Road;
- the North mains section, comprising A, B, and D Roads to the north of the North 4 Cross-cut;
- the newly developed Southeast section, comprising 1 East, 2 East and 1 Southeast.

The inquiry experts generally agree that the fire and the explosion started in the Southwest 2 section of the mine. As equipment and materials expert John Bossert explained: "All of the experts appear to agree that the explosion originated in the Southwest 2 region of the mine. This means that all of the equipment in this region should be considered as possible sources of ignition."[10] For the purposes of this discussion, the Southwest 2 area is illustrated in Figure 6.1.

The Southwest 2 area was developed in early 1992 after a very quick and opportune withdrawal[11] from the section inbye SW1-3 Cross-cut.[12] At the time of the explosion there were three working faces in the section: SW2-B Road, the Lefthander, and SW2-1 Road. Figure 6.1 shows a continuous miner and a shuttle car[13] at the face of SW2-1 Road, roof bolters at the working face of the Lefthander and SW2-B Road, and a boom truck located at the intersection of SW2-B and SW2-1 Roads – at SW2-2 Cross-cut. The positioning of this equipment has been established from the evidence of the draegermen who entered this area immediately following the explosion:

Continuous miner and shuttle car Don Dooley noted that the shuttle car showed very little evidence of burning. The driver's seat was not burnt, nor were the tires.[14] David Sample said the shuttle car was "parked behind the continuous miner in the position it would be to be loaded and was at least seven-eighths loaded with coal."[15] Wyman Gosbee confirmed the

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10 Exhibit 55.3, p. 4, undated addendum to Bossert Report, 4 November 1992. See Malcolm McPherson's evidence: "It is my opinion that the most probable location of the initial ignition was in the Southwest 2 area" (Hearing transcript, vol. 9, p. 1670). Bossert also points in his report (p. 3) to Don Mitchell's letter of 21 September 1992, which refers to the continuous miner as the ignition source.

11 **Comment** In fact, the company was literally "chased out" of the Southwest 1 section by the extremely unstable and hazardous roof conditions.

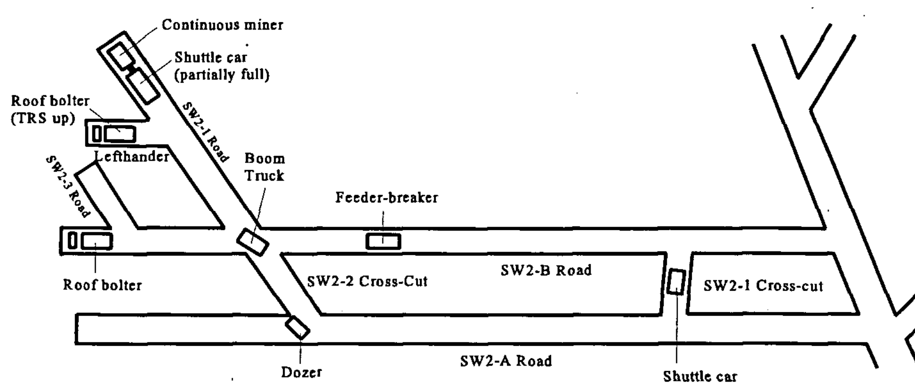
12 "Inbye" describes the location of things beyond a certain point in a mine. "Outbye" has the opposite meaning of a location closer to the portal or entrance. See the glossary in Reference.

13 There are varying estimates about the amount of coal in the shuttle car, ranging from 30 to 90 per cent full. They are relevant only to establish that the car was being loaded at the time of the explosion.

14 Hearing transcript, vol. 37, p. 8153; see also evidence of Jay Dooley (vol. 41, p. 9127).

15 Hearing transcript, vol. 30, p. 6517.

Figure 6.1 The Southwest 2 Section of the Mine, Showing Locations of Equipment at the Time of the Explosion



Source: From Exhibit 45.06.

location of the shuttle car, with the continuous miner at the heading, by reference to Exhibit 59, photo 25.[16] Jay Dooley said that the last sump was made by the continuous miner in SW2-1 Road and that the cutter had stopped after having "only made it down three or four feet."[17]

Roof bolter in the Lefthander We can infer from the evidence that one of the roof bolters was in the Lefthander.[18] Randy Facette confirmed this position: "There was another bolter further down in SW2-1 Road and in the cross-cut there off to the left, the Lefthander."[19] Clive Bardauskas examined the bolter located on the Lefthander of SW2-1 Road.[20] Lenny Bonner indicated that the continuous miner and the roof bolter switched places, and the bolter went into the Lefthander on 8 May 1992.[21]

Roof bolter in SW2-B Road This bolter was located at the face of SW2-B some 50 m from the intersection of SW2-2 Cross-cut and SW2-B Road. Jay Dooley described a piece of screening found at the top of SW2-B Road as being "at the bolter."[22] According to Facette, it was the bolter at the face of SW2-B Road on which he was working on 8 May along with Nelson LeDrew.[23]

16 Hearing transcript, vol. 25, pp. 5044–45.

17 Hearing transcript, vol. 39, p. 8703.

18 Hearing transcript, vol. 39, p. 8704.

19 Hearing transcript, vol. 33, p. 7239.

20 Hearing transcript, vol. 23, p. 4665.

21 Hearing transcript, vol. 24, p. 4791.

22 Hearing transcript, vol. 41, p. 9128; again, Dooley confirmed the location of the bolter (vol. 39, pp. 8705–06).

23 Hearing transcript, vol. 33, p. 7239.

Boom truck The boom truck was located at the intersection of SW2-B Road and SW2-2 Cross-cut, which runs directly into SW2-1 Road. It shows clearly in Exhibit 59, photo 27 (see photo 21 in Reference). Don Dooley also described it as being in that location.[24]

Inquiry experts Miklos Salamon, Malcolm McPherson, Reg Brookes, and John Bossert each suggested that one of these four pieces of mining equipment was the most probable source of ignition. Andrew Liney, a ventilation expert retained by the RCMP for the criminal prosecution,[25] postulated that the boom truck was the prime candidate as the source of ignition. His evidence will be dealt with later in this chapter.

The opinion of the experts varied. Brookes said, "I would put the continuous miner first . . . the boom truck second and the bolter third."[26] McPherson said, "I would not want to choose between the continuous miner and the boom truck. I think that both of them, Commissioner, were equally likely to have been the source of this particular ignition."[27] It is noteworthy that McPherson made this comment early in the hearings and before the evidence of the miners had been taken. In subsequent discussions, he seemed to favour the continuous miner as the most probable source.

Finding

The source of ignition that caused the methane accumulation to catch fire, most probably, was the cutting mechanism or picks of the continuous miner, which, when they struck either pyrites or sandstone, caused sparks of sufficient intensity to light the gas. The gas would be ignited in much the same way that the spark from the flint of a cigarette lighter will ignite the gas emitted from the lighter reservoir.

I shall now set out my reasons for finding the continuous miner as the strongest probable source of ignition: the continuous miner was likely operating at the time of the explosion, since the shuttle car was partially filled, the switches on the miner were in the "run" position, the conveyor on the miner had coal on it, the position of the cutting heads indicate that the miner was operating, and the evidence suggests sparking at the miner.

There is sufficient evidence on which to base the finding that the continuous miner was operating at the time of ignition, or very close to that time. This is contrary to the conclusions suggested in the final submission to the Inquiry of the United Steelworkers of America Local

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24 Hearing transcript, vol. 37, p. 8156. This piece of equipment also figured prominently in the investigation of the possible sources of ignition. It was the subject of some discussion among the experts, as will be seen later in this chapter.

25 *R. v. Curragh Resources Inc., Gerald J. Phillips and Roger J. Parry.*

26 Hearing transcript, vol. 11, p. 2029. In that evidence, Brookes corrected himself where he inadvertently placed the bolter second.

27 Hearing transcript, vol. 9, pp. 1676–77.

9332,[28] but it is consistent with other persuasive evidence. The presence of a partly filled shuttle car immediately behind the continuous miner is just one indicator of the state of the continuous miner at the time of the explosion. It would not be normal for the continuous miner to stop operating before the shuttle car was full. As mining expert Don Mitchell said, "[Y]ou have to have a darn good reason not to completely fill the shuttle car and let it get down and dump." He concluded that the shuttle car was about two-thirds full.[29] As noted earlier, Sample thought it was "at least seven-eights loaded with coal."[30] Don Dooley said that the operator of the continuous miner "wouldn't have backed out until he filled his shuttle car."[31] I have observed that a shuttle car can be fully loaded in less than a minute if the continuous miner is operating effectively.[32]

Clive Bardauskas was employed as a mechanic at Westray. He had some 20 years' experience in coal mining, including 19 years with the British Coal Board. He accompanied the RCMP into the Westray mine in September 1992 and he "walked right up to the continuous miner." All three switches on the continuous miner were in the "run" position, and he concluded that the continuous miner was cutting coal at the time of the explosion. The conveyor on the continuous miner had coal on it, and the cutting heads were "at the face." I asked Bardauskas how close the continuous miner was to the face, and he responded, "As close as you could get."[33] Don Dooley was a member of the mine rescue team that went into the mine on the day following the explosion, and he later went into the mine to assist the RCMP with the investigation. He told the Inquiry that, when he came upon the continuous miner during the rescue attempt, "the miner head was only two feet from the roof."[34] He was convinced that the operator backed away from the face and stopped mining because his equipment gassed out.[35] He didn't know of any other reason why the operator would back off from the face with the shuttle car not full. Jay Dooley said, "I believe he had come down on the sump about three, four feet from the back."[36] Don Dooley suggested hydraulic leakage over the intervening several months as the cause of the miner head being in a lower

28 "The continuous miner was on but it was pulled back two or three feet from the face. Most of the coal on its conveyor had run through, suggesting the operator was not cutting coal at the time he decided to leave the machine." David Roberts, "Ingredients for Disaster" (Halifax: Local 9332 USWA, 1996), 37.

29 Hearing transcript, vol. 16, p. 2927.

30 Hearing transcript, vol. 30, p. 6517.

31 Hearing transcript, vol. 37, p. 8194.

32 Jim Walter Resources, Inc., Brookwood, Alabama, uses a ramcar, which is about the same size and serves the same purpose as the shuttle car, except that it loads and unloads from the same end.

33 Hearing transcript, vol. 23, pp. 4663–66. Of the bolter located in the Lefthander, the witness said: "[T]here was no drill steel, they weren't drilling." As to the boom truck, he said, "At the time of the explosion, the boom truck was running."

34 Hearing transcript, vol. 37, p. 8186.

35 Hearing transcript, vol. 37, p. 8189.

36 Hearing transcript, vol. 39, p. 8703.

position in Exhibit 59, photo 24. This photo, reproduced in Reference as photo 17, was taken on 27 September 1992, some four and a half months after the explosion.

There is also sufficient evidence on which to base the finding that the continuous miner was the probable source of ignition. In his evidence, McPherson described the phenomenon of a "streak of incandescent material"[37] appearing like a ribbon of red hot or white hot material flowing from the back side of the cutting head picks. This incandescent streak would not be inhibited by the continuous miner's water sprays, which, under normal circumstances, are directed at the cutting head, not to the back of it.[38] The primary purpose of this water spray is to suppress the coal dust at the working face, not to prevent sparking.[39] To reach the degree of heat necessary to create the incandescent streak, the cutting head picks must find a non-coal material of sufficient hardness and abrasiveness to create sparks.[40] Individual sparks would seldom be of sufficient intensity to ignite a methane-air mixture, but the incandescent streak – a continuous cascade of individual sparks – may provide sufficiently prolonged heat to allow ignition. Dull cutting picks will also encourage sparking as the bits cut into or strike non-coal material. Rick Mitchell witnessed sparking of this nature when he operated the continuous miner in SW2-B Road. The sparking occurred even when the water sprays on the continuous miner were activated. At one time when the continuous miner was cutting into pyrite, Mitchell was burned on his neck from sparking.[41] Kevin Gillis, a geologist with the Department of Natural Resources who visited the Westray mine 12 times between May 1989 and September 1991, supports the evidence of sparking at the working face as the continuous miner operated: "And as it came near the roof, it would . . . put out a shower of sparks."[42]

The roof bolters located in the Lefthander and in SW2-B Road have been given low priority as a possible source of ignition. According to an RCMP report, "no steel drills were fitted and it appeared that those bolters

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37 Hearing transcript, vol. 9, p. 1672.

38 Hearing transcript, vol. 9, p. 1674. It is perhaps this phenomenon that prompted I. Hartman to comment in US Bureau of Mines Information circular No. 7727 (1955) that water "should be injected on both sides of the cutting bars, or better still compressed air-water sprays." This opinion is referred to by F. Powell, "Ignitions by Machine Picks: A Review," *Colliery Guardian* 239 (November 1991): 245.

39 Bossert (Hearing transcript, vol. 12, pp. 2163–64); McPherson (vol. 10, pp. 1715–16).

40 Photograph 16 in Reference clearly shows non-coal material at the face where the continuous miner was working.

41 Hearing transcript, vol. 31, pp. 6762–65: "Well I was cutting into the face and, naturally, we were cutting into that pyrite. . . . you could see the sparks rolling right with the head . . . when one came right back into the cab and burnt me in the neck." Continuous miner operator Buddy Robinson agreed that there "would probably be a lot [of sparking]" if the continuous miner was cutting into the rock pictured in Exhibit 59, photo 23, and if the operator wasn't using his water sprays (vol. 30, p. 6418).

42 Hearing transcript, vol. 46, p. 10110.

were not working."[43] McPherson suggested that the roof bolter in the Lefthander was "running" at the time – not necessarily operating.[44] That would allow for the possibility that the roof bolter could have been the source of an electrical spark, which is consistent with Brookes's comment that "it doesn't rule out a possible electrical source of ignition."[45] Again, with respect to the bolter at the working face of SW2-B Road, the evidence is fairly compelling that this machine was not operating at the time of the explosion, although it may very well have been running.[46] In such circumstance, the bolter motors may have been energized, but were neither drilling nor installing bolts.

In their evidence, some witnesses considered the boom truck a possible source of ignition. It was located at the intersection of SW2-B Road and SW2-2 Cross-cut (the continuation of SW2-1 Road), 100 m from the working face where the continuous miner was found. As shown in photo 21, the boom truck is a low-slung vehicle, lying quite close to the road. According to Bossert, this truck (No. 975-0414) was built in 1975 and originally conformed to U.S. standards as a flameproof machine. It was first used by Kaiser Resources at its hydraulic coal mine in British Columbia. Over the years, the boom truck underwent substantial modifications, which appear to have affected its flameproof condition:

> This machine was originally built as a flameproof diesel truck but . . . it has been modified extensively and is no longer flameproof. In addition, it was built in 1975 and has seen service in at least two coal mines so the engine was probably well worn. If one or more of the valves leaked, flames could have escaped into the intake or exhaust which were no longer equipped with flame arresters. This machine was correctly listed as a non-flameproof diesel machine and, as such, was not permitted beyond the last cross-cut or within 300 feet of the face. Therefore, it should not have been driven to the point where it was found.[47]

For these reasons, Bossert concluded that the exhaust from the boom truck was "the most likely source of the ignition." Brookes, referring to the boom truck, said, "I think it very unlikely that anything like that would be allowed in a British mine."[48] However, he still favoured the continuous miner as the most likely source of ignition. [49]

Andrew Liney, after examining some of the photographic evidence at the hearing,[50] advanced the theory that the boom truck was the most likely source of ignition. His hypotheses differ from those of other expert

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[43] Brookes (Hearing transcript, vol. 11, p. 2014). This information comes from Jay Dooley's report for the RCMP in Exhibit 34.0139–40.

[44] Hearing transcript, vol. 9, p. 1676. "Running" is used to describe equipment that is energized (powered up) but not necessarily actively operating. "Operating" is used to describe equipment that is being used at the time to perform the tasks for which it is intended.

[45] Hearing transcript, vol. 11, pp. 2014–15.

[46] Hearing transcript, vol. 11, p. 2015.

[47] John Bossert, "Report of the Investigation of the Equipment and Materials used in the Westray Coal Mine prior to the Explosion of May 9, 1992" (1995) (Exhibit 55.3, p. 5).

[48] Hearing transcript, vol. 11, pp. 2019–20.

[49] Hearing transcript, vol. 11, p. 2029.

[50] Exhibit 59, photo 27; Exhibit 122.09, photos 197–8; and Exhibit 73.10.66A.

witnesses and involve a piece of vent tubing that was found wrapped around the boom truck:

> I believe [that] the boom truck as it was travelling around the corner, under the duct, which it clearly had to do to arrive in the position that it was, the back end of the boom caught the duct which at that time was maybe hanging a bit low. If it pulled on it at all, it would have pulled it down for some length, and it would have laid it down on top of the boom truck . . .[51]

He then went on to say that he didn't believe it was duct that was laid on the floor near the boom truck because that was not the way one stored ducting. Normally, when ducting is stored in the mine, it is left in "concertina" fashion, rather than stretched out as this piece found on the floor appeared to be. He further explained that the operators of the boom truck would have been concerned about tearing down the piece of tubing that was supplying air to the bolting crew working inbye on SW2-B Road. He speculated that they would have left the boom truck running and started up the roadway to warn the bolters of the accident. Liney concluded that, as the men went into the heading towards the bolter,

> either the duct ignited, which is, in my opinion, entirely feasible, although I have no scientific evidence to suggest that the heat generated by the exhaust [of the boom truck engine] would ignite it. I do know that a relatively low temperature will ignite this type of duct. Or the gas that was entrained in the activity of pulling the duct down was ignited. And I favour the duct being ignited myself.[52]

He then described how the resulting methane fire would have dispersed throughout the Southwest 2 section and caused the death of the 11 miners working there at the time.

I find it difficult to accept Liney's theory as a plausible explanation for the source of ignition of this mine explosion. Too many factors that are not supported by the evidence would have to come into play.

The evidence of Don Dooley is, perhaps, the most damaging to Liney's theory. This evidence was not available when Liney appeared at the Inquiry. Dooley said there were fragments of used vent tubing lying around on the floor of the mine in this vicinity. He speculated that the shuttle car, in its many runs through this area, could have caught a piece of this discarded tubing and dragged it partly out into the roadway. He then suggested that the boom truck operator, Robbie Doyle, could have run over two or three feet "before he got stopped" to give the shuttle car enough room to get by. With respect to the vent tube wire wrapped around the boom truck, Dooley said, "Those are just a conglomeration of old vent tubes. That's not vent tubing that was hanging on the roof."[53] We must remember that Liney's theory was based, in part at least, on the assumption that any vent tubing lying on the roadway would be packed tubing in its compressed "concertinaed" configuration. Dooley also

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[51] Hearing transcript, vol. 18, pp. 3302–03.

[52] Hearing transcript, vol. 18, p. 3306.

[53] Hearing transcript, vol. 37, pp. 8166–67.

concluded that the boom truck was running at the time of the explosion, and said, "again, that leads me to believe the boom truck operator simply got off the boom truck to look for his supervisor to find out where to put his supplies."[54]

Don Mitchell would not speculate on whether the piece of vent tubing entwined around the boom truck was pulled down by the truck. He said there was no way of postulating that, since there was no evidence from the investigation that could lead to that sort of conclusion:

> [A]ll I can say from this [examination of boom truck photos][55] is there is little question that this vehicle indeed ran over some duct. Whether it was duct that was actually supplying air to the face at that time . . . or whether it was . . . just a piece of duct on the floor, I'm not capable of answering.[56]

Ted Deane was one of the boom truck operators. He said, "You always travelled with the arm [boom] back down onto the bed." When asked to comment on the possibility of the boom truck hitting and knocking out a vent, he replied: "Nobody would travel with it up that high to hit a vent. . . . There's no reason to travel with it up that high."[57] Steven Cyr, another of the boom truck operators, said that they ran over bolts, resin, and vent tubing "quite a bit."[58] He had never known the boom truck to snag a piece of vent tubing that was hung up, and the only such incident he could recall was one time when the continuous miner knocked out a piece.

For all the above reasons, I must reject the boom truck and return to the continuous miner as the most probable source of ignition.

Methane

The conclusion that the cutting head on the continuous miner is the most probable source of the sparking that caused the ignition of methane is defensible both historically and statistically.

The ignition of methane (or firedamp[59]) by the impact of hand tools and machines is a common cause of coal mine fires and has been known as such for several hundred years. In the 30-year period ending in 1989, there were more than 370 reported frictional ignitions of methane in mines in the United Kingdom. In 1979, there were 87 similar ignitions in coal mines in the United States.[60] One does not have to travel far afield to see evidence of these sorts of mine hazards. In the introduction to a study entitled "Frictional Ignition Control," the editor stated: "As the use of power loading equipment has become more widespread, frictional ignition

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54 Hearing transcript, vol. 37, p. 8161.

55 Exhibit 73.10.066A, photo 200; RCMP photo 199. The former is reproduced as photo 22 in Reference.

56 Hearing transcript, vol. 18, p. 3131.

57 Hearing transcript, vol. 26, pp. 5441–42.

58 Hearing transcript, vol. 25, p. 5156.

59 "Firedamp" is a common British term for a flammable methane-air mixture, descriptive of the gas's potential to ignite or explode. It is also used as a synonym for methane.

60 F. Powell, "Ignition by Machine Picks: A Review," *Colliery Guardian* 239 (November 1991): 241.

incidents have increased. There have been many fatalities and injuries from this cause."[61] The seriousness of these machine pick ignitions cannot be overestimated:

> While most of these machine pick ignitions produced no more than a localised flame, every ignition of firedamp [methane] is a potential disaster. Nine miners were killed in a 1963 Utah mine explosion in which frictional ignition was a likely cause. The seriousness of the problem cannot be overstated: in February 1979, in Nova Scotia, an ignition that led to a coal-dust explosion in which 12 miners died was attributed to frictional ignition caused by a shearer.[62]

Since it appears almost impossible to eliminate sparking at the mine face, especially when using machines such as a continuous miner, the first line of defence against a propagating methane fire – which could develop into a full coal-dust explosion – is ventilation.[63] Although this Report will study elsewhere, and in considerable detail, the mechanics of mine fires and explosions, the following excerpt from a South African journal is meaningful in the context of this chapter:

> One of the more usual disaster scenarios involves the following sequence: 1. The growth of a large, flammable methane-air zone near the face that is being mined. The flammable zone growth is the result of increasing methane emission. The mining process results in the rapid advance of the mine void into the fresh seam, which steepens the internal pressure gradient of the coal seam, which increased the flow of methane into the mine. If the ventilation [is] inadequate to dilute, render harmless, and to carry away that increased emission, significant flammable volumes are generated. 2. The ignition of that flammable volume by the frictional heating of cutting bits, by an electric or electrostatic spark, or by an explosives shot. 3. The development of a localized methane-air explosion, referred to as a "face ignition," and its outward acceleration from the closed-end or "face" of the mine entry. 4. The lifting of coal dust accumulations by the flows and pressures generated by the accelerating "ignition," and the mixing of that dust with air to create a flammable dust-air mixture. 5. The ignition of the dust-air mixture by the methane-air explosion. 6. The further turbulent acceleration of the flame front, which intensifies the aerodynamic disturbance, which lifts more coal dust mixing it with air throughout an increasingly lengthening zone in advance of the flame. 7. The propagation of a dust explosion throughout the mine.[64]

Of particular significance in this analysis is the work of the U.S. Bureau of Mines and its study of coal mine explosions.[65] The

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61 R.K. Singhal, D.B. Stewart, and J.P.L. Bacharach, "Frictional Ignition Control," *Colliery Guardian* 235 (May 1987): 176.

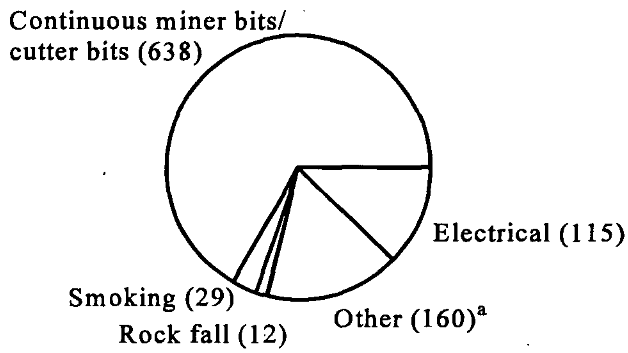
62 Powell, "Ignition," 241. The reference to the Nova Scotia mine is No. 26 colliery of the Cape Breton Development Corporation. See Commission of Inquiry into Explosion in No. 26 Colliery, Glace Bay, Nova Scotia, on February 24, 1979, *Report* (Canada: Department of Labour, 1980) (Chair Roy Elfstrom) [Elfstrom Report].

63 See Chapter 7, Ventilation.

64 Martin Hertzberg et al., "Methane and Coal Dust Explosion Inhibitors Tested," *Coal, Gold and Base Minerals of South Africa* 32 (September 1984): 21.

65 J.K. Richard et al., *Historical Summary of Coal Mine Explosions in the United States, 1959–81* (Washington, DC: Department of the Interior, Bureau of Mines, 1983).

Figure 6.2 Number of Ignitions and Explosions by Cause (U.S. Coal Mines, 1959–81)



Source: J.K. Richard et al., *Historical Summary of Coal Mine Explosions in the United States, 1959–81* (Washington, DC: U.S. Department of the Interior, Bureau of Mines, 1983), tables A1, S2.

[a] Includes cutting and/or welding, frictional ignition by roof drill bits, explosives, defective flame safety lamp, longwall bits, other frictional, other non-frictional, and cause unknown or not yet specified.

overwhelming cause of U.S. coal mine explosions from 1959 to 1981 was continuous miner bits. Figure 6.2 illustrates that, of the 954 recorded "incidents," 638 were attributable to frictional ignition from continuous miner (and other cutter) bits. These findings were largely supported in a study by John Nagy for the U.S. Mine Safety and Health Administration (MSHA) in 1981. As a result of his analysis, Nagy concluded:

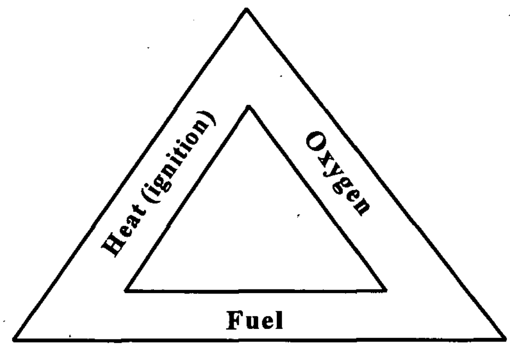
> Eighty-five percent of these ignitions were caused by frictional sparks generated by cutting machines or continuous mining machines when the bits struck hard materials at the working face. Each ignition has the potential to become an explosion if sufficient force develops to cause damage. . . . The trend in methane ignitions in British coal mines is approximately the same as in American coal mines.[66]

Propagation

Based on an analysis of the evidence and of the laboratory, statistical, and historical data, I have concluded, as noted above, that the ignition occurred at the working face as a result of sparking at the picks of the continuous miner. A spark cannot of itself, however, generate a lethal underground explosion. The classic "fire triangle" must be present. All three legs of the triangle must be present for a fire to sustain itself and, in this case, to

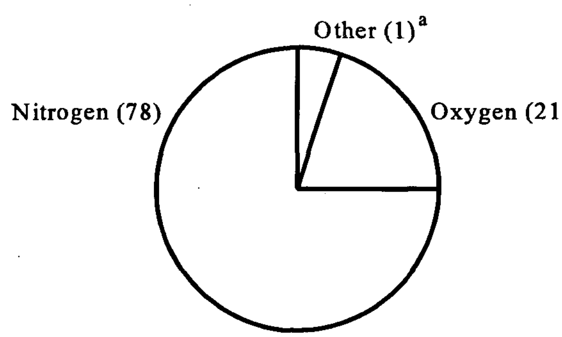
[66] John Nagy, *The Explosion Hazard in Mining*, IR 1119 (Washington, DC: U.S. Department of Labor, Mine Safety and Health Administration, 1981), 8. The author cites H.S. Eisner, J.K.W. Davies, and F.R. Brookes, "Mine Explosions: The Current Hazard," *Symposium on Health, Safety and Progress* (Harrogate, England, 1976).

Figure 6.3 The Fire Triangle



Source: Donald W. Mitchell, *Mine Fires*, 3rd ed. (Chicago: Intertec Publishing Inc., 1996), 5.

Figure 6.4 Composition of Clean Dry Air at Sea Level (approximate per cent by volume)



Source: United States, Department of Labor, Mine Safety and Health Administration, *Mine Gases*, Safety Manual No. 2 (Washington, DC: MSHA, 1991)

[a] Includes argon, carbon dioxide, neon, helium, krypton, xenon, hydrogen, methane, nitrous oxide, and ozone.

propagate into an explosion (see figure 6.3). The first leg, heat (or ignition source), has been established, on a strong balance of probability, as set out in the foregoing analysis. One can easily assume that the second leg, oxygen, was also present – men were working in the area, and the mine ventilation system was delivering air to them. Air normally contains approximately 21 per cent oxygen, as shown in figure 6.4. That leaves for determination only the presence of the third leg – the essential fuel on which the fire will feed.

It is almost a given that explosions in underground mines are caused by the ignition of methane – a colourless, odourless, non-toxic gas that is lighter than air. Its lower and upper explosive limits are approximately 5 per cent and 15 per cent, respectively, with 9.5 per cent being the optimum

explosive mixture.[67] How much heat, or energy, is needed to ignite methane? Nagy and Mitchell continue:

> A gas-air mixture is readily ignited by a weak electrical spark, a frictional spark, a heated surface, or an open flame.[68] The minimum electrical energy of a spark causing ignition varies with gas concentration, humidity, oxygen content of the atmosphere, temperature, and turbulence. As little as . . . about one fiftieth of the static energy accumulated by an average-sized man walking on a carpeted floor on a dry day [is required].

Finding

The ignition caused a rolling methane flame to travel away from the working face of SW2-1 Road and also propagated into the Lefthander, consuming all the oxygen in the roadways and leaving deadly quantities of carbon monoxide in its place. The rolling flame moved to SW2-2 Cross-cut, where it followed SW2-B Road both inbye and outbye the cross-cut and continued as a rolling methane fire inbye SW2-2 Cross-cut towards the roof bolter at the face. The rolling flame did not develop into a methane explosion, although it did increase in intensity.

As the flame turned outbye SW2-2 Cross-cut, three factors combined to cause the flame to propagate into a methane explosion, which, in turn, generated a preceding shock wave: the boom truck located in the intersection, the auxiliary fan in the cross-cut, and the change of direction of the flame down SW2-B Road towards SW1-B Road. The resulting shock wave then created greater pressure and increased turbulence, which caused dust particles to become airborne – just in time for the extreme heat of the trailing methane explosion to generate a full-blown coal-dust explosion. It is probable that this coal-dust explosion started at or near the Stamler feeder-breaker located about 30 m down SW2-B Road outbye SW2-2 Cross-cut. The resulting coal-dust explosion then moved rapidly through the entire mine, causing death and devastation in a matter of a few seconds.

The description of the rolling methane flame is consistent with Don Mitchell's evidence. Mitchell said that the Stamler feeder-breaker was the most probable location for the start of the coal-dust explosion, since it could create sufficient turbulence to raise coal dust into suspension – to be ignited by the methane explosion.[69] Eleven bodies were recovered from Southwest 2 section, six in SW2-1 Road between the working face and the intersection with SW2-B Road, and five along SW2-B Road between the intersection and the face at which one of the roof bolters was located. The precise location of the bodies is a matter of some uncertainty, since the evidence of some of the rescue teams is not conclusive. From the general

67. John Nagy and Donald W. Mitchell, *Experimental Coal-Dust and Gas Explosions*, Investigation No. 6344 (Washington, DC: Department of the Interior, Bureau of Mines, 1963), 19.

68. Nagy and Mitchell, *Experimental Coal-Dust and Gas Explosions*, 19; the authors cite H.F. Coward and G.W. Jones, *Limits of Flammability of Gases and Vapors*, U.S. Bureau of Mines Bulletin (1952), 503.

69. Hearing transcript, vol. 17, p. 3000.

location of the bodies relative to the equipment on which the miners had been working, it is a fair assumption that most of the men were running and that they fell as they were overtaken by the flame. If so, the miners in the Southwest 2 section had at least some minimal warning (perhaps 10 seconds) of the methane fire. This would support the finding that the methane had burned briefly before propagating into an explosion and would, as Don Mitchell suggested, also give more weight to the assumption that the fire started in the Southwest 2 section.[70] Other than these suggestions, it would be imprudent to speculate anything more from the location of the bodies.

According to the report of the chief medical examiner, Dr R.A. Perry, 10 of these miners died of carbon monoxide poisoning in the range of 65–80 per cent saturation.[71] The 11th deceased, Robbie Doyle, died of combined carbon monoxide poisoning (22 per cent saturation) and flash burns. Doyle's body was located in SW2-B Road some 20 m inbye the boom truck.

In his evidence at the criminal trial, Dr Perry indicated that all the deceased in the Southwest section, except Doyle, had superficial burns to parts of the body, whereas Doyle's body showed evidence of "burns of varying severity."[72] The relatively lower level of carbon monoxide poisoning and the increased severity of the burns led the doctor to conclude that the lower carbon monoxide level was consistent with acute spasm of the larynx (vocal cord area) due to the flame and heat effect on the larynx.[73] We can only speculate why Doyle suffered a different death from the other 10 miners who were in the same area of the mine and, presumably, were exposed to the same conditions. It could be that Doyle was located beneath a roof cavity containing additional methane, and, as the rolling flame from the methane fire passed over him, a more intense flash occurred, causing more severe burns and the acute spasm that was the primary cause of death.

What is significant in this analysis is that there were no signs of trauma on the bodies of these 11 miners in the Southwest 2 section to the degree shown on the bodies of the four miners found outside the Southwest section. Two of the latter group died of multiple blunt injuries, and, while the remaining two died of carbon monoxide poisoning, there was evidence of more severe external injuries as well as broken ribs. We may logically conclude that these four miners were buffeted about by a force such as the shock wave that would precede the coal-dust explosion. The more severe burning of these bodies is further indication that they had been involved in the coal-dust explosion rather than a methane fire. As Brookes said, "There would be considerable after burning of the coal dust particles which would cause severe burning to the men as opposed to just

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70 Exhibit 48.2.

71 Exhibit 44.0074–82.

72 *R. v. Curragh et al.*, transcript, 14 February 1995, pp. 209–10.

73 *R. v. Curragh et al.*, transcript, 14 February 1995, pp. 213–14.

superficial burns of the men here [referring to the Southwest section on the map]."[74] In the absence of similar evidence of trauma on the bodies of the 11 miners in the Southwest 2 section, it seems reasonable to conclude that the methane fire had not propagated into a full-blown coal-dust explosion at the time of their deaths. This is just another factor that supports the finding that the methane fire originated in Southwest 2 and probably propagated into a full coal-dust explosion shortly thereafter – probably before getting to SW1-B Road.

Brookes followed approximately the same line of thinking in arriving at his conclusion that the continuous miner was the most likely source of ignition. He stated his impression thus:

> So my picture of these men trying to get away, they're getting part way down the roadway, but then the flame developed in this layer and the turbulence caused by the initial flame starts to mix the gas so that the mixture of gas comes lower in the roadway, starts to burn more quickly and, indeed, may have passed over them as they made their way down the road. The products of the combustion, the carbon monoxide then hit them. They breathe that in and fell on the spot. . . .[75] And then you would get a more violent explosion down these two roadways and that violence would continue, perhaps picking up any gas from other cavities or any gas that was in those roadways in the form of a layer mixing it and increasing in violence until it reached the C-1 or B Road there, particularly the B Road where the conveyor is situated.[76]

Coal Dust

The Stamler feeder-breaker was located in SW2-B Road some 30 m outbye SW2-2 Cross-cut. As earlier indicated, its function is to receive the coal from the shuttle car, break it into smaller segments, and feed it onto the conveyor belt for eventual transport to the surface. Owing to the very nature of its function, the feeder-breaker generated considerable coal dust and would also liberate methane as the coal was broken. The coal dust would settle on the roadway, the finer particles attaching to the ribs and even the roof of the roadway. The liberated methane would rise and be either swept away by the ventilation system or added to the methane layering at the roof, if the ventilation system was inadequate for the purpose. It is very probable that the feeder-breaker, with the coal-dust accumulation around it and the fact that its presence alone would cause some turbulence, was the point at which the methane explosion travelling

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74 Hearing transcript, vol. 11, pp. 2013–14.

75 **Comment** Carbon monoxide is extremely lethal. During a safety instruction at the Skyline mine in Helper, Utah, I was firmly directed to hold my breath while transferring from the mouthpiece of the self-contained self-rescuer to the oxygen tank. The absence of oxygen, having been replaced by methane, can be equally lethal. I was told of an incident at the Jim Walter Resources mine in Brookwood, Alabama, where an experienced mining engineer was investigating a roof fall in one of the mines. He climbed to the top of the fallen roof section, encountered methane, and died instantly. His co-worker was warned by the change in pitch of the engineer's voice and fell to the ground, thus avoiding a similar fate.

76 Hearing transcript, vol. 11, pp. 2011–12.

down the SW2-B Road propagated into the coal-dust explosion. This strong probability was expressed by Brookes:

> In this scenario, the flame would develop moving faster as it came down to the open end of the entry. If there were cavities present, it may have produced turbulence which would bring gas out of those cavities because of the rising heat and combustion and convection and so that you start to get a rolling flame, and the progression of that flame would be faster, and by the time it got down to the intersection and into the SW1-A and SW2-B Roads where the conveyors [and the feeder-breaker] were situated, or perhaps at the intersection, there would be enough gas mix so that the whole roadway might be filled with a flammable mixture at this point. And then you would get a more violent explosion down these two roadways and that violence would continue, perhaps picking up any gas from other cavities or any gas that was in those roadways in the form of a layer mixing it and increasing in violence until it reached the C-1 or B Road there, particularly the B Road where the conveyor is situated.[77]

Dr Paul Amyotte is a mining engineer with considerable expertise and experience in experimental coal-dust and methane explosions. He is widely published in that and associated fields. He provided, both in his written report and in his testimony at the Inquiry, some interesting insights into the explosive characteristics of coal dust and methane. He bases some of his discussion on a graph, "Analysis of Post-Explosion Dust Samples from the Southwest Section," reproduced here as figure 6.5. The graph was prepared by Ken Richmond, formerly of the U.S. Bureau of Mines. Richmond was engaged, post-explosion, by the RCMP to analyse coal-dust samples taken from various areas of the Westray mine. The graph shows the results of tests performed for Richmond at the Ottawa laboratory of the Canada Centre for Mineral and Energy Technology (CANMET). The top line on the graph shows the average combustible content of the dust samples taken in the Southwest section. That line starts at the working face of SW2-1 Road, where the combustible content is shown as 70 per cent. At 60 m outbye the face, the line starts to dip and then levels off at about 100 m, where the combustible content is shown as 58 per cent. Commenting on this analysis, Amyotte said:

> I think that is one way, to me, in which the combustible content could decrease, that if that sample had previously been involved in a coal-dust explosion, you would expect the combustible components to be less . . . based upon my expertise in dust explosions, [it] is possible that the decrease in combustible content can be equated with the initiation of coal dust burning.[78]

It is obvious that Amyotte was somewhat tentative in the conclusions he drew from the Richmond charts. To further questioning on that point, Amyotte indicated that there was evidence of "coking" in the samples with the lower combustible readings. Coking is the term used to describe coal that has been subject to burning – generally when the more highly volatile

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77 Hearing transcript, vol. 11, pp. 2011–12.

78 Hearing transcript, vol. 13, p. 2298.

elements in the coal are burned off. He presented this evidence merely as a postulation that the drop in combustibles in the samples taken along SW2-1 Road and the Lefthander and out to SW2-2 Cross-cut could be accounted for by their being consumed at that point in a coal-dust explosion. "It's a piece of evidence that I felt was important to my analysis and which lent credence to that analysis," Amyotte told the Inquiry. "It was a valuable piece of evidence, as far as I was concerned." He agreed with me that this may present "[j]ust another little piece in the puzzle."[79] To further confirm that this evidence could be of some significance, Amyotte's testimony and the accompanying graphs were forwarded to McPherson for his review and comment.

McPherson observed that there was considerable scatter of the points on the Richmond graph (figure 6.5). Because of such scatter, no "well-defined line" could be drawn through the points. He also suggested that, in moving away from the working face of a mine, one usually found a reduction in combustible content. He concluded: "This particular set of results shows that the combustible content was lower in the throughflow airways than in the headings. I would be hesitant to put any stronger interpretation than that upon them."[80]

McPherson also presented a graph (figure 6.6), showing the results of dust sample tests from the cross-cuts of the main roadways – No. 1 Main (intake) and No. 2 Main (return). He explained the straight, ascending line this way: "This plot indicates that the further we move down the mains into the mine, the greater is the amount of coal in the settled dust. This is hardly a surprising result and is a trend that we could find in the majority of drift (slope) coal mines." In his concluding remarks, McPherson made the following comment:

> The bottom line on all of this is that the dust samples provide an additional indication that the initial gas explosion generated a dust explosion somewhere within the Southwest 2 workings and probably before reaching the B or C1 roadways. It may be inadvisable to be more dogmatic than that.

The analysis of the Richmond tests, as illustrated by the graphs, does not support any firm conclusions about the origin of the ignition or the subsequent explosion. It does provide one more indication that the coal-dust explosion occurred somewhere in the Southwest 2 section of the mine.

I shall now advance to an analysis of further evidence respecting the source of the ignition and the propagation of the coal-dust explosion.

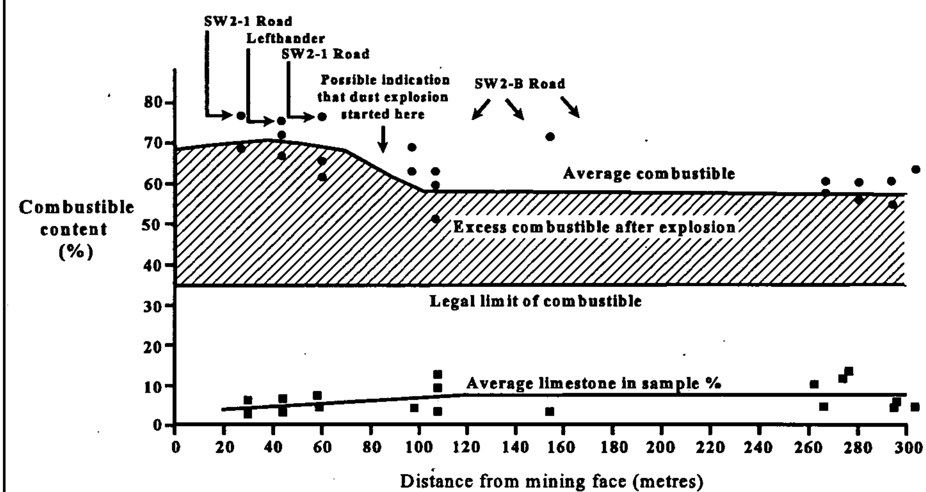
Ventilation

Early in this Inquiry, I reached the conclusion that ventilation in an underground coal mine is the most crucial aspect of mine safety in the

[79] Hearing transcript, vol. 13, pp. 2299–300.

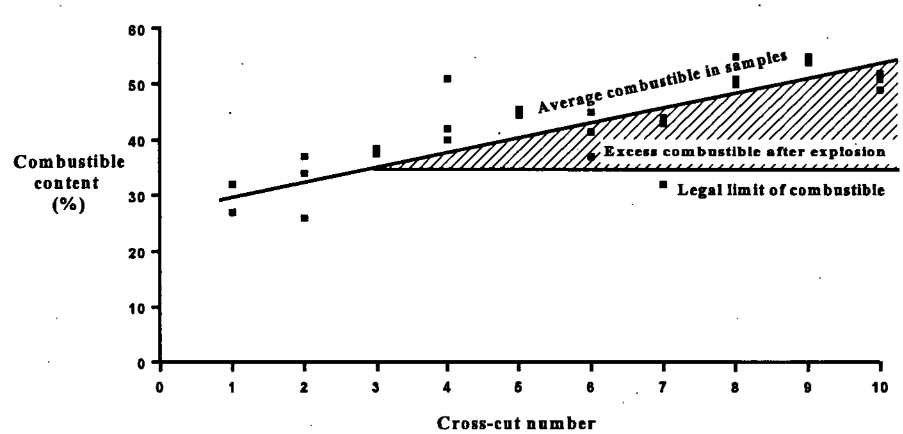
[80] Malcolm J. McPherson to Westray Mine Public Inquiry, 5 January 1996.

Figure 6.5 Analysis of Post-Explosion Dust Samples from the Southwest Section, Westray Mine



Source: From Exhibit 73.13 (second of two graphs).

Figure 6.6 Analysis of Post-Explosion Dust Samples from Cross-cuts between No. 1 and No. 2 Mains, Westray Mine



Source: From Exhibit 73.13 (first of two graphs).

context of mine fires and explosions.[81] This conclusion has been supported, and indeed strengthened, by later testimony and documentation.[82] A coal mine can be quite "forgiving" with respect to general housekeeping, stonedusting, and other aspects of safety, as long

81 Based on a review of the experts' reports as well as other pre-hearing readings.

82 Any repetition here of material covered in detail in the following chapters on ventilation and methane is for the reader's convenience.

as the ventilation system is properly planned, efficient for its purposes, and conscientiously maintained. Chapter 7, Ventilation, considering its length and detail, gives credence to this premise. This is not to say that the other aspects of safety are not important, but that coal mine ventilation is crucial in lessening or neutralizing many of the detrimental effects of the other factors.

We may conclude that there was a considerable degree of methane layering in the Southwest section of the Westray mine at the time leading up to the 9 May explosion.[83] Because methane, like the helium we use in balloons, is lighter than air,[84] it will tend to rise to the roof of mine openings once it has been liberated by the mining process or by fissures in the coal seams. With proper ventilation, the methane will be diluted by mixing with the main body of air; once mixed, it cannot segregate out again to form layering.[85] Without adequate ventilation, the methane will tend to accumulate on the roof in methane-air mixtures that may vary from almost pure methane (up to 100 per cent) to non-combustible quantities of less than 5 per cent. As the term implies, layering may also refer to the percentage of methane at any particular level near the roof of an opening. Methane content will likely be highest at the roof. Depending on ventilation conditions and the thickness of the methane layer, methane content may decrease with distance down from the roof. At some point, it will pass through its explosive zone (5–15 per cent). Then, as it gets closer to the airflow, the methane layer will be reduced to non-flammable levels of less than 5 per cent. Where the mine roof is uneven, particularly where overbreaks or cavities are created by roof falls, the methane may become trapped in the resulting cavities and remain undisturbed by the ventilating air passing through the mine roadway. This scenario is illustrated in figure 6.7.

How did methane accumulate in the roadways of the Southwest 2 section in quantities sufficient to create such a severe hazard? Much of the answer to this question is detailed in the following two chapters on ventilation and methane, but to complete our analysis of the explosion, some repetition is necessary here.

Methane is a natural component of coal, a by-product of the decomposition of the plant and animal matter from which coal is formed. In peat, an earlier stage of decomposition, the methane is popularly referred to as "swamp gas." Further into the earth, the decomposed material, which is now coal, has trapped within itself quantities of methane. When the coal is disturbed in its resting place of millions of years, this gas is emitted through the various seams and fractures. The coal acts as a sort of hard sponge that holds methane, which is released when

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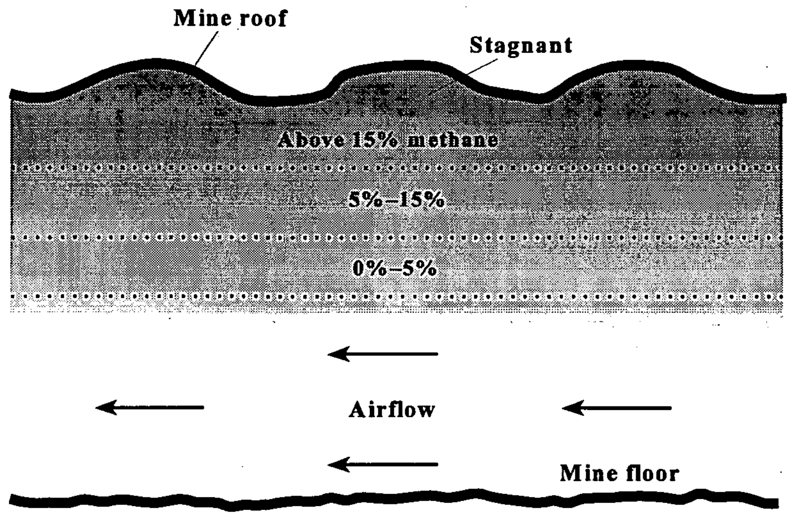
83 **Comment** Indeed, had there not been such methane layering in SW2-B Road, the explosion might not have occurred. The methane fire might never have passed out of SW2-B Road and propagated into a coal-dust explosion.

84 The specific gravity of methane is 0.554.

85 McPherson explains this phenomenon in his testimony (Hearing transcript, vol. 10, pp. 1796–97).

Figure 6.7 Methane Layering Near the Roof of a Coal Mine Opening



Source: Prepared by Malcolm J. McPherson for the Westray Mine Public Inquiry.

the coal is broken. Gas can escape from coal even after it has been cut from the mining face.

Methane can escape into the mining roadways in several ways:

- Gas is released in quantity as the cutting heads of the coal-cutting machines break the coal away from the face. This source probably produces the most methane.
- After the coal has been mined, the resulting disturbance will open fissures in the remaining coal through which methane will escape.[86] This seepage could go on for a considerable time, or until that coal is also mined.[87]
- Gas can seep into the active roadways of the mine from the abandoned or mined-out sections, depending on the effectiveness of the stoppings constructed at the entrances to those abandoned sections.

One of the principal functions of the ventilation system is to clear the methane at the working face of the mine (as the mining machines cut into the coal) and exhaust it out of the mine in non-explosive concentrations. It is clear that the Westray ventilation system was grossly inadequate for this task. It is also clear that the conditions in the mine were conducive to a coal-dust explosion. We will now discuss these two aspects of the explosion in greater detail.

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86 It is not uncommon to see methane bubbling up from the floor of the roadway or through the ribs.

87 At Jim Walter Resources, Inc. mines in Brookwood, Alabama, the methane is drained from the mined-out area (gob) for up to two years after mining has ceased.

The Exhaust System

There are two ways to move fresh air through a coal mine: the exhaust system and the forcing system. The names more or less describe their functions. With the exhaust system, a huge fan placed at the portal of the main return (exhaust) airway draws the air out of the mine, thus drawing fresh air in through the intake main. With the forcing system, the fan placed at the portal of the intake main blows or forces air into the intake main, through the mine, and out through the exhaust main to the surface. In both cases, depending on the efficiency and maintenance of the installation, fresh air enters the mine, travels through the working areas of the mine supplying breathable air to the miners, and carries off whatever impurities – such as methane, coal dust, diesel exhaust, and carbon dioxide – result from mining. The exhaust system was in use at the Westray mine. Apparently, Westray management chose to ignore the advice of the several consultants who had been engaged earlier to complete feasibility studies of the mine site. As noted by McPherson in his report to this Inquiry:

> All three feasibility studies[88] recommended a forcing system of main ventilation to be consistent with the locations of conveyors in return airways. It is unclear why Westray decided to ignore these recommendations and implemented an exhausting system.[89]

The exhaust system of mine ventilation, if properly planned, supervised, and maintained, can be effective.[90]

So far, we have discussed the main ventilation system. Wherever people are working beyond the main airflows, ventilating air must be brought to the working area by an auxiliary ventilation system. Here, section 71, paragraph 9(d) of the *Coal Mines Regulation Act* implies a mandated forcing system.[91] Westray, though, mainly used auxiliary fans in the exhaust mode. Therefore, the mine was technically in breach of the act from the outset – a fact that seemed to escape the attention of the various government agencies charged with regulating the mine, or one that they chose to ignore.[92]

As we shall see, the exhaust system of auxiliary ventilation has inherent difficulties, although it does have an advantage where a lot of dust is being created at the face. Indeed, for that reason, fire and explosions expert Don Mitchell said he would prefer the exhaust auxiliary

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88 Norwest Resource Consultants Ltd, "Pictou County Coal Project Feasibility Study," volume 2: Mining and Processing, report for Suncor Inc. (Calgary, 1986) (Exhibit 8, s. 13.3.1); Placer Development Limited, "Pictou Project Feasibility Study," volume 1: Geology, and volume 2: Mining (Vancouver, 1987) (Exhibit 10.2, p. 17); Kilborn Limited, "Technical and Cost Review of the Pictou County Coal Project," volume 1 of a feasibility study for Westray Coal Inc. (1989) (Exhibit 4, s. 3.5).

89 Exhibit 56.2, p. 8.

90 The four large underground coal mines at the Jim Walter Resources complex in Brookwood, Alabama, are all ventilated by the exhaust system.

91 "An auxiliary fan . . . shall be situated on the intake side and at least twenty feet out by the last open cross-cut or entrance to the place being ventilated."

92 Director of mine safety Claude White testified that his interpretation of the act "is that they [exhausting auxiliary fans] are permissible" (Hearing transcript, vol. 64, p. 14066).

system at the Westray mine.[93] One of the recognized problems associated with exhaust ventilation in room-and-pillar mining concerns the method of directing the air flow so that it clears the methane and the coal dust from the working face of the mine. To create sufficient turbulence at the face with the exhaust system, ventilation air must move as close to the face as possible. With exhaust ventilation, the fan draws the air into the ventilation duct rather than expelling the air as in the forcing system. Therefore, the intake end of the duct must be close to the face. With the system in use at Westray, it would be impossible, without some modification, to get the duct close enough to the face to create the required amount of turbulence to clear out the gas and dust. Photo 18 in Reference shows a remnant of the ducting in use. It illustrates the fact that such ducting would create an obstruction if it was hung too close to the working face of the mine.

One way of creating sufficient turbulence is to hang line brattice and direct the ventilating air to the face.[94] Trevor Eagles, the engineer in charge of ventilation at Westray, did not think that brattice was an effective response to the problems at Westray:

> [Y]ou would have needed probably three or four feet on either side of the miner as a minimum to keep him [the continuous miner operator] away from the brattice. . . . The other thing with the brattice is it has to be far enough from the face that allows you to get your [continuous] miner into the face to take the complete cut on the face, to advance your face. So your brattice would have stopped up to about 40 or 50 feet from the face to allow your miner to get in and line up properly to take his cut, which means you would have still needed something to generate some turbulence at the face.[95]

I do not wish to impugn Eagles's abilities in any way. He was a young, newly graduated engineer with no experience or training in the coal mining industry. Once hired, he was given no direction and left virtually on his own. It is more an indictment on the management at the Westray mine when I say that industry practice does not support Eagles's view. In fact, with exhaust ventilation in a room-and-pillar environment, it is essential to bring brattice curtains close to the working face without interfering with the operation of the continuous miner.[96]

Westray management ignored the advice of the experts in opting for the exhaust system of mine ventilation. It seemed to develop auxiliary ventilation on an ad hoc basis, without regard to the primary safety purpose of clearing methane from the working face. It is painfully clear from the testimony of miners, supervisors, mining engineers, and ventilation experts that the Westray ventilation system was deficient

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93 Hearing transcript, vol. 16, p. 2903.

94 Brattice cloth, heavy canvas-like material, usually flame resistant, is hung from the roof of the mine and temporarily deflects air currents to areas that are otherwise difficult to reach. The use of brattice is almost as old as coal mining itself – as various historical texts attest.

95 Hearing transcript, vol. 76, p. 16571.

96 See the section on methods of auxiliary ventilation in Chapter 7, Ventilation.

in several respects. First, there appears to have been no comprehensive ventilation plan for the mine, other than a one-page map.[97] Second, there is no indication that the Nova Scotia regulatory agencies – the Department of Natural Resources and the Department of Labour – had reviewed or approved any comprehensive ventilation plan, nor had the Westray engineer in charge of ventilation ever seen a detailed ventilation plan. Third, the maintenance of the ventilation system seemed to be ad hoc rather than consistent; for example, when the continuous miner was in danger of "gassing out"[98] from high methane concentrations, air was diverted from the roof bolter to the continuous miner as an emergency measure.[99] All of these general factors tended to create an environment in the Westray mine conducive to a less-than-efficient ventilation system. And this inefficient system, in turn, was ineffective in clearing the methane released during and after the mining process.

A comprehensive review of the mine ventilation at Westray is in Chapter 7, Ventilation. At this time, we will deal in summary fashion with those deficiencies in the ventilation system that may have directly contributed to that unsafe underground environment.

Methane Layering

Some additional factors aggravated the problem of methane layering in the Southwest 2 section. First, the exhaust ventilation system brought the air up SW1-C1 Road to SW1-3 Cross-cut, at which point the air was directed through the cross-cut to SW1-B Road. As will be seen in Chapter 7, Ventilation, this routing brought the intake air across the temporary stoppings that blocked access to the entire Southwest 1 section. Miners had recently been chased out of this Southwest 1 section by hazardous roof conditions, and the stoppings were not adequate to contain the methane being generated in the abandoned gob. This accumulation of methane was therefore released into the intake airflow being drawn past the two stoppings.[100] Second, the airflow was not sufficient to disperse the methane accumulations adequately into the air. This methane naturally found its way to the mine roof where it combined with the methane being liberated by mining in the Southwest 2 section. Third, the actual quantity of methane was increased by changes in barometric pressure, as described later in this chapter. This layering of the methane provided an even more robust fuel supply for the rolling methane fire and subsequent explosion.

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97 For example, the map in Exhibit 45.1.15 is entitled "Ventilation Survey, May 8, 1992."

98 "Gassing out" refers to the automatic shutdown of the continuous miner when the concentration of methane in the air reaches a preset limit. This is to prevent accidental ignition.

99 Testimony by Wyman Gosbee (Hearing transcript, vol. 25, pp. 5021–23) and Lenny Bonner (vol. 24, pp. 4785–86) refers to an incident in Southwest 2 on 7 and 8 May 1992. Don Dooley discusses the practice in general (vol. 36, pp. 7862–64).

100 Contrary to the provisions of the *Coal Mines Regulation Act*, RSNS 1989, s. 71(6).

Finding

Methane layering, the result of inadequate ventilation, was permitted to propagate, virtually undetected, throughout the Southwest 2 section. It provided a rich source of fuel for any ignition source to feed upon.

The Barometer

The barometer is an essential tool in the maintenance of a safe and effective ventilation system. According to the Devco training manual:

> A barometric pressure reading is made before entering the mine. The results of the reading are noted in the mine examiner's report and compared with the reading from the previous shift. Large or sudden changes in barometric pressure can have a profound effect on conditions underground.[101]

If the barometric pressure on the surface drops significantly, it will affect the underground mining environment. As the pressure on the roof, ribs, and roadway of the mine decreases, there is a likelihood that higher levels of methane will be liberated through whatever fractures, fissures, or crevices may exist. This increase may dictate change in ventilation, either by increasing air flow or by adjusting regulators, to ensure that the increased methane is dissipated safely. Of greater concern is the effect of the lowered barometric pressure on mine stoppings, especially temporary ones. In this circumstance, the accumulation of methane in the gob or other unworked or abandoned areas of the mine may bleed out through the stopping and add methane to the mine air. This is exactly what happened at the Westray mine during the early morning hours of 9 May 1992.

According to barometric pressure readings taken at the Environment Canada station at Caribou Point, Pictou County, the barometric pressure dropped 3.7 millibars during the 7 hours preceding the explosion.[102] McPherson calculated that this factor alone would add approximately 18 cubic feet per minute (cfm) of gas emission from the Southwest 1 section.[103] That section is the subject of considerable testimony because of the ineffectiveness of the plywood and plastic stopping erected inbye SW1-3 Cross-cut, which joined SW1-B Road and SW1-C1 Road. This additional quantity of methane would enter the main airflow, as described in Chapter 7, Ventilation, and be added to the methane layers in the roadways of the Southwest 2 section. Tom Smales, mining engineer and Inquiry consultant, said, "It's vital that the barometer should be examined

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101 Cape Breton Development Corporation, *Mine Examiner/Shotfirer Training Programme,* Module C/MO 4/3 (Sydney, NS: CBDC, 1987), p. 23.

102 Exhibit 37b.095, fax to Gerald Phillips dated 20 May 1992 from the Superintendent, Climate Services, Atlantic Region, Atmospheric Environment Services, Bedford, NS.

103 McPherson's calculations are explained in full in his report of 7 October 1995 (Exhibit 56.3), pp. 33–34. To put this in perspective, 18 cfm would be sufficient to fill the entire Southwest 2 section of the mine with 100 per cent methane in about three weeks; 18 cfm of methane would keep about 25 backyard barbecues going at maximum heat.

continuously."[104] The miner's perspective with respect to the importance of the barometer was expressed by Don Dooley as follows:

> [With a] dropping barometer, the gas is going to exhaust from the gob, from the actual working face, much more readily than a high barometer. The high barometer, the atmospheric pressure pushes that gas back in. So the barometer is very important.[105]

Trevor Eagles admitted quite candidly that he never saw a barometer at Westray and never realized the importance of having one. The only evidence of the presence of a barometer at the Westray mine came from miner John Lanceleve, who said he noticed one outbye No. 1 Cross-cut about three weeks before the explosion. He described it as "just a Canadian Tire, more or less, barometer," the same type as people had in their homes. He said he could tell "it was just put there because there was no dust or dirt on it."[106]

I am satisfied that, for most of the life of the Westray mine, there was no barometer on the premises. Even if one was placed near No. 1 Cross-cut, as suggested by Lanceleve, it was never used in a manner that would be effective in operating the mine ventilation system.

Finding

Westray mine management did not monitor the barometric pressure in any acceptable manner and neglected this significant factor in the maintenance of a safe and effective ventilation system.

The Water Gauge

Another essential piece of equipment for the maintenance of effective ventilation in the mine is the water gauge. Usually located inbye the main fan, the water gauge measures changes in the ventilating pressure in the mine. Changes in the ventilating pressure result from such circumstances as changes in fan speed, restrictions or obstructions in the airways, improperly set doors, improperly adjusted regulators, or airflow through the gob.[107] Any of these conditions may indicate that the ventilation system is not functioning properly, a problem that could result in insufficient fresh air getting to the various working faces in the mine. As well as causing a decrease in the availability of respirable air in the mine, a decrease in the airflow could increase the probability of methane layering at the roof. At Devco, it is the responsibility of the manager or the underground manager (at Westray, Gerald Phillips and Roger Parry, respectively) to "ensure that barometric pressure, temperature, water

[104] Hearing transcript, vol. 1, p. 75.

[105] Hearing transcript, vol. 36, p. 7784.

[106] Hearing transcript, vol. 27, pp. 5548–49.

[107] Cape Breton Development Corporation, *Underground Manager Training Programme,* Module C/MO 2/23 (1986), p. 47.

gauge, and humidity readings are taken each day at the mine."[108] It seems Phillips and Parry were either unaware of the importance of the water gauge or unconcerned about its absence at Westray.

Don Dooley was concerned about the absence of a water gauge at the mine. He had previous coal mining experience and was aware of the function of the water gauge. After having a consistent reading (commonly measured in inches) of the water gauge for several months, a change can indicate problems. As he explained:

> All of a sudden you go in there one morning and it's three inches. Well, there's something wrong with my ventilation. I've got a blockage here somewhere because it's [the fan] working too hard. . . . If it goes too low, I've got a short circuit in my ventilation. I'm losing my ventilation somewhere. Extremely important.[109]

Dooley went on to relate an incident with Parry concerning the location of the water gauge and the barometer. This exchange is interesting in that it shows the apathy – or incompetence – of the man who was the Westray boss underground:

> I asked Roger about both of them . . . "Where is my barometer; where is my water gauge?" I thought . . . maybe they did have one somewhere and I just wasn't privy to it. "We don't need those," he said, his exact words. "We don't need them."[110]

There was no water gauge at the Westray mine. It is obvious that the water gauge, if properly monitored and maintained, is a crucial instrument in determining the efficiency of the mine ventilation system. Without the water gauge, it would be almost impossible to get a daily assessment of the condition of the ventilation system – before entering the mine. Changes in the water gauge readings would give the underground manager or supervisor some indication of defects or radical changes in the ventilation system, which could affect the safety of the miners entering the mine. Such readings could give warning of recently occurring obstructions, such as roof falls, or problems with the fan itself, or evidence that regulators might have been left open and were short-circuiting the ventilation system. It is an extremely significant safety instrument.

Finding

Westray mine management failed to provide a water gauge to monitor the ventilation conditions of the mine from the surface and, as a result of this omission, deprived the mine workforce of another significant safety-monitoring device.

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108 Cape Breton Development Corporation, *Underground Manager Training Programme*, Module C/MO 2/23 (1986), p. 6.

109 Hearing transcript, vol. 36, pp. 7784–85.

110 Hearing transcript, vol. 36, p. 7785.

If one accepts the comments of Parry as related by Don Dooley, it is difficult to describe this attitude in terms other than "cavalier" or "foolhardy." Whatever adjective one chooses, this attitude falls far short of the kind of behaviour or demeanour that one would expect from an underground mine manager charged with the safety of the mine workforce. Although the absence of a water gauge may not have had a direct bearing on the mine explosion, it is symptomatic of the overall attitude of mine management towards mine safety at Westray.

Auxiliary Ventilation Ducting

It will become clear from the findings in the Ventilation chapter that the ducting used in the auxiliary ventilation system to provide air to the headings at Westray was inadequate. Taken alone, the ducting itself was too small.[111] The flexible ducting used at Westray had a higher resistance to airflow than rigid ducting and had a propensity to collapse and greatly reduce the airflow. I question the technical wisdom of using this sort of flexible ducting in an exhaust system of ventilation, for several reasons. First, during the mining process, it is impractical to locate the suction end of the duct close enough to the working face to clear the face of methane and dust; with the exhaust system, it is impossible to blow air onto the face. Second, even with properly sized ducting, the air surrounding the duct itself is largely undisturbed by the air moving into it. There might be quite acceptable duct systems in use; the one in place at Westray was not one of them.

The principal defect in Westray's auxiliary ventilation system that bore directly on the propagation of the explosion was its inability to produce air flows of sufficient velocity to disperse the layers of methane that accumulated along the roof in the Southwest 2 section. McPherson isolated three weaknesses in the auxiliary ventilation system that contributed to the lethal buildup of methane layering at the roof of the Southwest 2 section:

> In particular, the main weaknesses were ducting that was too small, air volume flows that were inadequate to produce the air velocities that would prevent methane layering, and the use of exhausting systems that would inhibit adequate mixing of methane with air at the face.[112]

Finding

The combination of poor ventilation pressure, small ducting, lack of bratticing, and deficient ventilation controls made it almost impossible to clear methane from the working faces of the mine. Together, they are a further indication of incompetence or negligence in the safety planning and administration of the Westray mine.

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111 Malcolm J. McPherson, Ventilation at the Westray Mine, report prepared for the Westray Mine Public Inquiry (1995), (Exhibit 56.3) p. 15.

112 McPherson, Ventilation, p. 15.

Management Response

It is obvious that a number of factors combined to create a hazardous environment underground – factors that bring up the entire issue of planning and management at the Westray mine. Interestingly, management dismissed these factors and preferred another explanation for the explosion, which is dealt with in the following section of this chapter, Methanometer Tampering.

The hearing transcripts are replete with references to the excessive coal dust in the mine. This subject will be covered more fully in other sections of this Report, and I will merely refer here to four incidents. First, on 29 April 1992, mine inspector Albert McLean, his supervisor Claude White, and mine inspector Fred Doucette went into the mine for an inspection. As a result, an order was issued by McLean and served on the company the following morning requiring that coal dust be cleaned up immediately. Although he returned to the mine on 6 May, McLean did not follow up on that order, indicating instead that he expected the order to be carried out according to the directives. Second, Eagles said that, during the period from 29 April to the explosion, "In the areas that I travelled, there were still significant amounts of coal dust in some of those areas."[113] Third, Dan MacIntosh, a reporter-cameraman with ATV (Atlantic Television network), went into the mine on 7 May 1992 to shoot some television pictures following the award of the John T. Ryan safety trophy to the company.[114] He entered the mine with a normal TV camera that had no special safety features.[115] He found walking difficult, because the dust was soft and up to his ankles. He noted that the dust was dark in colour.[116] Fourth, miner Lenny Bonner gave evidence that on 5 May he had a "run in" with Phillips following an earlier confrontation with Parry. He concluded not only that Phillips was aware of the excessive coal-dust situation but that management intended to deal with it by installing a sprinkler system.[117]

Finding

During the period leading up to 9 May 1992, there was excessive untreated coal dust in the mine. Little or no effort had been made either to clean up that dust or to render it inert by the addition of sufficient stonedust. Mine management was aware of this problem, but failed to respond to complaints by employees or to the orders of 29 April 1992 from the Department of Labour.

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113 Hearing transcript, vol. 76, p. 16640.

114 See Chapter 5, Working Conditions at Westray, for discussion of the award.

115 During my visit to the Skyline mine in Helper, Utah, I was directed to leave my flash camera on the surface, since it was prohibited in the mine. The RCMP, during its post-explosion investigation at Westray, used a camera in a scuba-diving (waterproof) case to avoid the possibility of sparking.

116 *R. v. Curragh et al.*, transcript, 15 February 1995, p. 339.

117 Hearing transcript, vol. 24, p. 4776.

During the course of the investigative and research phase of the Inquiry, I and the Inquiry staff were cognizant of the possibility that any number of mechanical defects could have caused or contributed to this disaster.[118] No evidence came to light of any inherent equipment faults, either mechanical or electrical, that could be reasonably considered in this context, nor did any documentation disclose any such fault.

The following commentary was prepared in direct response to certain explanations advanced over the past several years by Gerald Phillips and Clifford Frame. Neither of these key players in the Westray saga would come forward and give evidence at the Inquiry hearings. They instead chose the media in their various forms as their sounding board. That seemed to suit their particular purpose since such commentary is not subject to rigorous questioning or cross-examination, nor is it given under oath.

Methanometer Tampering

In his various comments reported in the media, Gerald Phillips seems consistently to blame the miners for the 9 May 1992 explosion.[119] In light of all of the evidence respecting the mis-management, neglect, and incompetence that seemed to plague Westray, this simplistic explanation proffered by Phillips can only be regarded as a defensive ploy to deflect attention away from the real causative factors. Unfortunately, this explanation was picked up by former premier Donald Cameron, as indicated in his statement: "The bottom line is that that mine blew up on that morning because of what was going on in there *at that time*. That's the bottom line."[120] I can only assume that Clifford Frame was referring to the same sort of conclusion when he said that the explosion was a "simple accident."[121] After hearing all the evidence and having that evidence analysed and studied by several mining experts, we are now able to label these explanations for what they really are – self-serving, cynical, and simplistic.

It is abundantly clear – from Chapters 7, 8, and 9, Ventilation, Methane, and Dust – that ventilation in the Westray mine was woefully deficient in almost every respect. The airflow was inadequate for the purpose of clearing methane from the working face during mining and

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118 During the hearings, it came to our attention that certain manufacturer's modifications had been made to the Fletcher roof bolter in order to reduce the incidence of sparking as the nut was tightened onto the steel roof plate. I thought it prudent to follow up on this information, even though it was merely a suggestion that came to our attention. We determined that the modification consisted of a vinyl washer placed on the roof bolt as the nut was tightened against the plate. In consultation with Tom Kessler, superintendent of the National Mine Health and Safety Academy, Beckley, West Virginia, and one of his consulting staff, I was informed that such a modification had indeed been made, but for a different purpose. The addition of the vinyl washer in the bolting process was prompted by a need to increase the torque on the bolt, and not by any sparking problem at the mine roof during the bolting process.

119 See, for example, the story in the Halifax *Chronicle-Herald*, 19 April 1996.

120 Hearing transcript, vol. 66, p. 14432. Emphasis added.

121 *Globe and Mail*, 17 February 1997.

preventing the layering of methane on the roof. As the coal was cut from the face by the continuous miner, the methane being released simply eddied about the face and rose to the roof to join with the existing methane layer.[122]

I don't dispute the many dangerous and foolhardy practices of the miners in the days immediately preceding 9 May 1992. There is a question, though, raised by the statements of Phillips, Cameron, and Frame: Had it not been for these practices, would the explosion of 9 May have occurred? The answer, based on the evidence and the careful analysis of the several experts, must be Yes, it would have. The consensus of the experts suggests strongly that Westray was an accident waiting to happen. Only the extent and the seriousness of that accident could not be predicted with accuracy.

Cameron was particularly adamant in his testimony that an incident of tampering with the methanometer on the continuous miner in the SW2-1 heading was a "pretty important [item] of why that explosion took place on that night."[123] Let us look briefly at the evidence concerning the activities in the Southwest 2 section, particularly with respect to the operations of the continuous miner during the last days of Westray.

According to underground mechanic Wayne Cheverie, the methanometer on the continuous miner in the Southwest 2 section had been not functioning for the entire night shift of 7 May.[124] He was told this by Mick Franks, the electrician who also said that he had not been permitted to take the machine out of production to repair it at the time that the methanometer had stopped working during the 7 May day shift. According to Cheverie, Franks "seemed quite upset that the continuous miner working in our section was cutting coal with no methanometer working on it." Franks had been told that the methanometer would be repaired on the night shift, but it had not been. As a result, this continuous miner in the Southwest 2 section operated for the entire night shift of 7 May without the methanometer. According to continuous miner operator Buddy Robinson, the "sniffer" on the methanometer was disconnected on the instructions of foreman Arnie Smith after it malfunctioned, and Robinson operated the machine for the shift using a hand-held methanometer. Robinson would check as close to the face as he could get with the methanometer after loading each shuttle car, which took about 10 seconds. He would get out of the cab of the continuous miner and check for gas. "But every time . . . the readings weren't what I would cut coal in," Robinson testified, "so I would have to wait until the gas dissipated." Robinson said that this was something that he had done in other mines: "[I]t wasn't something you would do every day. It wasn't

122 This is simplified here, but the subject is carefully detailed in the chapters referred to.

123 Hearing transcript, vol. 66, pp. 14428–29.

124 Hearing transcript, vol. 21, p. 4014.

common practice, but it wasn't something that you wouldn't do until parts were forthcoming and it was fixed."[125]

Apparently, the methanometer on the continuous miner was repaired by Franks on 8 May. The notation on Cheverie's tradesmen report for 8 May says "C/M 2002, helped electrician install new cable for sniffer. At the same time we had side & top covers off so I cleaned out and tightened loose hydraulic fittings."[126] According to Mick Franks, Myles Gillis, the night shift electrician, had brought the repair materials into the mine on the previous night intending to fix the methanometer and had left them by the switchgear in SW2-A Road near SW2-2 Cross-cut. After looking at Gillis's report and noting that "he wasn't that busy," Franks speculated that "they just wouldn't have allowed Myles to fix it the night before."[127] Franks said he repaired the methanometer by installing a new hose and cable to the sniffer. Franks did not have the gear to calibrate the methanometer properly, so he got Arnie Smith to check it against his hand-held methanometer: "[H]e checked . . . what was at the head, and it was 0.4 and it matched up . . . with the methanometer right there." Franks also said that Smith pushed the readout button and it flashed a warning light at 1 per cent and shut down at 1.2 per cent. At that point, Smith suggested that Franks adjust the methanometer to shut down at 1.5 rather than at 1.2 per cent:

> And Arnie said words to the effect of "I thought we were supposed to be turning these things up to 1.5," which is what I'd heard had been taking place. So I said, "Well I never really heard about that, Arnie," I said, "but, you know, I don't really want to do it, and besides it would take time. I don't want to be screwing around with it." . . . I don't think it was a real good idea to start turning up the set point on them. So he said, well, if I just turned the reading down a bit, it would be the same thing. I said, "It wouldn't be the same thing, Arnie." I said, "Whatever you figure, buddy, but just leave me out of it." And he took my screwdriver out of my top pocket – a little screwdriver, and he went to the back and turned down the set point. To my knowledge, he turned down the set point. So Wayne and I were putting the plates on the machine at this time.[128]

When Franks left the mine at the end of his shift on 8 May, "it [the methanometer] was still at 1.2 per cent. It was set to trip at 1.2 per cent, but the readings could have been anywhere after it had been tampered with. . . . I would say maybe 1.7 . . . I don't know. I'm no expert."[129]

John Bossert, the Inquiry's equipment and materials expert, gave evidence as to the effect of tampering with a machine-mounted methanometer in the manner described. Bossert said that the methane monitor from the continuous miner had been sent to the CANMET

125 Hearing transcript, vol. 30, pp. 6392–94.

126 Exhibit 75.3.3.

127 Hearing transcript, vol. 21, pp. 4182–83.

128 Hearing transcript, vol. 21, pp. 4184–86.

129 Hearing transcript, vol. 21, p. 4192.

Canadian Explosive Atmospheres Laboratory in Ottawa, which confirmed that the setting was 1.5 per cent. Bossert went on to say:

> There was another test done by Lobay and Dainty [CANMET laboratory personnel] to see whether the calibration of the instrument could be altered by adjusting the span adjustment. This is another adjustment accessible by removing this cover and they found that, yes, indeed, it could be. In fact, they were able to adjust it so that it wouldn't alarm until something like three and a half percent instead of one and a half. So not only was the higher level cutoff set, but it was possible if someone had the ingenuity to fiddle with the controls and make it read much lower that it should have
>
> . . .
>
> [T]hey were unable to determine whether the sensitivity had been adjusted because they did not have the original sensing heads from the machine. The RCMP removed the instrument but not the sensing heads. When they hooked up another sensing head, they did find, indeed, it was set. It was desensitized. There are variations between sensing heads, so that's not proof that it was set that way.[130]

None of this is in any way conclusive as to the effect of the tampering by Arnie Smith, or even if the methanometer was returned to its proper setting during the fateful night shift that ended early in the morning of 9 May. We do know that Myles Gillis was the electrician for that shift and we do know that Gillis had been ordered to adjust the methanometer (by raising the trip point) to 1.5 per cent on 5 May.[131] We also know that Gillis was anxious to repair the methanometer on 8 May, since he had brought the repair materials in with him that night, but, according to Mick Franks, he was not allowed to shut the continuous miner down for repairs: "I knew he intended to fix it, you know, and given the way Myles was, I knew he would have fixed it if he got the chance."[132] We also know that Gillis complained vehemently to safety officer Randy Facette when he heard rumours that they were going to turn up the set point to 2 per cent. Given all this, it is probable that Gillis would not have returned the methanometer to the 1.5 per cent setting unless he had been ordered to do so. We will never know that.

The fact remains that, after the methanometer was repaired by Franks on 8 May, it was not properly calibrated but only matched up to the 0.4 per cent reading on the hand-held methanometer. The only definitive conclusion is that the methanometer on continuous miner 2002 was not accurate, and it could not be set accurately without the proper gas sample for testing. Bossert has said that the worst case scenario, based on the evidence, is that the tolerance level of the methanometer on the continuous miner could increase to about 2.5 per cent. This would result from resetting the gauge from 1.2 per cent to 1.5 per cent, to which would be added the maximum of 1 per cent from the span adjustment. He

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130 Hearing transcript, vol. 12, pp. 2209–10.

131 Mick Franks, Hearing transcript, vol. 21, pp. 4189–90.

132 Hearing transcript, vol. 21, p. 4183.

also suggested that, since the lower level of flammability of methane is 5 per cent, there would remain a safety margin of 100 per cent (2.5 percentage points).[133] Even if that safety factor had been further eroded by a higher setting on the methanometer, if such was possible, it could not have had such a devastating result without the dismally inadequate ventilation system and the accumulation of untreated coal dust.

What does this mean in our examination of the cause of the explosion that took the lives of 26 men? Did the methanometer tampering by Arnie Smith, as foolhardy and as dangerous as that was, cause the explosion? Let us review the salient facts.

It is clear that the continuous miner in the SW2-1 headings had been gassing out on a regular basis, but in spite of this there was a reluctance to take the machine out of service for repairs. There is clear and unequivocal testimony from the experts that the ventilation system in the mine was inadequate, especially for clearing away the methane at the working face. It was this defect, combined with the apparent obstinate reluctance of management to do anything about it, that was causing the gassing out. To reduce the incidence of gassing out and losing production time, an underground supervisor, probably out of frustration, unwisely and foolishly tampered with the methanometer.

Had the ventilation system been in any way adequate, he would have had no reason to resort to such perilous tactics:

- With an adequate ventilation system, the methane at the working face would have been mixed into the air to a safe level and exhausted in the normal course.
- With an adequate ventilation system, there could not have been a build up or layering of methane along the roof of the mine, since that methane would also be mixed into the air and exhausted.
- With an adequate ventilation system, any methane fire caused by sparking during the coal cutting process would have been localized, and even if a large gush of methane were involved, its effect would probably remain confined to the working face.[134]
- Even if a methane fire did occur in the Southwest 2 section, with proper housekeeping procedures such as the removal of coal dust and stone dusting as required by the *Coal Mines Regulation Act*, the fire could not have propagated into a methane explosion followed by a coal-dust explosion sweeping through the entire mine.

For these reasons it is deceptive, simplistic, and disingenuous to suggest that tampering with the methanometer on the continuous miner, as foolhardy as it may have been, could be the sole cause of the explosion

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133 Conversation on 26 February 1997, followed by a confirmatory letter of the same date.

134 Many studies and reports give examples of such methane fires, which burn themselves out with little or no damage or injury.

on 9 May 1992.[135] This, in my view, is a complete answer to the cynical comments of Phillips as reported in the media and picked up by Messrs Cameron and Frame.

Finding

The evidence indicates that there was tampering with the methanometer on the continuous miner in the Southwest section. The evidence does not support a finding that this tampering in any way caused the explosion.

Conclusion

It is unfortunate that we are unable to state with complete certainty what caused the death of those 26 miners in the early morning hours of 9 May 1992. Failing that, we must analyse the known facts, and the opinions based on those facts, and arrive at the most probable cause of death. To support these findings, we relied on the anecdotal evidence of the miners and the mine rescuers, the photographic evidence gained as a result of the RCMP investigations, and the opinions, based on this evidence, of the several experts. The opinion evidence of Andrew Liney, Don Mitchell, and Malcolm McPherson, although not always in agreement on every issue, leads to the conclusion that the miners in the Southwest 2 section were overcome by carbon monoxide and died almost immediately. This conclusion is consistent with an intense methane fire that consumed all the oxygen, producing carbon monoxide among other products of combustion. It is also consistent with the findings of the chief medical examiner as set out above. The miners in the North mains and the Southwest sections most probably died of a combination of carbon monoxide poisoning and severe bodily injuries. They would have died instantaneously. This is consistent with a coal-dust explosion and the severe physical force exerted by the shock wave preceding the actual coal-dust conflagration.

In other chapters of this Report, we examine in considerable detail the workings of the mine and the planning of those workings; the geological structures and the impact those structures had on mine planning and safety; the operation, planning, financing, and management of the mine; daily working conditions in the Westray mine during its short lifespan; and the conduct and attitudes of the several government departments, and their officials, that had statutory responsibilities for various aspects of the Westray mine. As I suggested at the beginning of this chapter, these examinations have been made to answer the question of why 26 men died

[135] **Comment** Donald Cameron, having no expertise in coal mining equipment, cannot be faulted for accepting the opinion of the mine general manager. What he can be faulted for is obstinately maintaining and defending that opinion in the face of overwhelming evidence to the contrary.

on 9 May 1992. It will become further evident during the ensuing examination why the Westray story was a predictable path to disaster.

Finally, the Report contains recommendations for avoiding similar tragedies in the future. Since workplace safety transcends the underground coal mining environment, many of the recommendations and suggestions will have general application in the workplace. Sadly, I have come to the conclusion that many workplace safety programs are disaster driven. Perhaps it is an opportune time for the three interested parties – owner, worker, and regulator – to move beyond a "reactive" mentality towards an anticipatory approach and to forestall such predictable events. This will be addressed at greater length elsewhere in this Report.

7 Ventilation

To inquire into . . .

(d) whether there was any defect in or about the Mine or the modes of working the Mine;

(f) whether there was compliance with applicable statutes, regulations, orders, rules, or directions

The ventilation system of any underground mine is an arterial network of interconnected roadways that are also used as transportation routes for personnel and vehicles and the products of mining. Fresh air is drawn from the surface atmosphere. As the air passes through the underground passages, its quality deteriorates as a result of pollutants produced from the strata and from the effects of machines and mining procedures. The contaminated air is returned to the surface, where it is rejected to the outside atmosphere.

A mine ventilation system has to deal with both gaseous and particulate (dust) pollutants. All mines produce dusts that may lead to long-term health problems for mine workers. Many mines are subject to emissions of gases from the strata. Diesel equipment, increasingly used in underground mines, produces a variety of gases and other emissions that can have adverse physiological effects. Some mines require temperature and humidity to be controlled so that personnel may perform their duties safely and without undue discomfort. *The primary objective of any mine ventilation system is to provide breathable airflows in sufficient quantity and quality to dilute airborne pollutants to safe concentrations in all areas where personnel are required to work or travel.*

Methane is the most prevalent strata gas in underground coal mines. Although non-toxic, methane is hazardous because of its flammability. It will explode when in concentrations of between 5 and about 15 per cent by volume in air, and it reaches maximum explosibility at about 9.6 per cent. The gas is emitted from the coal seams and, sometimes, adjacent strata when those formations are disturbed by mining activities.

The second most dangerous pollutant routinely present in coal mines is coal dust. When exposed to significant concentrations of such dust over a number of years, miners may develop coal workers' pneumoconiosis, known also as black lung disease, a debilitating reduction in lung function that can lead to serious heart disorders. Coal dust, like most finely divided organic materials, is also explosive when suspended in air.

Protection of the health and safety of personnel is at the foundation of mining legislation in all jurisdictions that have such laws. Additionally, experience, prudent regard for safety, and the need to safeguard the continuity of mineral production have resulted in guidelines and procedures for designing, planning, and maintaining effective systems of mine ventilation.

Ventilation in Underground Coal Mines[1]

Every underground mine has at least two systems of ventilation. The first, made up of the *main* structure, consists of a network of interconnected airways (also known as entries or openings) along which passes the throughflow ventilation. The movement of air is maintained by the main fan (or fans) and any booster fans that may be used to help promote that airflow.[2] As mining advances into previously unworked areas, there will inevitably be blind headings that cannot be part of the main throughflow system. Ventilation of those headings is accomplished by the second system – local, or *auxiliary*, ventilation.

The Structure of a Mine Ventilation System

Air enters the mine ventilation system by being drawn from the surface atmosphere into one or more vertical shafts, slopes, or level adits. The air flows through passages known as *intake* airways until it reaches the active work areas where the mineral is being mined. This is where most of the airborne contaminants are added. The air then proceeds along *return* airways until it re-enters the surface atmosphere.

Main Forcing and Main Exhaust Systems

In the vast majority of modern mines, the movement of air through the ventilation system is maintained by one or more main fans. In Nova Scotia, as in most jurisdictions, legislation requires that the main fans at coal mines be located on the surface.[3] This requirement is a precaution against damage to those fans in the event of an underground emergency condition. The main fans may blow air into the intake airway to form a *main forcing* (or blowing) system, or they may draw air from the return airway to form a *main exhaust* system. The two systems are illustrated in figure 7.1.

Larger mines may be equipped with main fans at more than one surface connection and operating in either the forcing or the exhaust mode. In a few mines, both forcing and exhaust fans may be used to provide a "push-pull" system.

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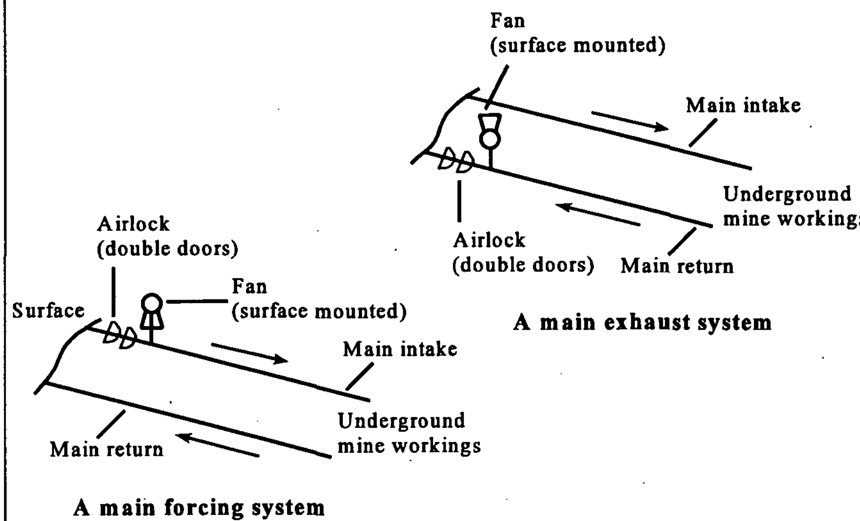
1 The Inquiry is indebted to Dr Malcolm J. McPherson, mining engineer and coal mine ventilation expert, for his assistance and advice in the preparation of Chapters 7, 8, and 9 of this Report relating to ventilation, methane, and coal dust. His testimony at the hearings, as well as his review and interpretation of other evidence, has been essential to an understanding of the complex interrelationships among these factors and the way they contributed to creating the explosive environment that led to the disaster of 9 May 1992. A more technical treatment of these subjects is found in McPherson's book *Subsurface Ventilation and Environmental Engineering* (London: Chapman and Hall, 1993) and in the papers he prepared for the Inquiry.

2 There were no booster fans in the Westray mine. In the United States, there is a general prohibition on the use of booster fans. (The United States seems to regard the requirement for booster fans as evidence of poor ventilation planning.) The booster fan is quite acceptable in many UK and other European mines, however, probably because these are older mines that have extended their mining areas beyond the capacities of the original main fans.

3 *Coal Mines Regulation Act*, RSNS 1989, c. 73, s. 71(3).

Figure 7.1 Main Ventilation for Underground Mines



Source: Prepared by Malcolm J. McPherson for the Westray Mine Public Inquiry.

A main exhaust system is the more common ventilation design in coal mines. This system allows intake airways to remain unencumbered by airlocks or ventilation control doors, thus facilitating transportation along the intake routes. More importantly, however, should a main exhaust fan stop, the atmospheric (barometric) pressure will rise throughout the mine and temporarily inhibit the release of gases from old workings or other zones where such gases may have collected. It is inadvisable to design a system in which belt conveyors pass through airlocks, because increased leakage and dust dissemination occur at such points. Where there is good reason to locate belt conveyors in return airways, a main forcing system may be preferred to a main exhaust one.

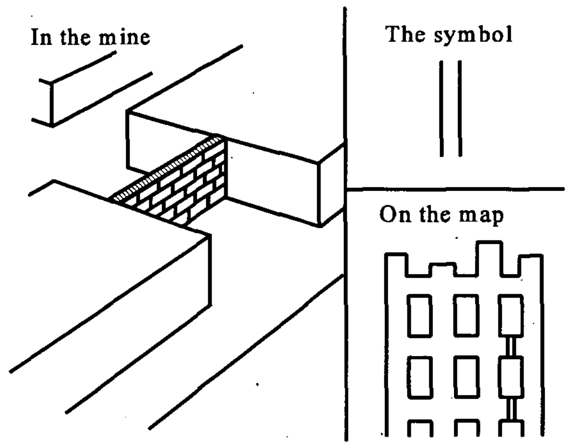
Ventilation Controls

As mine workings are developed – and to alleviate the need for excessively long blind headings (open at one end only) – connections known as *cross-cuts* are driven between intake and return airways. Cross-cuts allow the main ventilation system to advance. However, they must subsequently be blocked by *stoppings* built of masonry, concrete, or other substantial material in order to prevent excessive leakage from the intake to the return airways.[4] Access between intakes and returns must still be provided at strategic points, where the stoppings are equipped with *ventilation doors*. Ventilation doors vary in size from about 0.6 m² for personnel access to doors large enough to allow vehicles to pass through. For vehicles, Nova Scotia law requires that two doors be used so that at least one remains closed while vehicles are passing through.[5] The two-

4 *Coal Mines Regulation Act*, s. 71(11). See figures 7.2 and 7.3 for illustrations of stoppings.

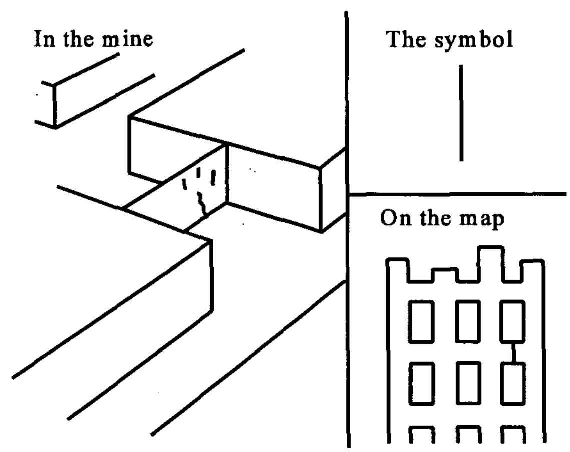
5 *Coal Mines Regulation Act*, s. 71(12).

Figure 7.2 Permanent Stopping



Source: United States, Department of Labor, Mine Safety and Health Administration, *Mine Ventilation*, Safety Manual No. 20 (Washington, DC: MSHA, 1991).

Figure 7.3 Temporary Stopping

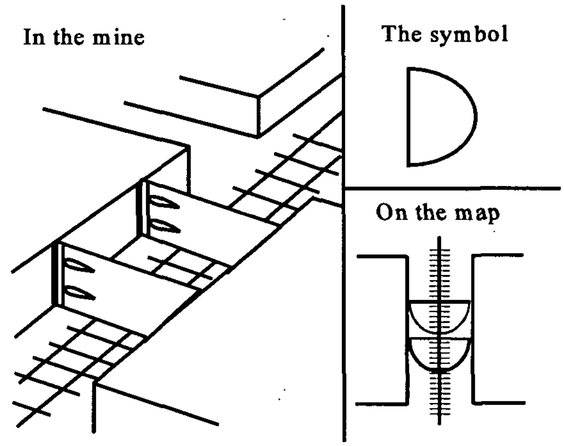


Source: United States, Department of Labor, Mine Safety and Health Administration, *Mine Ventilation*, Safety Manual No. 20 (Washington, DC: MSHA, 1991).

door arrangement is known as an *airlock* (see figure 7.4). All doors should remain closed except when they are used for access, because short-circuiting of the air can result in insufficient airflows to the areas of active mining. It is crucial that this requirement be observed at access points between a main intake and an adjoining main return.

If the air were allowed to flow freely between the sections of a mine, some sections would receive excessive airflows while other sections, more distant from the surface, could suffer from insufficient ventilation. It is therefore necessary to balance the airflows to their required values by

Figure 7.4 Mine Doors Forming an Airlock



Source: United States Department of Labor, Mine Safety and Health Administration, *Mine Ventilation*, Safety Manual No. 20 (Washington, DC: MSHA, 1991).

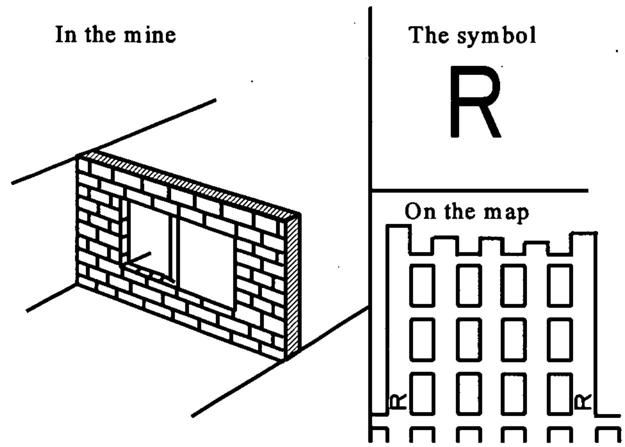
deliberately placing an obstruction within the air courses (intakes or returns) of the otherwise overventilated sections. Such a deliberate obstruction normally takes the form of a ventilation door with an adjustable rectangular opening cut into it. Sliding panels partially cover the opening and are used to regulate the airflow down to the required value. These devices are known as *regulators* (see figure 7.5).

Where the layout of the mine requires intake and return airways to cross each other, steps must be taken to prevent direct short-circuiting of the ventilation at the intersection. The most common way to construct an *air crossing*, or overcast, is to excavate additional material from the roof or floor of the entries and to build a horizontal platform across the intersection to separate the two airways. That platform may take the form of girders with concrete slabs cemented into place. Additional sealant material may be added to the intake side to minimize leakage. For less substantial types of air crossings, air ducts or metal sheeting may be used to separate the two airstreams (see figure 7.6).

Methods of Auxiliary Ventilation

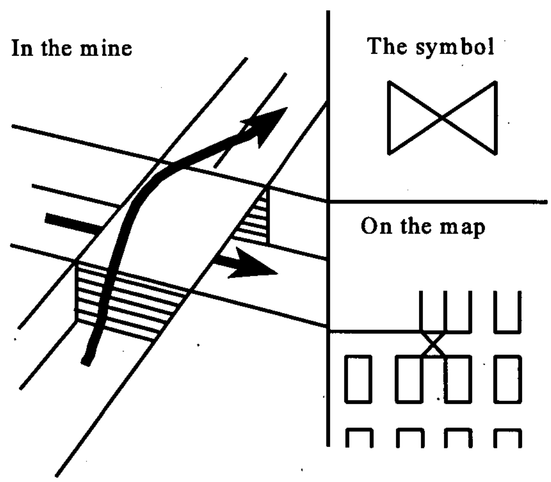
In addition to the mine ventilation system through which airflow is induced by the main fan(s), there may be headings or rooms open at one end only. These cannot be ventilated as part of the main throughflow system, so ventilation can be accomplished only through a local, or *auxiliary*, method. In particular, the room-and-pillar method of mining requires many such headings. Because the major emissions of gas and dust occur at the advancing ends, or faces, of those headings, it is particularly important that the airflows available at the faces are sufficient to remove pollutants safely and efficiently, ensuring that legal limits of their concentrations are not exceeded.

Figure 7.5 Regulator



Source: United States Department of Labor, Mine Safety and Health Administration, *Mine Ventilation*, Safety Manual No. 20 (Washington, DC: MSHA, 1991).

Figure 7.6 Air Crossing (Overcast)

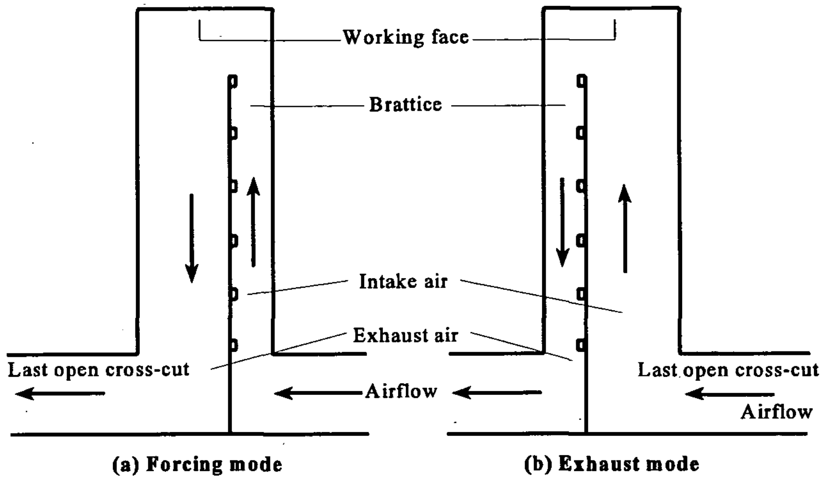


Source: United States, Department of Labor, Mine Safety and Health Administration, *Mine Ventilation*, Safety Manual No. 20 (Washington, DC: MSHA, 1991).

Two methods of auxiliary ventilation are widely practised: the line brattice method, and the auxiliary fan-and-duct method.

The *line brattice* method is favoured in the United States. The principle is illustrated in figure 7.7. In this method, brattice cloth, a heavy woven fabric coated in flame-resistant plastic, is used as a local and temporary means of controlling airflows in underground mines. A continuous line, or curtain, of brattice cloth, reaching from floor to roof along the heading, extends across the last open cross-cut, allowing the airflow to be diverted towards the face of the heading. In the forcing mode,

Figure: 7.7 The Line Brattice Method of Auxiliary Ventilation



Source: Malcolm J. McPherson, *Subsurface Ventilation and Environmental Engineering* (London: Chapman & Hall, 1993), 114.

illustrated in figure 7.7, the line brattice is located so that the corridor carrying air towards the face is narrower than the return path. (Typically, the brattice is placed about one-quarter of the width of the heading from the rib.) The air thus passes relatively quickly to the face. The return path is used for access of personnel and equipment, while the narrower intake passage is only for ventilation. The opposite effect occurs in the *exhaust* mode (figure 7.7). Line brattice can be used with the kind of continuous miner used at the Westray Mine. With an extendable curtain, the airflow can be concentrated to within 2 m of the working face.[6]

The advantages of the line brattice method are:

- It uses the main ventilation system of the mine and, hence, the main fans. It follows that auxiliary ventilation will be maintained as long as the main ventilation structure is operational and the line brattice remains in place.
- It does not require local fans.
- It does not impede access for moving equipment, allowing adequate headroom.
- Vehicular access along the last open cross-cut is facilitated by overlapping sheets of brattice cloth. A vehicle will push aside the cloth, which falls back into place once the vehicle has passed through.
- Capital costs are low in the short term.
- Line brattice requires no power and emits no noise.

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[6] This type of installation is used by Jim Walter Resources, Inc. in Brookwood, Alabama, to ventilate the mine face while driving entries on either side of the longwall panel. It is also used in the exhaust mode.

The disadvantages of the line brattice method are:

- One of the ribs in the heading is hidden from view. The narrower passage can become obstructed by debris that has sloughed from the rib, or even by materials stacked in that inappropriate location.
- Vision is restricted in the last open cross-cut, producing a potential hazard for moving vehicles.
- The ventilating efficiency of the system is low. A significant fraction of the air (usually the majority) will leak across the curtain before reaching the face. The section of brattice in the last open cross-cut often fails to fall back into place after it has been disturbed by vehicles or personnel.
- Line brattices in high workings are more difficult to erect and maintain. The larger surface area is subjected to greater force arising from the air pressure differential across it.
- The additional resistance offered by the line brattice increases the pressure differentials across stoppings and other ventilation controls all the way back to the main fan(s). This causes additional leakage at those points and greater power costs for operating the main fans.

In the *fan-and-duct* system of auxiliary ventilation, the method used at Westray, a fan is located in-line with lengths of ducting. The principle is shown in figure 7.8. In the design of such a system, it is important that the fan-duct combination is able to provide the required airflow at the face of the heading. The resistance offered by the ducting depends upon its length, size, type, and restrictions or shock losses caused by bends, fittings, and configuration of entry and exit. Here again, the technique can be used in either forcing or exhaust mode. In the former, the fan and entrance to the duct are located in the last open cross-cut, upstream from the heading. The relatively fresh air passes through the duct to emerge within the heading with sufficient momentum to project it as a jet further towards the face. The forcing mode ensures the duct is under positive gauge pressure; thus, an unreinforced type of flexible ducting may be used. This type of ducting is less expensive and easier to transport than other varieties.

In the exhaust mode, the fan is located in the last open cross-cut, downstream from the heading.[7] The fresh air is drawn up the main body of the heading and returns through the duct. In this case, the air in the duct is at negative gauge pressure, causing suction. Therefore, the ducting must either be constructed from a rigid material (fibreglass or steel) or, if it is flexible, be reinforced against inward collapse. Internal steel spirals normally provide the reinforcement.

In both forcing and exhaust modes, the ducting should be hung close to the roof and, if the roof is laterally inclined, at the higher side. This placement reduces obstruction to equipment and helps prevent methane layering at the face end of gassy headings.

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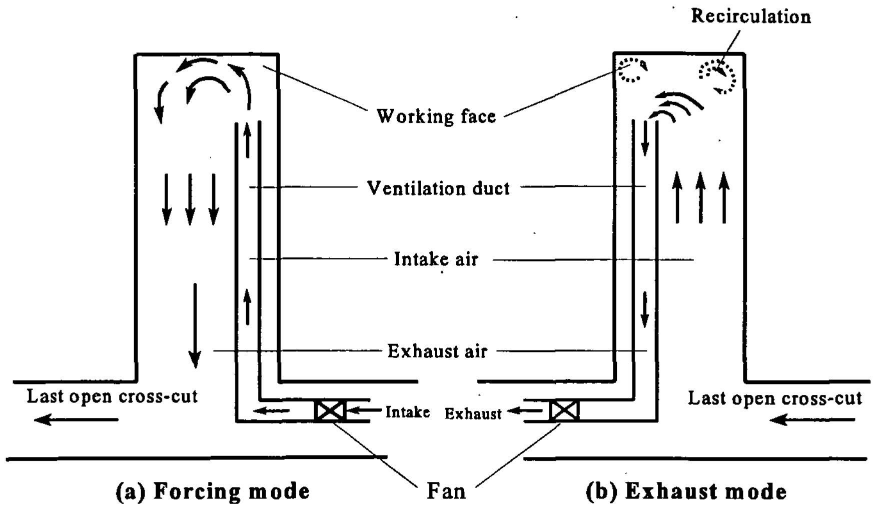
7 This is the system principally used at Westray.

Figure 7.8 The Fan-and-Duct Method of Auxiliary Ventilation



Source: Malcolm J. McPherson, *Subsurface Ventilation and Environmental Engineering* (London: Chapman & Hall, 1993), 115.

The advantages of the fan-and-duct method are:

- It provides a positive and more controllable method of providing airflow to a heading than does the line brattice method. (Line brattice is passive in that it deflects the existing airflow.)
- The velocity of air emerging from the duct in the forcing mode is considerably higher than in the corresponding line brattice application. The jet's longer reach provides improved airflow at the working face.
- Ducting is less liable to leakage than is line brattice.
- Visibility is improved, both within the heading and in the last open cross-cut.
- It causes no additional resistance to the main ventilation system of the mine, thus reducing pressure differentials and leakage across outbye stoppings or doors.
- In the exhaust mode, the momentum of the air emerging from the fan into the last open cross-cut produces a small ventilating pressure, which helps to promote airflow through the main ventilation structure.[8]
- Filters can be located within the ducting to remove dust from the air. Cooling units can similarly be employed in hot mines.
- For headings longer than about 30 m, the fan-and-duct system is the only technique that will provide acceptable airflows to the face area.

The disadvantages of the fan-and-duct method are:

- Fans are noisy.

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8 Note that, in poorly designed layouts, particularly where entries are large, the resulting turbulence can cause undesirable recirculation. This phenomenon occurred at the Westray mine, as will become clear later in this chapter.

- Electrical power is required at the fans.
- Capital costs for auxiliary fans will be incurred as well as the operational expenses of ducting and maintenance.
- Headroom for the passage of vehicles is reduced even with the flatter elliptical ducting. This disadvantage may preclude the use of any ducting when thinner seams are mined.
- Ventilation in the heading is lost when the fan is switched off or loses power.
- Both the electric motors and the high-speed impellers of auxiliary fans may produce sparking in a potentially gassy atmosphere.

If partial recirculation of air through the ducting is to be avoided, the auxiliary fan must pass a volume of air less than that available in the last open cross-cut. Section 71(9c) of the *Coal Mines Regulation Act* requires that the auxiliary fan take no more than 40 per cent of the air passing the fan. A properly designed and monitored system of controlled partial recirculation can improve the mixing and dilution of gases and reduce airborne dust concentrations, but the regulations of most coal mining jurisdictions do not allow the technique because of the fear of its being misapplied. Some jurisdictions, however, grant special permission case-by-case.

Modes of Auxiliary Ventilation

As illustrated in figures 7.7 and 7.8, both the line brattice and the fan-and-duct methods can be used in either forcing or exhaust modes, but there is an essential difference. In the forcing mode, the fresher air is transported and delivered relatively rapidly to the face area, while the return air progresses relatively slowly back along the main body of the heading where the equipment and personnel are located. Conversely, in the exhaust mode, fresher air passes through the main body of the heading, while the polluted air is drawn into the exhaust duct or behind the return brattice.

In specific cases, arguments can be made for either system. The preferred mode depends largely on the pollutant of greatest concern: gas, dust, or heat. In gassy headings, the scouring effect of an air jet issuing from a forcing duct can assist greatly in mixing and diluting gas emitted at the face (figure 7.8a). The same effect is observed, although to a lesser extent, in a forcing line-brattice system. Current Nova Scotia regulations mandate that when an auxiliary fan is used, it must be in the forcing mode.[9] In an exhaust system, no such air jet is available to flush the face. The air is drawn directly into the duct or into the narrower passage behind the brattice, leaving local and sluggish pockets of uncontrolled recirculation near the face of the heading (figure 7.8b).

Where little gas is being produced in the heading, leaving dust as the primary concern, an exhaust system may be preferred. The airborne dust is drawn behind the return brattice or into the exhaust duct rather than

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9 *Coal Mines Regulation Act*, s. 71(9d).

progressing through the main body of the heading. Whether the forcing or exhaust mode of auxiliary ventilation is used, neither will be effective if the inbye end of the line brattice or the duct is not maintained close to the face. This positioning is particularly important in the exhaust system because of the absence of a jet effect.

Abandoned Areas

All but the newest mines have abandoned areas from which the coal has been extracted. Although nobody enters them, these zones are a potential source of danger.

Methane emissions do not cease when coal mining stops. The gas continues to issue from any remaining coal.[10] If the stress on pillars and on ribs remains constant within the abandoned area, the gas emission will decay with time. The rate of that decay depends on a number of factors, including the extent of the old workings, the initial gas content of the emitting strata, and the permeability of those strata. If strata movement continues within the abandoned section because of crushing of pillars or ribs, or because of roof collapses and the subsequent subsiding of overlying strata, the gas emissions will continue at a higher rate than would be the case if the ground had reached equilibrium.

If the abandoned area is not ventilated adequately, the composition of the atmosphere will change. In addition to an increase in methane, a reduction of the oxygen content and an increase in carbon dioxide will result from oxidation. Accumulations of gases in old workings present several hazards. Unless the mine layout has been properly designed, the accumulated gases may emerge at high concentrations into active sections of the mine. The amount of gas that emerges from an abandoned area over a two-week period (for example) will be approximately the same as the amount of gas emitted from the strata into that area over the same period of time. What goes in must come out. However, variations in the surface barometric pressure cause short-term variations underground. Falling barometric pressure will cause gases held within all worked-out areas to expand, increasing their rate of emission into the mine's ventilation system. For this reason, a barometer should be kept at the surface of the mine and read at the start of each shift.[11]

A sudden large collapse of roof within the old workings can cause a more violent emission of gases from an abandoned area. If the collapse is over a sufficiently large area, a windblast capable of destroying strong stoppings may then occur. Explosions of methane and coal dust have also

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10 **Comment** The mined-out areas of the Jim Walter Resources mines at Brookwood, Alabama, are a source of methane for Black Warrior Methane Corp. During a tour of methane extraction facilities, Black Warrior's president, Gerry Sanders, told me that the company can profitably drain the gob (the mined-out area) for as long as two years after active mining has ceased. Presumably, some of the hazards associated with the mined-out areas of the mine will be alleviated by this process.

11 *Coal Mines Regulation Act*, ss. 36(2), 38(4), 92(1). The importance of the barometer in underground coal mining is discussed in detail in the section on the barometer in Chapter 6, The Explosion.

been initiated within abandoned areas, these resulting from at least three possible sources of ignition within old workings: friction between blocks of quartzitic rock (sandstones) or between rock and steel during falls of roof; spontaneous combustion of fragmented coal; and, more rarely, a phenomenon know as adiabatic compression, in which the pressure of an explosive atmosphere is so great that it explodes without an outside source of ignition or increase in temperature.

Spontaneous heating of broken coal occurs because of complex physical and chemical reactions taking place on the surface of the material when exposed to air. If insufficient air leaks through the fragmented coal to maintain oxidation, the temperature of the coal will stabilize at a safe level. If the flow of air is sufficiently great to remove heat as quickly as it is being produced, then the temperature will stabilize. However, a dangerous situation arises when there is sufficient air to encourage the oxidation, but not enough to carry away all the heat produced. In such circumstances, the temperature will escalate, further encouraging the rate of oxidation, into a runaway condition. The coal will become incandescent. Spontaneous combustion of this type will produce the highly toxic gas carbon monoxide, as well as large quantities of carbon dioxide.

Two approaches can be taken to minimize the dangers associated with abandoned parts of mines: the old workings must be either ventilated or sealed off, with provisions made in either case to direct emerging gases into return airways. The former method, favoured in the United States, must be used with caution if the coal is susceptible to spontaneous combustion. Figure 7.9 illustrates the back-bleeder system, which may be used both during and after mining has taken place within the section. A regulated flow of air is allowed to move continuously through the section and into the back-bleeder returns, which connect into a main return.

Several precautions must be taken if the abandoned section is to be sealed. First, the seals should be capable of maintaining their integrity in the event of an explosion within the sealed section. This implies double stoppings, keyed into roof, sides, and floor, with the intervening space completely filled with an inert material. Second, the ventilated entry adjacent to the seals should not be an intake airway.[12] In some cases, one or more air crossings may have to be built to meet this requirement.

The difference in air pressure across a sealed area should be as low as possible to minimize leakage through or around the seals. A skilled mine ventilation engineer will use the data gathered through well-managed pressure-volume surveys to plan for the control of pressure differentials across worked-out areas. This planning is particularly important when spontaneous combustion is a possibility.

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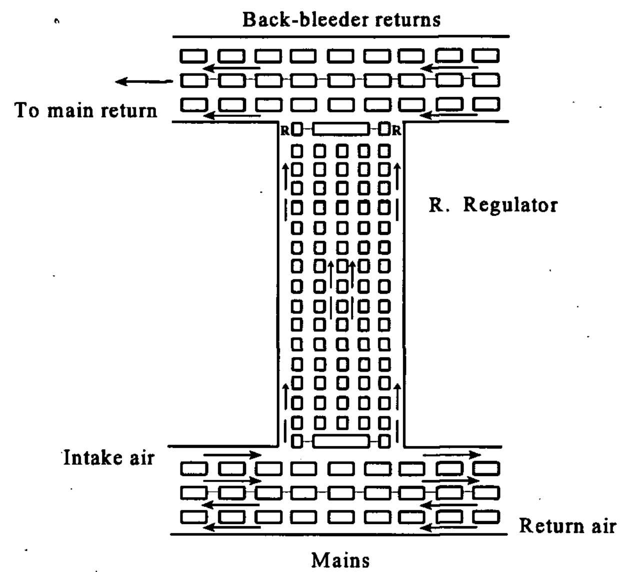
[12] *Coal Mines Regulation Act*, s. 71(6).

Figure 7.9 The Back-bleeder System of Ventilating a Room-and-Pillar Section



Source: Prepared by Malcolm J. McPherson for the Westray Mine Public Inquiry.

The Main Ventilation System at Westray

The ventilation system in place at the time of the explosion at the Westray Mine is shown in maps 5, 6, and 7 in Reference.[13] The intake airways were generally used to transport personnel and materials on diesel vehicles, while the belt conveyors were located in the return airways. This arrangement is known as *homotropal ventilation,* since both the airflow and the transported coal travel in the same direction. It would tend to minimize freezing problems on the main conveyor during the winter months.

This section of the chapter, which describes the development of the throughflow ventilation system at Westray, is divided into three parts. The first part deals with the main access roadways, the main fan, and the surface recirculation duct. The second part describes, in some detail, the condition of the ventilation system in the North and Southeast sections of the mine and reviews how it changed during the three months leading up to the explosion. The third part repeats the process for the Southwest sections of the mine. The auxiliary ventilation of headings is dealt with separately.

Access Mains

As shown on map 5 in Reference, the intake slope known as No. 1 Main served for access of personnel and materials as well as for fresh-air entry

[13] These three maps reconstruct the ventilation picture at the time of a survey taken 8 May 1992 (Exhibit 45.01.15).

into the mine. No. 2 Main, the parallel exhaust slope, carried the main belt conveyor and return air back to the surface. Despite the locations of the conveyors, the mine operated on a main exhaust system of ventilation. This was contrary to recommendations given in feasibility studies carried out by Norwest Resource Consultants Ltd in 1986, by Placer Development Limited in 1987, and by Kilborn Limited in 1989. Although, as indicated earlier in this chapter, there are good reasons for preferring the main exhaust system in gassy mines, it would seem that Westray chose a main exhaust and homotropal system primarily so that it could use non-permissible diesel equipment for transporting personnel and materials in the intake airways.

Two main fans, one operating and one as a standby, were on the surface above, and connected to, No. 2 Main (the return slope). The fans indicated in the drawings used by the installer, Alphair, were Joy Axivane units, Model M72-43-1200. The model numbers indicate that the fan-casing diameter was 72 inches,[14] the fan hub diameter was 43 inches, and the nominal speed was 1200 rpm. The same model number is indicated on the ventilation maps produced by Westray. Although this model seems to have been installed, the application for permission to use the main fans gives the model number as 72-50-1180.[15]

An airlock, through which the belt conveyor passed, was located near the portal of No. 2 Main. Current regulations require that a pressure differential gauge, commonly known as a water gauge, be connected to the casing of the main fan to indicate that a suitable ventilating pressure is applied to the mine.[16] In addition to providing a continuous record of the pressure developed by the fan, a recording pressure differential gauge also yields invaluable information about explosions, fires, or any other emergency situation that affects the ventilation system of a mine. As discussed in Chapter 6, The Explosion, no such instrument was available at Westray. Neither was a barometer – also a statutory requirement – provided.

An additional duct, fitted with a butterfly valve, was connected to the outlet of the main fan.[17] This duct, which ran across the mine surface to No. 1 Main to recirculate a fraction of the return air back into the main intake, was used in the winter months of 1991–92 in an attempt to increase the temperature of the intake air and to alleviate problems such as icing of the roadway caused by cold temperatures in the main intake. Although the regulations specifically disallow recirculation of auxiliary ventilation, they

[14] All major nations have converted, or are in the process of converting, to Système Internationale (metric) units. In the United States, federal agencies are required to use SI units, but the vast majority of industry and commerce still retains the old British imperial (foot-pound-second) units. Canada is further advanced in its adoption of SI, but its speed of conversion is inhibited by its proximity to the large U.S. market. The old units are still used widely in the Canadian mining industry. In this Report, both systems of units are used, with conversions given where appropriate.

[15] Exhibit 69b.153.

[16] *Coal Mines Regulation Act,* ss. 36(2), 38(4). The importance of the water gauge to underground ventilation control is discussed in detail in Chapter 6, The Explosion.

[17] Exhibit 73.2, photo 17.

make no mention of recirculation in the primary air circuits of a mine.[18] Controlled partial recirculation of air in mines remains a matter of some controversy. It is practised at some mines in Canada and other countries for various reasons, including the alleviation of low temperatures and the reduction of air-heating costs in cold climates. However, where it is so used, continuous monitoring of the quantity and quality of the air – particularly for carbon monoxide as an indication of fire – should be carried out. No continuous monitoring of either the quantity or the quality of the recirculated air appears to have been carried out at Westray.

Permanent stoppings were constructed between the main slopes in Nos. 1, 2, 4, 6–8, and 10 Cross-cuts. No. 5 Cross-cut had a single stopping with a large steel door for vehicle access. The lack of an airlock (at least two sets of doors) was in contravention of section 71(12) of the act. On at least one occasion, this door was held open, short-circuiting the main ventilation system for about half an hour while mining continued.[19] Double sets of doors large enough to permit vehicle access were installed on No. 3 and No. 11 Cross-cuts. At No. 10 Cross-cut, the intake air split into roughly equal proportions between the North mains and the Southwest. The air returning from the Southwest passed over an air crossing to connect, via No. 9 Cross-cut, into No. 2 Main.

The splitting of the airflows between the North mains and the Southwest was controlled by a regulator in No. 2 Main between No. 9 and No. 10 Cross-cuts (see map 6). This regulator, through which the main conveyor passed, consisted of vertical timber posts with plywood sheets nailed to them. Contrary to the construction of a properly built regulator, there was no way of adjusting it other than by physically removing or adding plywood sheeting.[20]

Finding

Generally, the regulating, control, and monitoring of the main airflow was inadequate and poorly planned. In some cases, the regulating devices contravened the requirements of the Coal Mines Regulation Act. In other cases, these devices were simply improperly constructed, as in the regulator in No. 2 Main between No. 9 and No. 10 Cross-cuts.

Throughflow Ventilation

The changes that took place in the throughflow ventilation arrangements within the sections of the mine in 1992 can be traced from the airflow measurements taken and recorded in ventilation "survey" reports,

[18] *Coal Mines Regulation Act*, s. 71(9b).

[19] Clive Bardauskas (Hearing transcript, vol. 23, p. 4632).

[20] Trevor Eagles (Hearing transcript, vol. 76, pp. 16429–30).

summarized below.[21] The airflows measured between 12 February and 8 May 1992 are given in table 7.1.

At Westray, the measurements of airflow were made at weekly intervals, from February onward, by Trevor Eagles, an engineer-in-training. Routine check measurements and ventilation surveys will be discussed later in this chapter, in the section on ventilation planning.

North and Southeast Sections

12 February 1992 The first of the 1992 reports, dated 12 February 1992, indicates that, at that time, mining in the North workings had ceased because of a major fall of ground in 3 North Main on 9 February. All auxiliary fans in the section were switched off. However, the primary ventilation system maintained throughflow around North 4 Cross-cut. Temporary plastic stoppings in North 1 and 2 Cross-cuts were in need of repair or replacement. More seriously, the stopping in No. 11 Cross-cut between No. 1 Main and No. 2 Main was a temporary arrangement of plastic that was leaking 28.4 kcfm (thousand cubic feet per minute). The report indicates that a permanent bulkhead was required in this location.

19 February 1992 The following week, the stopping in No. 11 Cross-cut was still constructed from plastic. However, steel doors in the stopping were recorded. Five headings – 1 North Main, 2 North Main, North 5 Cross-cut, 3 North Main, and what was to become 1 East – were ventilated by three auxiliary fans operating in a series ventilation arrangement.[22] Tee-jointed ducts were used in the 2 North Main and North 5 Cross-cut headings and in the 3 North Main and 1 East headings.[23] The stoppings in orth 1 and North 2 Cross-cuts were still the temporary plastic ones, with an air recirculation from 2 North Main (main return) into 1 North Main (main intake) of between 10 and 15 kcfm.[24]

26 February 1992 On 21 February, work in the North was again suspended by large falls of ground, this time in North 4 and North 3 Cross-cuts. The blade angle of the main fan was adjusted from 12 to 17 degrees, resulting in a significant increase in the airflow in the main slopes (see table 7.1). Some 36 kcfm passed over the fall in North 4 Cross-cut. The

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21 Exhibit 37a.044–96. This exhibit includes Eagles's reports to management on his weekly ventilation surveys. Much of the following narrative (North and Southeast Sections; Southwest Sections) is based on these reports and the accompanying maps in Exhibit 45.01.07–15.

22 Series ventilation occurs, in this context, when air issuing from a heading is returned into a throughflow airstream, which is then used, further downstream, to provide air for the auxiliary ventilation arrangements of one or more further headings. Since each heading adds airborne pollutants, it follows that the air will progressively suffer a loss of quality. For this reason, series ventilation should be avoided wherever possible. (See also *Coal Mines Regulation Act*, s. 71(5).)

23 For an explanation of tee-jointed ducts, see the section on use and maintenance of ducting later in this chapter.

24 Recirculation in the North and Southeast sections was a recurring theme throughout the records in 1992. It was caused by a combination of the air jets issuing from exhausting auxiliary fans into the throughflow ventilation system, and natural ventilating effects resulting from warmer air in a rising return airway.

Table 7.1 1992 Measured Airflows (kcfm)

Location	12 Feb 92	19 Feb 92	26 Feb 92	4 Mar 92	11 Mar 92	18 Mar[b]	2 Apr 92[c]	8 Apr 92	15 Apr 92	23 Apr 92	29 Apr 92	8 May 92
No. 1 Main, outbye 1 Cross-cut	166.3	163.5	182.7[a]			181.4	223.6	218.4				
No. 1 Main, inbye 8 Cross-cut	155.5	144.0	176.8	160.2	172.0	176.0	207.7	204.1	201.6	197.3	203.4	190.8
No. 1 Main, inbye 10 Cross-cut	88.8				76.1		103.9	99.9	102.4	103.3	101.1	100.8
SW1-C1 Road	68.6	65.6	71.2	80.5	87.3	89.3	97.6	99.0		94.2	96.8	93.5
No. 1 Main, inbye 11 Cross-cut	60.4	73.8	68.4	60.9	61.4		78.8	74.1	76.1	95.9	91.5	89.5
1 North Main, outbye North 4 Cross-	51.8	81.2	36.4		27.7		74.5		75.8	79.5		
SW1-6 Cross-cut	30.6	29.3	41.8	48.6								
No. 2 Main, at 9 Cross-cut		132.0	157.0	157.2	155.7	158.8				(d)		
No. 1 Main, outbye 11 Cross-cut		76.7	83.7	73.7			98.8	98.2	100.2		98.8	
1 North Main, outbye North 2 Cross-		70.8	64.0	62.3	65.8				75.9			
SW1-B Road, outbye SW1-1 Cross-cut				86.4	86.4	84.5	100.4	103.6	98.3	95.0	93.7	88.4
SW1-3 Cross-cut				11.2								
SW1-B Road, inbye SW1-6 Cross-cut					48.1							
2 North Main, inbye North 2 Cross-cut					35.1							
SW1-B Road, outbye SW1-8 Cross-cut						49.1						
SW1-C1 Road, inbye SW1-3 Cross-cut							20.9					
1 North Main, outbye North 4 Cross-								76.1				
2 North Main, outbye North 4 Cross-										77.2	83.2	77.5
1 East								31.9	32.4	62.1		75.5
1 North Main, inbye North 4 Cross-cut								87.5				63.8
SW2- B Road, outbye SW2-1 Cross-									78.4	81.5		
2 East											66.8	
SW1-C1, outbye SW1-3 Cross-cut											65.8	
SW2-A Road, inbye SW2-1 Cross-cut											38.2	59.8
SW1-A Road (face)			11.7	7.0	5.2							
SW1-A1 Road (face)			13.9	10.4	7.2							
SW1-A2 Road (face)			10.4	17.0	13.0							
SW1-A3 Road (face)				13.6	16.8							
SW2-B Road (face)									7.8			
SW2-A Road (face)									6.4			
SW2-1 (fan)												5.2
SW2 "C" (fan)												5.3
Southeast (fan)												7.0
Northwest 1 Cross-cut (fan)										4.7		
2 North Main (fan)										5.2		
SW2-B Road (fan)										4.7		

Source: Exhibit 37a 044–96.

a Blade angle changed from 12° to 17°
b Anemometer damaged, could not complete survey
c Southwest 1 production stopped 25 March, abandoned by 28 March
d Regulator in No. 2 Main opened

plastic stopping in North 2 Cross-cut was opened to short-circuit the obstructed areas and to further assist in maintaining acceptable ventilation as far as that cross-cut in the North Mains.

4 March 1992 A limited rate of production in the North did not resume until 4 March. The airflow measurements taken on that date indicate that the auxiliary fans remained switched off. The plastic stopping with steel doors in No. 11 Cross-cut, still not replaced by a bulkhead, was leaking some 12.7 kcfm.

11 March 1992 By 11 March, limited production was taking place in 2 North Main and 2 East, with those two headings ventilated in series. The North 2 Cross-cut remained open, short-circuiting 33.7 kcfm and leaving only 27.7 kcfm to find its way over the fall in North 4 Cross-cut to provide air for the 2 North Main active heading. It is unclear why this direct short-circuit was allowed to continue. The plastic stopping in No. 11 Cross-cut continued to leak at a rate of 12.2 kcfm.

18 March 1992 The airflow measurements taken on 18 March were cut short because of a damaged anemometer. No airflow measurements were made in the North or Southeast sections during this week.

Mining continued in the 2 North Main, North A Road, and 2 East headings, with series ventilation. The fan providing air to 2 North Main and the North A heading was located in North 5 Cross-cut, requiring an excessive length of ducting. The section of ducting adjacent to the fan serving 2 East needed replacing. The stopping in No. 11 Cross-cut remained as a temporary construction, with an air leakage of 12 kcfm. Although the North A heading had now joined up with 2 North Main, advancing the main throughflow system, North 2 Cross-cut remained open as a direct short-circuit between the main intake and return.

2 April 1992 There are no records of airflow measurements having been taken between 18 March and 2 April. The temporary plastic stopping in North 2 Cross-cut had been removed on 21 February because of the fall in North 4 Cross-cut. A properly constructed permanent stopping should have been built in North 2 Cross-cut as soon as the fall was bypassed by the 2 North Main to North A Road interconnection. That connection occurred during the week prior to 18 March. However, the stopping was not reported as being replaced until 2 April. During that period, there had been a large loss of air across the short-circuit. When the stopping in North 2 Cross-cut was eventually replaced, it was by yet another temporary plastic one instead of a permanent structure and was leaking 7.5 kcfm. Air pressure increased across the plastic and steel door stopping in No. 11 Cross-cut, where the air loss had risen to 20 kcfm. On 2 April, auxiliary fans were ventilating the North A and North B headings in the North and 1 East and 2 East in the Southeast, again effectively in series. A section of the ducting in the North A heading had collapsed. A recirculation of approximately 15 kcfm occurred over the fall in North 4 Cross-cut. Concern over the growing rate of recirculation may have been the reason

for an additional adjustment of the main surface fan, as reflected by another increase in the main slopes' airflow measured during this week (see table 7.1).

8 April 1992 Once again, ground control problems were occurring in the Southeast area, and the auxiliary fans in 1 East and 2 East were switched off. Ducts remained operating in the North A, North B, and 2 North Main headings. Despite the adjustment to the main fan in the previous week, the recirculation situation was growing worse. Although an airflow of 87.5 kcfm was measured approaching the last open cross-cut (North A Road), only 74.1 kcfm progressed inbye along 1 North Main (measured outbye North 4 Cross-cut). There was, therefore, a recirculation of at least 13.4 kcfm in the North section. (The measurements indicate 11.4 kcfm recirculating over the fall in North 4 Cross-cut, and a further 2 kcfm recirculating across North 2 Cross-cut). The leakage across the plastic and steel door stopping in No. 11 Cross-cut had increased further, to 24 kcfm.

15 April 1992 The damaged anemometer had been repaired, recalibrated, and returned to the mine by this date. However, the only work in progress in the North and Southeast sections was the setting of steel arches. No mining was going on; the only auxiliary fan operating was that serving the North A heading. Although reported two weeks earlier, a section of the ducting in that heading still needed to be replaced. Construction of a permanent concrete-block stopping had, at last, been started in No. 11 Cross-cut and was now half-complete – nine weeks after the engineer responsible for the airflow measurements had first requested that a proper bulkhead be built in this location. Recirculation estimated at 10 kcfm continued over the fall in North 4 Cross-cut. An airflow of 5 kcfm occurred along 3 North Main between 1 East and 2 East. The 15 April report recommended that a stopping be constructed in this location.

23 April 1992 No ventilation map is available for the 23 April measurements. The permanent stopping in No. 11 Cross-cut had now been completed and, coupled with the widening of the regulator setting in No. 2 Main between No. 9 and No. 10 Cross-cuts, resulted in a significant increase in the airflow supplied to the North sections. The stopping in North 2 Cross-cut was reported to be constructed from strips of conveyor belt and leaking at a rate of approximately 10 kcfm. The 2 North Main and North A headings were being ventilated. Once again, the ducting in the North A heading was reported as needing replacement. An auxiliary fan was located in 2 East to ventilate the 1 Southeast heading. This was causing a recirculation of 13.3 kcfm from 2 East to 1 East, the stopping requested the previous week for 3 North Main not having been constructed.

29 April 1992 No ventilation map is available for the 29 April airflow measurements. However, Eagles reported an auxiliary fan exhausting from the North A heading. The fan located in 2 East continued to exhaust air from the 1 Southeast heading, but a plastic stopping had now been erected

in 3 North Main to control the recirculation from 2 East back to 1 East. As had been the case since March, the ventilation of the Southeast section continued downstream from, and in series with, that in the North section. Eagles indicated further dissatisfaction with the belt-strip "stopping" in North 2 Cross-cut.

8 May 1992 This final set of airflow measurements was recorded less than 24 hours before the explosion and may therefore be considered fairly representative of the state of the ventilation system at the time of the explosion. The situation is illustrated on map 7. An auxiliary fan was located in Northwest 1 Cross-cut, exhausting from the North A heading.[25] A second fan in Northwest 1 Cross-cut was attached to ducting in the North B heading. The operational status of this fan on 8 May is unknown. A fan in 2 North Main drew air via a tee-jointed duct from the 2 North Main heading and North 6 Cross-cut. There were, therefore, four headings with series ventilation in the North section. These, in turn, were in series with the auxiliary ventilation of the 1 Southeast heading, giving a total of five headings with series ventilation.

The ventilation arrangements for the 1 Southeast heading can only be described as strange. Mining had been severely inhibited in this area because of methane emissions.[26] The length, type, and size of ducting in 1 Southeast restricted the exhaust ventilation to 7.1 kcfm – insufficient to remove the gas effectively from the heading, even with a 30 kW (40-horsepower) fan. An attempt was made to increase the airflow in the heading by attaching a short length of ducting to a fan located on the downstream side of the heading entrance and using it in the forcing mode. The map for 8 May shows this ducting protruding only a few metres into 1 Southeast. The effect would be to increase the airflow within that short distance, yet it would have minimal influence on the flow drawn from the inbye end of the heading by the primary exhaust duct.

Observations

Throughout the life of the North and Southeast sections of the mine, production was interrupted frequently by falls of roof. These had a severe impact on the ventilation structure and continuity of airflows to the headings. Despite the proximity of the main intake and return slopes and the commensurate need for vigilance against leakage, only one permanent stopping was built inbye No. 10 Cross-cut in the main slopes. This was in No. 11 Cross-cut, and it was not built until 15 April 1992 – nine weeks after it had been requested by Eagles. All other stoppings were constructed from plastic or, in the case of North 2 Cross-cut after 15 April, strips of conveyor belting. Such structures were out of compliance with section 71(11) of the *Coal Mines Regulation Act*.

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25 This cross-cut is not labelled on the maps. It connects North A, B, and D Roads inbye the North mains.

26 Don Dooley mentioned this in his testimony (Hearing transcript, vol. 35, p. 7837).

Air leakage rates were high, and uncontrolled recirculation of air was prevalent. It would appear that the mine management was ignorant of the reason for the recirculation. The main cause was the induction of additional air motion by a jet of relatively high velocity air from each auxiliary fan exhausting into throughflow airstreams. This would have been avoided by employing forcing auxiliary fans, as required by section 71(9d) of the act.

No airflow measurements were made in the North or Southeast sections during the week of 18 March 1992 because of a damaged anemometer. Spare anemometers should have been available on site because airflow measurements are the primary means for checking the operation of a mine's ventilation system.

Throughout the three-month period described above, headings were ventilated in series, to a total of five headings in series by 8 May 1992. In conjunction with the uncontrolled recirculation and inadequate auxiliary ventilation, this situation led to dangerous mining conditions, particularly in the Southeast section, with respect to methane.

Finding

The ventilation system in the North Mains and Southeast sections of the mine was haphazard, reflecting little or no planning. Plastic stoppings were generally in a state of disrepair – increasing the leakage of air, promoting the recirculation of air, and decreasing the quality and flow of ventilation air. Faulty placement of auxiliary fans further decreased the flow and caused problems such as collapsed ducting, which remained in that state for unduly long periods. The placement of the auxiliary fans in these sections further diminished the airflow – to the extent that it was incapable of flushing liberated methane from the headings. The combined effect of all these deficiencies was to perpetuate poor air quality, the air circulating or recirculating within the sections at velocities too low to remove dangerous contaminants. Significantly, these conditions appear to have been tolerated, or even ignored, by a complacent or careless management.

Especially appalling is the thought that these dangerous conditions were not even recognized by an ill-trained and incompetent management.

Southwest Sections

12 February 1992 In early February, mining was taking place in the Southwest 1 (SW1-B, SW1-A, and SW1-A1) headings. The SW1-A and SW1-A1 headings were ventilated by a common exhaust fan and a tee-jointed duct, in series with the SW1-B heading. Of the 68.6 kcfm that entered the Southwest area, at least 38 kcfm (55 per cent) were lost by leakage through the stoppings in SW1-1 Cross-cut (wooden construction), SW1-2 Cross-cut (wood), and SW1-3 Cross-cut (plastic). There was a slight recirculation through SW1-5 Cross-cut (wood). No measurements of airflow in the auxiliary ducts were recorded. However, the report for

this date indicated that the flows were very low in the SW1-A and SW1-A1 headings.

19 February 1992 Little change in the throughflow ventilation had been made from the previous week, the leakage remaining at 55 per cent. The wooden stopping at SW1-1 Cross-cut was reported as leaking 15 kcfm. The plastic stopping at SW1-5 Cross-cut was in poor condition and recirculating approximately 5 kcfm. Three auxiliary fans were now in operation, one exhausting from the SW1-B heading, and one from the SW1-A heading. The duct serving the SW1-B heading was reported as being 75 per cent closed off and, unsurprisingly, yielding poor ventilation. The third fan operated in the forcing mode, providing air through a tee-jointed duct to the SW1-A1 heading and the developing SW1-4 Cross-cut. During the three-month period preceding the explosion, this is the only auxiliary fan-and-duct arrangement that complied with the mandatory requirement for a forcing system.

26 February 1992 An adjustment of the blade angle from 12 to 17 degrees on the impeller of the main fan had resulted in an increase from 65.6 to 71.2 kcfm in SW1-C1 Road (supplying air to the Southwest section). The leakage across the stoppings between SW1-C1 and SW1-B Roads had been reduced to 29.4 kcfm (41 per cent), indicating that those stoppings had received some attention. Exhaust fan-and-duct arrangements continued to serve the SW1-A and SW1-A1 headings, in series with the forcing fan that ventilated the SW1-A2 and SW1-4 Cross-cut headings. For the first time, airflows were measured in the auxiliary ducts (see table 7.1). All ducting was reported to be in good condition.

4 March 1992 The airflow entering the Southwest section had risen to 80.5 kcfm, resulting from a reduction in the open area of the regulator in No. 2 Main following the 26 February measurements. Additional repair work to the Southwest stoppings had been carried out. Nevertheless, the leakage between SW1-C1 and SW1-B Roads remained high at 32 kcfm (40 per cent). A plastic stopping, erected in SW1-A1 Road, was recirculating approximately 7.5 kcfm. The duct exhausting air from the SW1-A heading was reported at 50 per cent closed, resulting in poor ventilation in this heading. The SW1-A2 heading had connected into, and advanced beyond, SW1-8 Cross-cut and was now ventilated by a dedicated exhaust fan and duct. The forcing fan had been moved to the outbye end of SW1-A2 Road and ventilated the new SW1-A3 heading. This gave four headings ventilated in series.

11 March 1992 On 11 March, depillaring (pillar recovery) began in Southwest 1. Leakage across the stoppings separating SW1-C1 and SW1-B Roads remained high at 39.2 kcfm (45 per cent). Exhaust fan-and-duct auxiliary systems ventilated the SW1-A, A1, A2, and A3 headings, all in series. The duct serving the SW1-A heading was tee-jointed, drawing air from both the SW1-A heading and SW1-10 Cross-cut. This duct was in a particularly poor state, with the section of ducting adjacent

to the fan 80 per cent closed, resulting in a total airflow of only 5.2 kcfm serving the SW1-A heading and SW1-10 Cross-cut (see table 7.1). The ducting in the SW1-A1 heading was also in poor condition, passing an airflow of 7.2 kcfm. Control of the throughflow ventilation in Southwest 1 was being lost at this stage. Figure 7.10 shows that the active areas were all west of SW1-B Road and were supplied by a total airflow of 48.1 kcfm, via SW1-8 Cross-cut and returning through SW1-4 Cross-cut. The SW1-A Road contained the belt conveyor, but no stopping. Therefore, there was a direct and open short- circuit between the intake (point X on figure 7.10) and the return (point Y). Nevertheless, Eagles commented in his notes that only minor flow was measured in this airway. This observation indicates that the main ventilation system was incapable of providing a positive ventilating pressure differential across the active working area in Southwest 1. The airflow that proceeded through this area was induced primarily by the air jets issuing from the auxiliary fans and resulting in a recirculation of 7.5 kcfm through the plastic stopping in SW1-A1 Road.

18 March 1992 The ventilation system in Southwest 1 had changed little since the previous week. Depillaring continued in the SW1-A heading and the nearby SW1-B extension. Both were supplied via a tee-joint from the same exhaust duct. No airflow measurements in the ducts were recorded, since the high-speed anemometer used for this purpose had been damaged. It is unlikely that satisfactory ventilation could have been provided to depillaring operations by a tee-jointed duct. As reported in the previous week, the ducting drawing air from the SW1-A1 heading was again in a poor condition, with several sections crushed. As well, a section of the ducting in SW1-A2 Road needed to be replaced. The inbye end of this duct was an excessive 30 m from the face, indicating that there was no effective ventilation at the face of this heading. At the time of these observations, the fan serving the SW1-A3 heading was switched off, resulting in an unquantified recirculation in the completed section of SW1-A3 Road. A plastic stopping had now been erected in the SW1-A belt road. The wooden stopping in SW1-3 Cross-cut between SW1-C1 and SW1-B Roads had deteriorated and was passing a leakage of approximately 15 kcfm. Eagles reported that it had holes in it and was in need of repair.

2 April 1992 There are no quantified reports of airflow measurements between 18 March and 2 April. On 25 March, one week after the 18 March observations, production ceased completely in the Southwest 1 section because of crushing of the finger pillars. Equipment was withdrawn, and the area was abandoned by 28 March. Of the numerous hazardous situations that occurred at Westray, the withdrawal from Southwest 1 was the most dangerous operation prior to the actual explosion.[27] The

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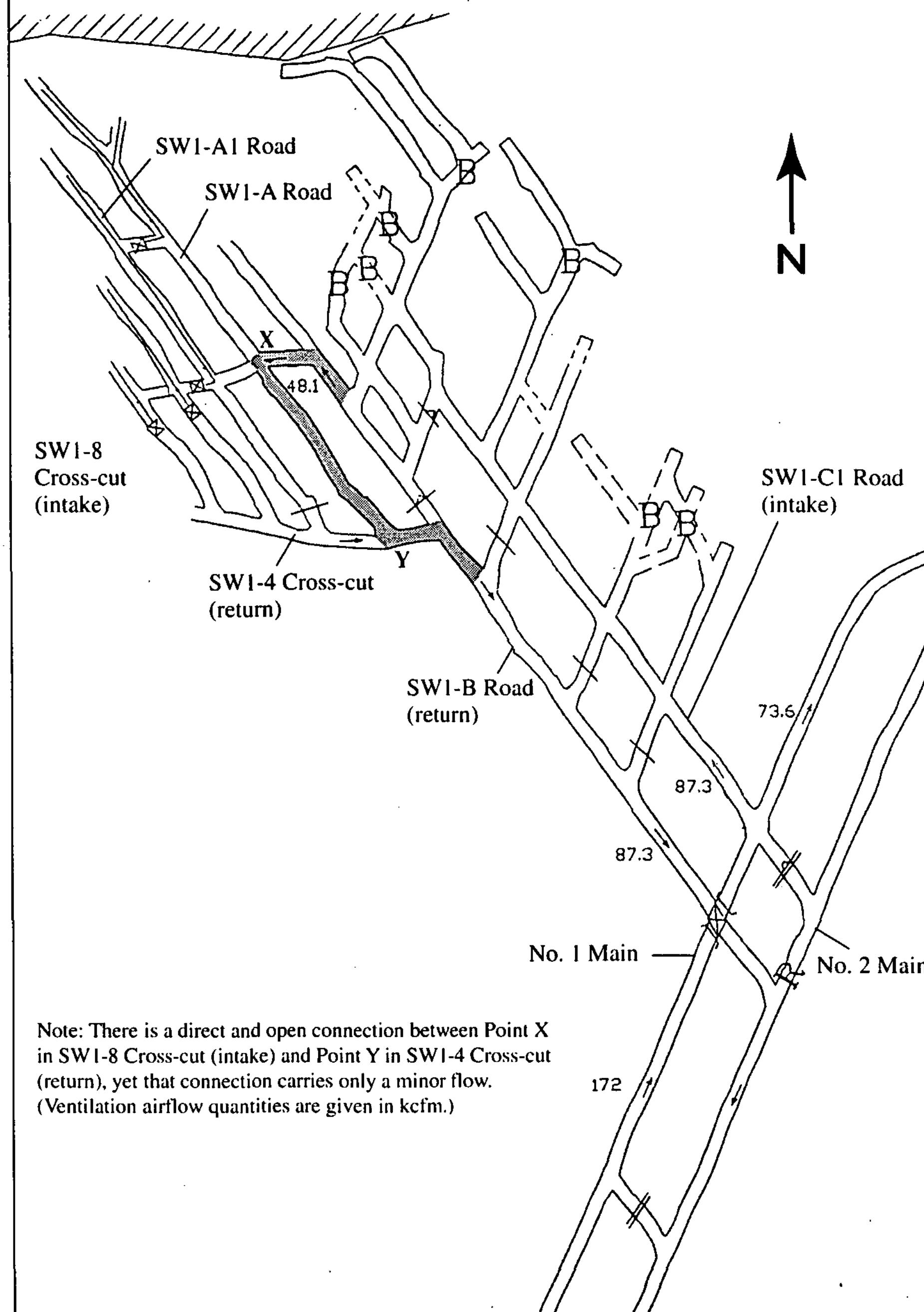
27 A number of witnesses attested to the hazards of this operation. Trevor Eagles was familiar with the inadequate ventilation and high levels of methane in Southwest 1 (Hearing transcript, vol. 76, pp. 16472–78, 16505–06, 16517–20). Wyman Gosbee discussed the poor ventilation and high methane (vol. 25, pp. 4983, 4987–89). Lenny Bonner spoke of operating equipment

Figure 7.10 Short-circuiting in Southwest 1, 11 March 1992



Note: There is a direct and open connection between Point X in SW1-8 Cross-cut (intake) and Point Y in SW1-4 Cross-cut (return), yet that connection carries only a minor flow. (Ventilation airflow quantities are given in kcfm.)

Source: Prepared for the Westray Mine Public Inquiry by Dr Malcolm J. McPherson from ventilation map of Southwest 1 on 11 March 1992 (Exhibit 45.01).

depillaring operations of the preceding week and crushing of the remaining pillars would have created emissions of gas probably greater

under extremely dangerous conditions (vol. 24, pp. 4753–58). The withdrawal from Southwest 1 is covered in Chapter 10, Ground Control, and Chapter 5, Working Underground.

than those experienced in the headings. Damage to stoppings and further loss of control of the already inadequate ventilation would have resulted in methane remaining inadequately diluted and failing to be removed from the area. The methane would accumulate – initially at roof level, especially in roof cavities created by the falls of roof during the withdrawal – and continue to fill the entries after abandonment of the area.

No ventilation map is available for this date, although the situation is approximated by the map for the following week. An increase in the total airflow supplied to the mine suggests that the main fan had been adjusted during the preceding week (see table 7.1). All work had been abandoned in the Southwest 1 section. A wood-and-plastic stopping had been erected in SW1-B Road inbye SW1-4 Cross-cut. The SW2-A and SW2-B headings had been started and were ventilated by exhaust fan-and-duct arrangements in series. An airflow of 97.6 kcfm entered the Southwest area via SW1-C1 Road. There were wood or wood-and-plastic stoppings in SW1-1 and SW1-2 Cross-cuts. The three entrances to the abandoned Southwest 1 section immediately inbye SW1-3 Cross-cut remained open. These were SW1-C1 and SW1-B Roads, and the old 2 North Main A entry that was obstructed by a roof fall. A belt-strip "stopping" had been erected in SW1-3 Cross-cut in an attempt to induce airflow around Southwest 1. This allowed vehicles to access the developing Southwest 2 section via the intakes – SW1-C1 Road and SW1-3 Cross-cut. The belt-strip stopping was ineffective and allowed the passage of approximately 70 kcfm. A measurement taken in SW1-C1 Road inbye SW1-3 Cross-cut indicated that the airflow progressing into the Southwest 1 section was limited to approximately 21 kcfm.

From this time onward, the new Southwest 2 section was ventilated by intake air that had been routed past the entrances to abandoned workings. This contravened section 71(6) of the *Coal Mines Regulation Act*. To compound the problem, an airflow was being deliberately diverted through those old workings – insufficient to deal with the methane that was being produced, but enough to carry dangerous concentrations of the explosive gas towards the Southwest 2 developments. Methanometer measurements taken in SW1-B Road outbye SW1-4 Cross-cut showed that the air returning from Southwest 1 contained 2.5 per cent methane in the general airstream and 9.0 per cent near the roof.

8 April 1992 SW2-A and SW2-B Roads had advanced to the point where they could connect through SW2-1 Cross-cut. Nevertheless, the auxiliary exhaust fans had not yet been moved forward, remaining in SW1-B Road. The wood-and-plastic stopping in SW1-B Road inbye SW1-4 Cross-cut, and the belt-strip "stopping" in SW1-3 Cross-cut, had both been dismantled. An airflow estimated at 15 kcfm and a methane concentration of 4.0 per cent (near the roof) were reported for the former location.

15 April 1992 Two days before the 15 April measurements were taken, plywood stoppings had been erected in SW1-C1 and SW1-B Roads, both inbye SW1-3 Cross-cut. These stoppings prevented access to the

abandoned Southwest 1 section and reduced the airflow supplied to that section to leakage values. Ground control difficulties had been experienced in those same locations and wooden chocks had been built for roof support.[28] One of the miners building the chock in SW1-B Road became dizzy while working near the roof. His dizziness was probably caused by displacement of oxygen by methane.[29] Plywood sheets, ¼-inch thick, were nailed to the chocks to form the stoppings intended to isolate the abandoned workings.[30] The construction of such stoppings did not follow with prudent practice. Old workings should either be ventilated adequately and directly into return airways or, if not so ventilated, be isolated by explosion-proof seals. Unfortunately, the flimsiness of the plywood stoppings was not their only weakness. They were built in disturbed ground; in particular, the stopping in SW1-B Road was incapable of preventing high concentrations of methane from issuing out into the intake air supplying the Southwest 2 section. Leakage air moved inbye across the stopping in SW1-C1 Road and re-emerged, contaminated by methane, back into the intake route through the stopping in SW1-B Road.

The auxiliary fan exhausting from SW2-B Road had been moved up to SW2-1 Cross-cut. The fan serving SW2-A Road was located at the outbye end of the road, requiring an unnecessarily long length of ducting. The two headings were ventilated in series. Airflow measurements indicated low flows of 7.8 kcfm for SW2-B Road and 6.4 kcfm for SW2-A Road. The ventilation map for this date indicates that a stopping had been erected in the belt road (SW1-B Road) between the entrances to SW2-A and SW2-B Roads.

23 April 1992 No ventilation map is available for the 23 April measurements. Upward movement of the underlying strata (floor heave) was causing the plywood stoppings in SW1-C1 and SW1-B Roads to buckle. The ducting exhausting air from SW2-B Road was reported as being in good condition but not hung straight. Nevertheless, the measured airflow for the corresponding fan was only 4.7 kcfm, indicative of a significant obstruction in the duct. No airflow measurement was recorded for the SW2-A heading.

29 April 1992 No ventilation map is available for 29 April. Floor heave and buckling of both Southwest 1 stoppings in SW1-C1 and SW1-B Roads were noted. Apertures had developed in those stoppings, allowing an estimated leakage of 5 kcfm through the Southwest 1 section.[31]

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28 Don Dooley (Hearing transcript, vol. 36, pp. 7956–57).

29 Harvey Martin (Hearing transcript, vol. 23, pp. 4538–39).

30 Jonathan Knock (Hearing transcript, vol. 26, pp. 5285–86).

31 The ventilation survey report of 29 April refers to the estimated leakage (Exhibit 37a.074). Eagles said in testimony that "[the stoppings] were closed off, but you could, if you really wanted to, probably stick your head through and take a look in some of the buckles" (Hearing transcript, vol. 76, p. 16599). Mick Franks, in his testimony, said, "I don't know if the floor was heaving or if the roof was coming in, but it was all busted. The plywood was all busted" (vol. 21, p. 4150).

The total airflow entering the Southwest section via the outbye end of SW1-C1 Road was 96.8 kcfm. Unfortunately, 58.6 kcfm (61 per cent) of this airflow was lost to leakage. The wood-and-plastic stopping in SW1-2 Cross-cut had now been replaced by conveyor belt strips and was suffering from a large leakage of some 31 kcfm. The background to this change was that the previous access route around SW1-3 Cross-cut had become inaccessible for vehicles because of poor roof conditions at the junction of SW1-C1 Road and SW1-3 Cross-cut. Vehicles were now required to travel inbye from SW1-C1 Road, through the belt-strip stopping in SW1-2 Cross-cut, across SW1-B Road, and up SW2-A Road to the working areas. The initial location of the Southwest 2 conveyor had been in SW2-A Road (return), with the conveyor drive at the junction with SW1-B Road. Because this would have made that junction unsuitable for the passage of vehicles, the conveyor for the Southwest 2 section had been moved to SW2-B Road (intake).[32] A consequence of these changes was that vehicles now travelled in a return entry, which is not suitable for non-permissible vehicles. An alternative plan would have been to construct an air crossing at the SW1-B Road and SW2-A Road intersection and reverse the ventilation around the Southwest 2 section. This would have allowed intake access for vehicles and would also have eliminated the need for the Southwest 2 intake route to pass the stopped entrances of the abandoned Southwest 1 section.

In addition to the large loss of air at SW1-2 Cross-cut, the plastic stopping in SW2-1 Cross-cut was passing an excessive leakage of 22.6 kcfm. A further 5 kcfm was lost through the conveyor stopping in SW1-B Road. Two exhaust auxiliary fans were now located side by side in SW2-2 Cross-cut – one ventilating the SW2-B heading and the other drawing air from SW2-1 Road. In series with those was the fan exhausting air from the SW2-A heading. There are no records of airflows having been measured in the auxiliary systems.

8 May 1992 The Southwest airflows measured the day before the explosion are shown on map 6. Two exhaust fans remain side by side in SW2-2 Cross-cut. The corresponding ducts are both tee-jointed, one drawing air from SW2-3 Road and the advancing SW2-B heading, the other exhausting from SW2-1 Road and the Lefthander. Only two of these airflows were recorded: 5.2 kcfm in SW2-1 Road, and 5.3 kcfm in the SW2-B heading. A third fan exhausted air from the SW2-A heading, giving an effective five headings ventilated in series. The belt-strip stopping in SW1-2 Cross-cut continued to leak approximately 17 kcfm, with an additional 16 kcfm lost across SW2-1 Cross-cut and the conveyor belt stopping in SW1-B Road. These combined leakages represented 36 per cent of the air entering the Southwest section. The conveyor belt stopping was constructed from wood and plastic, and it had a personnel door.

[32] Bryce Capstick, in his testimony, explained these changes (Hearing transcript, vol. 42, pp. 9364–67). Eagles also discussed the situation in his testimony (vol. 76, pp. 16575–76).

Observations

The weaknesses of the main ventilation system in the North and Southeast sections not only appeared in the Southwest sections, but were also compounded by further defects. Not one permanent stopping was built anywhere in Southwest 1 or Southwest 2. All stoppings were flimsy constructions of wood, plastic, or, even worse, strips of conveyor belting. As in the northern sections, such structures were out of compliance with section 71(11) of the *Coal Mines Regulation Act*. The result was that high leakages occurred. Westray practised series ventilation throughout the lives of both Southwest 1 and Southwest 2 sections, with up to five headings ventilated in series.

Lack of planning or of forethought led to a loss of control of ventilation in Southwest 1 even before mining had to be terminated because of failing pillars. Recirculation was common and out of control. Given the ground conditions and heavy emissions of methane, the withdrawal of equipment from Southwest 1 was an extremely hazardous procedure. For more than two weeks – from 28 March to 13 April 1992 – the abandoned Southwest 1 section, although known to be filling with an explosive gas, was left with neither stoppings nor ventilation adequate to dilute and remove the gas safely. When the stoppings were erected, they were built from ¼-inch plywood in highly disturbed ground that continued to be unstable. Such structures were completely incapable of withstanding either strata pressures or any sudden air movement that might be caused by large roof falls or an ignition of gas within the abandoned area. Neither were they capable of preventing emissions of gas into the main ventilation system. Contrary to both the law and common sense, intake air for the Southwest 2 section was routed past those inadequate stoppings, beyond which the old workings were still actively producing methane.

Deteriorating ground conditions at the junction of SW1-C1 Road and SW1-3 Cross-cut led to a relocation of the Southwest 2 conveyor into an intake airway and necessitated the use of a return airway for access of vehicles, some of which were not designed for use in potentially gassy atmospheres.

Finding

The ventilation system in the Southwest section was consistently defective and inadequate. The ventilation system in the North Mains and the Southeast sections was also defective and inadequate. The litany of defects includes:

- **poorly constructed plastic stoppings, permitting air leakage of up to 55 per cent of the total airflow;**
- **the broken anemometer (with no replacement on site), which prevented the taking of airflow measurements for two weeks;**
- **low ventilation pressures and low airflows, which provided little or no air movement at the working faces where required to clear methane;**
- **intake air directed past the two plastic stoppings inbye the SW1-3 Cross-cut, which were leaking quantities of methane from the abandoned areas**

into the active workings of the Southwest 2 1 section and contributing to the methane-layering problem; and

- **placement of conveyors in an intake airway, necessitating the movement of non-permissible vehicles in the return airways.**

All these factors lead inexorably to the conclusion that Westray's management was either apathetic or, through incompetence, unaware of the implications of its actions and decisions in these crucial matters.

Auxiliary Ventilation at Westray

Section 71(9c) of the *Coal Mines Regulation Act* stipulates that an auxiliary fan must take not more than 40 per cent of the air passing the fan. This regulation is a safeguard against recirculation within the heading itself and was complied with at Westray. However, the intent of the regulation was circumvented by the excessive number of headings ventilated in series and by uncontrolled recirculation within the ventilation structure. Notwithstanding the weaknesses of the ventilation structure, the major cause of the difficulties experienced in the headings at Westray was a completely inadequate system of auxiliary ventilation. The method of auxiliary ventilation chosen was the fan-and-duct system, in itself an acceptable choice. However, problems arose not only from the overuse of series ventilation, but also from a combination of low airflows, ducting that was too small, incompatibility between the auxiliary fans and the choice of ducting, and ventilation ducts that were often split to service two headings at once, inadequately maintained, and, on frequent occasions, deliberately obstructed.

Airflow Requirements in Headings

The initial step in designing any system of ventilation in an underground coal mine is to assess the amount of air that will provide a safe and reasonably comfortable environment for mine workers. In the case of coal mines with significant emissions of methane, the airflow must be sufficient to dilute the gas at least to concentrations below the threshold limit values specified within the relevant regulations. Owing to the uncertainty involved in predicting rates of methane emission in specific work areas, it is prudent practice to design for gas concentrations well below the legal threshold limit values. At the points of emission, the atmosphere contains a very high concentration of methane that will therefore pass through the explosive range as it is diluted into the general body of air. Hence, a second consideration is that the air velocity should be sufficient to cause efficient mixing of the gas and to ensure that it does not accumulate as pockets or layers. Since it is lighter than air, methane tends to form layers along and under the roof of mine entries if not mixed into the air.[33]

[33] See the section on buoyancy effects and methane layers in Chapter 8, Methane.

On the basis of seam gas content studies, an average methane content of the coal in the Pictou coalfield was assessed to be 4.25 m^3/t.[34] If one assumes that 10 per cent of this is emitted before the coal leaves a heading, and that coal is mined at a rate of 6 tonnes per minute, the gas emission rate would be 0.0425 m^3/s.[35] If this is to be diluted to a general body concentration of 0.625 per cent (half the threshold limit value at which electrical power must be switched off), the required airflow is 0.0425/0.00625, or 6.8 m^3/s (14.4 kcfm).

Methods are available for calculating the velocity of the general airstream to prevent methane from layering along the roof, as is discussed in the section on methane layering in Chapter 8. However, considerable uncertainty exists about the proportion of methane that remains unmixed by the motion and turbulence caused by a mining machine and other face equipment. Furthermore, gas will be emitted not only from the coal actually being fragmented, but also from ribs and standing faces. Indeed, gas from these latter sources is more likely to stream upward to form a roof layer.[36] For these reasons, a pragmatic, though inexact, approach is to select an air velocity that experience has shown to minimize the formation of methane layers. In the United States, the minimum air velocity to be maintained in exhausting face ventilation systems is set at 60 feet per minute (0.3 m/s):

> **75.326 Mean entry air velocity.**
> In exhausting face ventilation systems, the mean entry air velocity shall be at least 60 feet per minute reaching each working face where coal is being cut, mined, drilled for blasting, or loaded, and to any other working places as required in the approved ventilation plan. A lower mean entry air velocity may be approved in the ventilation plan if the lower velocity will maintain methane and respirable dust concentrations in accordance with the applicable levels. Mean entry air velocity shall be determined at or near the inbye end of the line curtain, ventilation tubing, or other face ventilation control devices.[37]

There is no minimum air velocity mandated in the regulations governing coal mining in Nova Scotia.

For the large rectangular entries (6 × 3.5 m nominal size) that were driven at Westray, layering of air and gas streams occurs more readily. Hence, it would have been appropriate to employ the higher value of 0.4 m/s.[38] This gives the airflow required to inhibit methane layering to be 6 × 3.5 × 0.4, or 8.4 m^3/s (17.8 kcfm), indicating that it was the inhibition of methane layering, rather than gas dilution, that was the dominant factor in arriving at an appropriate airflow for headings at Westray. *None of the*

34 Jacques, Whitford and Associates Limited, 10 August 1984 (Exhibit 73.01); Suncor, 11 September 1984 (Exhibit 73.01); Algas Resources Ltd, March 1981 (Exhibit 73.03).

35 Norwest Resource Consultants Ltd, July 1986 (Exhibit 8, s. 13).

36 See figure 8.2 in Chapter 8, Methane.

37 *Code of Federal Regulations,* Title 30, Mineral Resources [30 CFR], Part 75, Mandatory Safety Standards – Underground Coal Mines (Washington, DC: Office of the Federal Register, National Archives and Records Administration, 1 July 1996).

38 Exhibit 8, s. 13.1.3.

measurements of auxiliary ventilation during the three months before the explosion reached 8.4 m^3/s.

In the Westray Coal Inc. Manager's Safe Working Procedures (G. Phillips, 15 December 1988), a minimum airflow of 2.5 m^3/s (5.3 kcfm) was required within 8.5 m of the face in coal driveages when no diesel equipment was in the heading.[39] Measurements of airflows in the ducts of the auxiliary ventilation systems were not undertaken each week or in all ducts. Those measurements that were reported in Eagles's weekly reports are shown in table 7.1. There appears to have been a distinct deterioration in airflows in auxiliary ventilation ducts during the 2½ months prior to the explosion. The limited frequency of sampling and the sparsity of sampling points make rigorous analysis impossible. However, we note that the 11 readings taken in February and March 1992 range from 5.2 to 17.0 kcfm, with an average airflow of 11.5 kcfm. The eight (different) points sampled in April and May had airflow ranging from 4.7 to 7.8 kcfm, with an average of 5.8 kcfm.

If the effects of leakage into the ducting are not taken into account, half of those airflows in the month preceding the explosion comply with the 2.5 m^3/s (5.3 kcfm) specified in the Manager's Safe Working Procedures of 1988. However, a comparison with the 8.4 m^3/s (17.8 kcfm), shown to be advisable in order to inhibit methane layering, indicates that the value given in the Manager's Safe Working Procedures was totally inadequate and that the measured airflows in the headings at Westray were only 26 to 44 per cent of the airflow required to inhibit methane layering. An airflow of 2.5 m^3/s distributed over a cross-section of 6×3.5 m gives an average air velocity of only 0.119 m/s, or 24 feet per minute. Such a velocity would be imperceptible to personnel, and the air would appear to be effectively stagnant. Dave Matthews, a Westray miner, described working conditions in the North A, B, and D Road headings: "There was air movement, but very little . . . the dust would be pretty stagnant, would stay around for a long while."[40]

Specifications for Auxiliary Ventilation

On 19 February 1992, Robert Parry, the maintenance superintendent, applied to the Nova Scotia Department of Labour (Mine Safety Division) for permission to use five auxiliary fans of motor power 37 kW (50 horsepower) and 18 auxiliary fans of motor power 18.5 kW (25 horsepower).[41] All these fans were described as being manufactured by Engart, used, and in good condition. The fans were stated as having flameproof motors designed for use in underground coal mines and had been certified by the British Certifying Authority in Buxton, England. Letters of approval for the fan specifications were issued by director of

39 Exhibit 37a.118. This is page 1 of the Manager's Auxiliary Ventilation Plan – Coal Driveage.

40 Hearing transcript, vol. 31, pp. 6525–26.

41 The fans were denoted on the ventilation reports and accompanying maps as having motor powers of 40 and 20 horsepower, respectively.

mine safety Claude White on 4 March 1992.[42] The documentation did not indicate either the electrical frequency for which the motors had been designed or the rotational speed of the impellers. The manufacturer's specification data indicated that all the fans ran at a speed of 2,850 rpm.[43] Because this was a British specification, it is implied that this speed was attained at an electrical frequency of 50 Hz (current alternating at 50 cycles per second).

These fans had been purchased as used equipment from British Coal (formerly the National Coal Board) in the United Kingdom. The motors had been designed to run on an electrical frequency of 50 Hz. The standard frequency of electrical power supplied by utilities in North America is 60 Hz. The speed of rotation of a fan is proportional to the electrical frequency; hence, when supplied with 60 Hz electrical power, it would run at 20 per cent above its design speed.[44] This would have several consequences. First, when connected to a duct of a given (fixed) resistance, the fan would pass 20 per cent more air (60/50). Second, the pressure developed by the fan would increase by 44 per cent ($(60/50)^2$). Finally, the air power developed by the fan would rise by some 73 per cent ($(60/50)^3$). The last effect would place an abnormally heavy load on the motor and reduce its life considerably. Auxiliary fans burned out frequently at Westray, resulting in the motors' having to be rewound.[45]

Section 71(9d) of the *Coal Mines Regulation Act* states:

> An auxiliary fan may be installed or operated in a mine only on the written permission of an inspector and, after such fan has been installed it shall be situated on the intake side and at least 20 feet out by the last open cross-cut or entrance to the place being ventilated.

The location of the fan specified in this regulation clearly indicates that a forcing system should be employed. Similarly, forcing fan-and-duct systems of auxiliary ventilation were specified to be used at Westray in the Manager's Safe Working Procedures.[46] Notwithstanding those legal and company mandates, a letter sent by Kevin Atherton, senior mine engineer at Westray, to Albert McLean of the Department of Labour on 15 October 1991, requested permission to use auxiliary fans in both forcing and exhaust configurations.[47] The letter indicated a number of limitations that would be imposed on the use of auxiliary fans. Three of these were that fans would be operated continuously, that they would be operated such that recirculation did not take place, and that ducting would be maintained to "within 10 m of the face, or as required to deliver an adequate supply of air to within 5 m of the face." The weekly ventilation reports indicate

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42 Exhibit 69b.155–62.

43 Exhibit 38.12.

44 John Bossert discussed this point in his testimony (Hearing transcript, vol. 12, pp. 2103–04).

45 Mick Franks testified to this effect (Hearing transcript, vol. 21, pp. 4153–54; vol. 22, p. 4199). Harvey Martin also noted the frequency of auxiliary fan burnout (vol. 23, pp. 4496–97).

46 Exhibit 37a.126, 129–32. Diagrams 1, 4–7, show the forcing system only.

47 Exhibit 37a.136–7.

that, in practice, these conditions were not fulfilled. The Inquiry has been unable to trace a written response to that letter. During the three months preceding the explosion, there was only one location in which a forcing system of auxiliary ventilation was used (see the earlier section in this chapter, Throughflow Ventilation in the Southwest Sections (19 February, 26 February, and 4 March 1992)). All others employed an exhaust arrangement.

The relative merits of forcing and exhaust arrangements of auxiliary ventilation and of fan-and-duct systems were discussed earlier in this chapter. The inbye end of a line of ducting should be maintained as close as practicable to the face. As noted in his letter to McLean, Atherton specified that the duct would be maintained "as required to deliver an adequate supply of air to within 5 m of the face." It is impractical, however, to locate the inbye end of the duct so far forward that it interferes with the operation of the continuous miner. The distinct advantage of a forcing system in gassy conditions is the jet of air projected forward beyond the end of the duct. Conversely, an exhaust system gives poor control of airflow at the face (see figure 7.8). Therefore, in addition to remaining in compliance with the law, a forcing system of auxiliary ventilation would have been preferable at Westray. Because exhaust ventilation was used in all but one of the auxiliary systems at Westray, it became even more important to maintain the end of the ducting close to the face. In one of the airflow measurement reports, a duct was reported as being approximately 30 m back from the face.[48]

In the design of a fan-and-duct system, the size and configuration of the ducting must be compatible with the fan capacity. There are several approaches. Each begins with specifying the airflow. To diminish methane layering in the headings at Westray, an airflow of 8.4 m^3/s (17.8 kcfm) has been suggested earlier in this chapter as appropriate. One guideline, used to provide acceptable pressures within the ducting, is to assume an air velocity of 10 m/s in the duct. The standard diameter of ducting that will produce that airflow and velocity is 1,050 mm (42 inches). The 37 kw fans were capable of passing the required airflow of 8.4 m^3/s.[49] However, the ducting used at Westray was 750 mm (30-inch) diameter spiral-reinforced flexible tubing. That gave a resistance to airflow of more than five times greater than the larger-diameter duct of the same construction ($(42/30)^5$).

The smaller-diameter ducting would fail to allow the required airflows when the fans that were provided were used. Furthermore, the higher-powered auxiliary fans would have given static pressures in excess of 2 kPa (8 inches water gauge) for duct resistances that resulted in airflows of less than 6.6 m^3/s (14 kcfm).[50] The majority of auxiliary airflow measurements were considerably below this figure and resulted in excessive suction pressures being applied to those sections of ducting

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48 18 March 1992 (Exhibit 37a.067).

49 Performance curve for Model B70 (Exhibit 38.12).

50 Performance curve for Model B70 (Exhibit 38.12).

closest to the fan. Furthermore, if a fan had been running at a speed greater than its design value of 2,850 rpm owing to its being supplied with 60 Hz electrical power, the situation would have worsened. Not surprisingly, inward collapses of ducting were common at Westray. The matter of the type and size of ducting was raised as a concern by the engineer responsible for airflow measurements. Eagles had talked to the underground manager "about using three-inch pitch next to the fan to try to prevent the problem from happening."[51] He commented to the Inquiry that "they could have gone to a rigid duct . . . constructed out of an anti-static fibreglass . . . which would have been the ideal solution."[52]

Use and Maintenance of Ducting

The spiral-reinforced ducting of the type used at Westray is manufactured from a flame resistant material sewn around a spring-steel-wire spiral. The spring steel keeps the ducting open when it is bent around corners and when it is subjected to a negative gauge pressure, as in an exhausting auxiliary ventilation system. The pitch (spacing between spirals when fully stretched) is normally 150 mm (6 inches) for ducting in a forcing system and 50–100 mm (2 to 4 inches) for exhaust applications. At Westray, the ducting was hung from roof screen by hooks attached to grommets in a reinforced webbing running along the top of the tubing. The ducting was supplied in 7.6 m (25-foot) lengths. The couplings between sections of ducting were made of circles of wire rope sealed into the end of the material. Those circular bands could be inserted one inside the other and reinforced by metal clamps.

Damaged ducting, common at Westray, was mentioned in "ventilation survey" reports and during the testimony of mine personnel.[53] The damage would have inevitably resulted in leakage of air into the duct, leaving the headings, already with dangerously low ventilation, with even further reductions in their airflows. It was also in contravention of section 71(9e) of the *Coal Mines Regulation Act*.[54]

The incompatibility between the ducting and the higher-duty fans is also reflected by the number of examples of ducting damaged by inward collapse. For example, the night-shift foreman for Southwest 2 section reported on 7 May 1992: "v-tube collapse on new fan."[55] Such a collapse would flatten and effectively close the ducting against passage of air. The reaction of the fan would be to increase the suction pressure and seal the collapsed section even more tightly. The fans could possibly operate in a

51 Hearing transcript, vol. 76, p. 16510.

52 Hearing transcript, vol. 76, p. 16544.

53 Trevor Eagles (Hearing transcript, vol. 76, pp. 16510–13, 16543); Don Dooley (vol. 36, pp. 7836–37).

54 ". . . air ducts or tubing shall be maintained in such condition as to minimize air leakage and to ensure an adequate supply of air being delivered within fifteen feet of the face."

55 Exhibit 42h.0061. Buddy Robinson also confirmed collapsed ducting (Hearing transcript, vol. 30, p. 6444). Eagles discussed the matter in some detail (vol. 76, pp. 16422, 16496, 16507, 16509–11, 16531).

stalled condition in these circumstances, resulting in increased noise levels and vibration. The effect of collapsed ducting would be to reduce the ventilation of the headings to near zero.

As indicated on the ventilation maps produced to illustrate the weekly airflow measurements,[56] tee-jointed ducts were used frequently. In this arrangement, a single duct, connected at one end to an exhausting fan, was divided further inbye into two ducts in order to draw air from a pair of adjacent headings. A prefabricated flexible tee-shaped (or "y"-shaped) piece was used at the junction of the ducts. This is an acceptable practice, provided the single duct and the fan to which it is connected both have the capacity required to ventilate two headings adequately. This was not the case at Westray. Indeed, no duct passed the 8.4 m^3/s deemed appropriate to ventilate even a single heading properly. While all fan-and-duct systems should be well engineered, a careful design is particularly important when a tee-jointed arrangement is to be used.

The most disturbing treatment of ventilation ducting in the Westray headings was the deliberate obstruction of one side of a tee-jointed duct system. In the pairs of headings that were ventilated in this manner, it was common for roof bolting to be in progress in one heading while active mining was carried out in the other. Because of the inadequate auxiliary ventilation, methane concentrations often rose to unacceptable levels. While such levels were dangerous in both headings, they were particularly so in the heading where mining was taking place, on account of the concentration of equipment and friction at the pick points of the continuous miner. Furthermore, when properly fitted to the continuous miner, a methanometer would cut off electrical power from the machine at a preset level of gas concentration. This caused frequent interruptions to the production of coal. In those circumstances, a common practice at Westray was to restrict airflow to the duct in the roof bolting heading in an attempt to improve the ventilation in the adjacent mined heading. Wyman Gosbee recalled roof bolting in the SW2-1 heading on 7 May 1992 – less than 48 hours before the fatal explosion – when his foreman, Arnie Smith, came into the heading and "he took the piece of rope and he wrapped it around the vent tube, and he just cinched it up, choked it right off." When Gosbee asked him what he was doing, Smith replied that " 'we need the air over there to mine.' "[57]

Restrictions were applied in one of two ways. The first was to apply a wire screen to the inlet end of the duct and to cover it with plastic sheeting, effectively sealing the duct. The second was to restrict the ducting partially, by tightening a length of wire around it in the manner of a tourniquet. In either case, the practice can be described only as extremely

[56] Exhibit 45.01.

[57] Hearing transcript, vol. 25, p. 5022. A number of other witnesses also testified about blocking vent ducts: Eagles (vol. 76, p. 16511); Wayne Cheverie (vol. 21, pp. 4046–47); Lenny Bonner (vol. 24, pp. 4785–89); Doug MacLeod (vol. 27, pp. 5647–51); Randy Facette (vol. 33, p. 7241); Don Dooley (vol. 36, pp. 7862–66); Jay Dooley (vol. 39, pp. 8657–61 and vol. 41, p. 9129); Bryce Capstick (vol. 42, pp. 9382–83).

hazardous and foolish. The total, or partial, restriction of ventilation to a heading would have been imprudent even in an inactive heading at Westray, because of gas emissions. To restrict ventilation while operations were in progress was patently reckless.

Finding

The auxiliary ventilation system at the Westray mine was defective in several ways. Some of the more hazardous defects were:

- **It was ineffective in removing the methane from the working face.**
- **The exhaust system of auxiliary ventilation (used in all but one location) was contrary to the *Coal Mines Regulation Act* and Westray's own Manager's Safe Working Procedures.**
- **In most cases, the ventilation ducting was too small for the size of the auxiliary fans. This situation resulted in high resistance in the ducts and excessive suction, which caused collapsing of the ducts and loss of ventilating air to the working faces.**
- **Poor airflow to the face permitted the accumulation of high levels of methane, which, in turn, caused the continuous miner to shut down until the methane was cleared and safe operating levels attained. To alleviate this gas accumulation and direct more intake air to the working face, miners would, on occasion, block the ventilation ducting serving the roof bolters – a reckless and foolhardy practice.**

Concluding Comments on the Ventilation at Westray

In his commentary on the evidence following the hearings, Inquiry ventilation expert Malcolm McPherson made the following observations:

> Minimal thought seems to have been given to the planning and control of ventilation in any section of the mine. Indeed, little was done in accordance with either the law or prudent practice. Decisions appear to have been made in an ad hoc manner to produce a temporary alleviation of an immediate problem. The result was a series of "band-aid" fixes, each of which led to an even greater difficulty. The problems were self-accumulating and created a very high probability that the mine would suffer a major hazardous incident early in its life.
>
> Recommendations made by the engineer who took the airflow measurements were either ignored or delayed for inordinate periods of time. The weakness of mixing engineers' responsibilities between mine production and matters relating to safety, and in not engaging persons totally dedicated to ventilation and safety, was demonstrated all too tragically at Westray.

Ventilation Planning

The planning of ventilation for an underground mine is a vital component of the overall mine-planning procedure. Unless the airflow system is carefully engineered, it will lack efficiency and effectiveness throughout the life of the mine, reacting adversely on mine productivity and perhaps causing premature cessation of mining. A poorly planned system may

result in the underground environment's not meeting minimum legal requirements. It may also lead to both short- and long-term health problems for mine workers and, at worst, result in the tragedy of a mine disaster involving multiple fatalities. Ventilation planning should therefore be carried out by people knowledgeable about the appropriate legislation and skilled in the discipline of underground mine ventilation engineering. Planning of the subsurface airflow systems is an essential part of the total mine-planning procedures and should be integrated into matters relating to mining layouts, production targets, ground control, and types and sizes of equipment to be employed.

The need for ventilation planning does not stop when a new mine becomes operational. The condition of the ventilation system must be checked regularly and, when appropriate, the long-term plans must be updated to take account of variations in the mining layout, in airway conditions, or in emission rates of airborne contaminants. In this section of the chapter we discuss, first, the initial ventilation planning of a proposed new mine and, then, the ongoing procedures of ventilation planning once the mine has entered into production.

Ventilation Planning for a New Mine

A proposed mining operation begins with feasibility studies before a decision is made to proceed. The next phase, the engineering phase, will involve a detailed investigation of all the technical aspects of a modern mining undertaking. During this phase, ventilation planners should work closely with others who are designing alternative mining layouts and the step-by-step development of the mine for as many years as can sensibly be foreseen, given proven reserves and established markets. The ventilation planners are particularly concerned with the length, number, size, and interconnectivity of the underground openings. These are also important matters to ground control engineers, who are responsible for the stability of those same openings, and to operations planners, who must ensure that the entries satisfy the requirements of moving equipment, traffic control, and transportation of the mined material. A number of iterations are usually undertaken before all requirements for the underground structure are satisfied.

An initial task for ventilation planners is to assess the airflow requirements at working faces as well as at other areas and facilities requiring ventilation, including underground workshops, electrical equipment, transportation routes, and pump stations. The heaviest demands for airflow occur at the working faces. Using data that may have been obtained from borehole samples or neighbouring mines, engineers estimate probable methane emission rates. They also assess dust, heat, and humidity. Diesel exhaust emission rates can be calculated from machine specifications. Calculations can then be carried out to determine the airflows required to dilute and remove those contaminants in a safe and effective manner.

A number of time phases projecting through the predictable future of the mine should be selected. These will typically include the early stages of development, the initial production, and then two-year intervals, extending to five-year intervals, throughout the planned life of the mine. The ventilation planners will concentrate on periods of particularly heavy demand on the ventilation system. These will include periods when faces are at their greatest distance from main airways, and times of transition – when additional districts may require ventilation simultaneously. For each of the time phases, the airflow requirements should be determined and indicated on a corresponding map. The next step is to determine the optimum location and duties of main fans and whether modifications will be necessary to the initial estimates of the number and sizes of airways. In the case of a relatively simple mining layout, such as the one at Westray, the location of the main fan(s) is often prescribed.

The methods used for planning mine ventilation layouts have changed radically since the mid-1960s. Earlier methods relied on summing pressure differentials along the longest intake and return routes, based on assumed airflows, to arrive at a rough assessment of required fan pressures. Since the 1960s, computer simulation packages have become readily available, enabling ventilation planning to be carried out with unprecedented precision and speed. Mine ventilation network analysis by computer has been conventional textbook material since 1982, and it is now routinely practised throughout the world.

Such analysis concentrates initially on the main ventilation structure rather than on auxiliary ventilation systems. Identifying numbers are allocated to junctions of airways in the layout under investigation. Data relating to all branches represented in the ventilation network are then entered into the computer. For a proposed new mine, the data involve the length and dimensions of each branch, together with a measure of the roughness of the airway lining and matters relating to bends or other factors that introduce additional resistance to airflow. Fans of selected pressure-volume characteristics may be entered at locations throughout the network. The computer can then rapidly produce tabulated listings and graphic depictions of the network, showing the distributions of airflows, pressure differentials, airway resistances, operating costs, and other parameters that may suggest improvements to the system. The ventilation planner can make modifications and rerun the simulation in seconds. Through such means, alternative ventilation layouts can be investigated rapidly to arrive at an optimum system.

Each simulated ventilation system that appears to be practicable and efficient is subjected to a number of acceptability checks. The predicted system is examined to ensure that it complies with all legal requirements. Air velocities must lie within specific ranges. If they are too low, problems may arise from inefficient mixing and delays in the removal of gases or airborne dust. Air velocities close to the normal travel speeds of diesel vehicles should be avoided so that drivers do not remain within the exhaust fumes when travelling in the same direction as the airflow. Air

velocities that are too high will give rise to dusty conditions, causing discomfort and creating health hazards. Considerations of air velocity may necessitate changes in the number and sizes of mine entries. If the airflow requirements initially established for a particular time phase have been met, the dilution of contaminants to safe and legally acceptable levels will have been satisfied. These levels are subject to an additional check, however, in light of predicted airflow patterns.

Checks are carried out on alternative escapeways from the mine in the event that normal travel routes become inaccessible. Ventilation network analysis exercises should be carried out to investigate the travel paths of smoke and toxic gases from fires that might occur at critical locations within the system. These exercises are valuable for designating selected routes as escapeways and for choosing locations for refuge chambers underground.

The economics of the system should also be analysed in order to optimize between capital and operating costs – whether, for example, it makes sense to pay for a larger main entry, with consequent lower fan-operating costs. The main fans should be selected so that they can handle the wide range of duties that may be required over their life span. Similarly, the number and size of main entries to be driven should suit an economically acceptable period of time, such as the 15-year projected lifespan of the Westray mine. The series of analyses conducted for each period should be monitored for continuity between time phases. For example, if one knows that a new surface connection will be required at some future date, then it may be more cost effective to drive it before it becomes absolutely necessary. The speed and versatility of ventilation simulation software have enabled this level of detail in planning to be used routinely.

Initial Ventilation Planning for the Westray Mine

The ventilation planning carried out before construction of the Westray mine was limited to the relevant sections in three feasibility studies: The first of these, entitled "Suncor Inc. Pictou County Coal Project Feasibility Study," was prepared by Norwest in 1986.[58] Section 13 of that study dealt with ventilation of the mine. Although Norwest used the older, traditional techniques of mine ventilation planning, its treatment of ventilation was the fullest of the three studies.

The Norwest study refers to methane desorption tests conducted by Suncor on borehole samples of coal seams in the Pictou area. A large-scale study had been carried out by Novacorp Engineering (formerly Algas Resources Ltd) on the Pictou coalfield in 1980. While the maximum value of total gas was recorded as 6.6 m^3/t (cubic metres per tonne), the average value was 2.4 m^3/t, and only 6 per cent of the samples showed gas content

[58] Exhibit 8. An earlier report prepared by Norwest for Suncor, submitted in January 1985 (Exhibit 12), involved access by vertical shafts and shortwall mining methods. Section 9.6 of that report gives a two-page outline of the ventilation arrangements envisaged for that mining layout.

in excess of 5 m^3/t. Norwest chose an average gas content of 4.25 m^3/t for the purposes of assessing ventilation needs. This seems a reasonable assumption in the absence of empirical values obtained from mining experience in the area. Norwest assumed that 10 per cent of the total gas content would be emitted into the working face, based on a residence time of 10 minutes before fragmented coal was removed from the face area. No separate account was taken of emissions from standing faces or ribs.

For room-and-pillar faces, Norwest assessed a required airflow of 4.8 m^3/s (10.2 kcfm) to dilute methane to a concentration of 0.9 per cent. A preferred technique would have been to base airflow requirements for methane emissions on a dilution to one-half the mandatory threshold limit value (TLV) at which electrical power must be shut off. In the case of Nova Scotia, this TLV is 1.25 per cent methane. The corresponding airflow in a room-and-pillar heading (using Norwest's assumed gas emission rate) becomes 6.8 m^3/s, or 14.4 kcfm.

The Norwest report was the only study that considered air velocity. To prevent the layering of methane along the roofs of headings, Norwest proposed a minimum air velocity of 0.4 m/s, which was entirely reasonable, although a higher velocity may have been required in some areas to prevent the formation of methane layers. Unfortunately, the study did not take the next logical step of recommending the corresponding airflow, by multiplying the minimum velocity by the cross-sectional areas of the entries.

Norwest commented on tests that had previously been conducted on the propensity to spontaneous combustion of the Foord and Cage seams. These tests seem to have been based entirely on experiments carried out on samples of the coal and appear to ignore the many other mining and atmospheric factors that also influence the susceptibility of any given coal mine to spontaneous combustion. The authors of the Norwest study appear unimpressed with the reliability of those tests.[59]

In designing a mine ventilation system, it is inadvisable to locate a conveyor where it will pass through a main airlock, because this passage can raise coal dust in addition to being a source of air leakage. Since the Westray slope conveyor was to be located in the return airway, Norwest recommended a forcing system of ventilation, with the main fan located near the top of the intake slope. Personnel and materials would have to pass through an airlock, but the conveyor would be left unimpeded.

The Norwest study projected total airflow requirements for each of the first four years in the life of the mine. These forecasts were based on assumed air leakages – a traditional but imprecise method. Similarly, the old technique of summing pressure drops was used to estimate the corresponding pressures to be developed by the main fan. In the fourth year, the fan duty was projected to rise to an airflow of 155 m^3/s at a pressure of 2145 Pa. The cost of heating the intake air by propane during the winter months was also addressed.

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[59] Exhibit 8, s. 13.2.

The Norwest study included a calculation on the fans and ducting required for the auxiliary ventilation of headings. To accommodate a medium-sized supply vehicle in a heading, the recommended minimum airflow at the face was increased from 4.8 to 6.6 m^3/s. For that airflow, Norwest suggested a duct diameter of 915 mm (36 inches). If we ignore the effects of leakage, this size implies an air velocity in the duct of 10 m/s, which agrees with the design value often used as a first approximation for duct air velocity. Using an airflow of 8.4 m^3/s to reduce the risk of methane layering (as discussed earlier in this chapter, in the section on Auxiliary Ventilation Systems Used at Westray), and employing a nominal duct velocity of 10 m/s, we arrive at a required minimum diameter of ducting of 1,034 mm. In practice, this would be rounded up to the nearest standard duct size of 1,050 mm (42 inches).

Section 71(9c) of the *Coal Mines Regulation Act* requires that auxiliary fans not draw more than 40 per cent of the airflow available at the inlet to the duct. Taking this figure and duct leakage into account, the Norwest study arrived at an airflow of 23.75 m^3/s to be available at the outbye end of a heading. If the value of 8.4 m^3/s had been used for the heading airflow, and allowing a duct leakage of 20 per cent, the corresponding estimate of available airflow would become $8.4 \times 1.2/0.4 = 25.2$ m^3/s, or 53.4 kcfm.

A second feasibility study was assembled by Placer in July 1987.[60] The section on ventilation was limited to a single paragraph and a "general ventilation flow" figure that shows a few airflows without background justification. Again, reference was made to the tests for gas content of the coal. A main forcing system of ventilation was chosen, with a fan duty of 175 m^3/s at a pressure of 2,080 Pa. Each of the mine sections was to receive an airflow of 19 m^3/s. Here again, there is no indication of how these values were determined. The treatment given to ventilation in this study can only be described as trivial.

The third study, undertaken for Westray Coal Inc. by Kilborn, was submitted in 1989.[61] Section 3.5 of that report deals with ventilation of the mine and is limited to one page. The treatment is simplistic. It assumed a coal production of 450 t per section, producing gas at a rate of 6.2 m^3/t. This gave a gas emission rate that necessitated an airflow of 20 m^3/s to dilute it to a concentration of 0.5 per cent. For five mining units, the required airflow was, therefore, 100 m^3/s. A volumetric efficiency of 55 per cent was assumed (airflow usefully employed divided by airflow at the main fan), giving a main fan airflow of 180 m^3/s. The corresponding fan pressure was stated to be 2,100 Pa, based on the summation of frictional pressure drops of 800 Pa in each main slope and 500 Pa across

60 Exhibit 10.2, "Pictou Project, Feasibility Study: Volume 2 – Mining." This document appears to have been put together from contributions by Placer US, Suncor Inc., and Associated Mining Consultants Ltd. (AMCL), with information drawn from previous documentation by Golder Associates (1984–86), Norwest Mining Consultants (1986), AMCL (1987), Nova Scotia Mines Inspection Reports (1873–1951), the Geological Survey of Canada (1987), and a Suncor geological report (1986).

61 Exhibit 4, "Technical and Cost Review of the Pictou County Coal Project: Nova Scotia."

the split of maximum pressure drop. These values were not backed up by calculations shown in the report. As in the Norwest study, a forcing system of ventilation was recommended, with the main fan sited at the top of the intake slope.

In the case of headings, an airflow of 5 m^3/s was stated to be required at each working face, with ducting sizes of 600 mm diameter (approximately 24 inches). Again, no justification was given for these values. This study recommended the installation of an underground environmental monitoring system to monitor concentrations of carbon monoxide and methane at strategic locations and to record those parameters continuously at the mine surface.

In summary, the treatment of ventilation in the 1986 Norwest study was of the nature of an initial overview that might be produced in preparation of a full ventilation-planning study. The single paragraph on ventilation in the 1987 Placer report indicates that ventilation was not treated as a serious part of that study. And the Kilborn treatment of 1989 was elementary and indicates that little effort was made to analyse ventilation. Feasibility studies for any proposed new mine should, as the term suggests, entail investigations into whether the project under consideration is feasible from every consideration – technical, financial, human resources, marketing, and environmental. The results of feasibility studies provide sufficient information for a decision on whether to proceed with the project. If that decision is positive, a comprehensive engineering study should be initiated to provide the detailed specifications for every technical aspect of the work.

There appears to have been no organized and documented engineering study carried out for Westray. Hence, there is no record of properly constituted ventilation plans having been produced. In the absence of such plans, it is almost ludicrous that the Westray mine could be approved either by the financing agencies or by the regulators. We reviewed an example of a ventilation plan submitted for approval under the U.S. *Code of Federal Regulations*. The plan is a 75-page document of impressive scope and detail. It comprises monitoring and degasification procedures; detailed drawings of typical seals, doors, dust and methane control methods, and bleeder systems; drawings of typical mining and ventilation procedures; a detailed cutting sequence plan, including bolting and line brattice detail; equipment lists; dust sampling plan; and a procedure for maintenance of underground workings during monthly scheduled fan stoppages.[62]

Such plans are a necessary component in ensuring that the mine can develop safely, efficiently, and productively over its predicted life.

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62 Jim Walter Resources, Inc., Blue Creek No. 3 Mine, "Ventilation System and Methane and Dust Control Plan," (Adger, Ala.: JWR, Inc. 1995). This six-month update was approved by MSHA under 30 CFR 75.370 in January 1996. Charles Dixon, senior vice-president of engineering with JWR, provided the Inquiry with a copy of the complete plan.

Finding

Ventilation planning for the Westray mine did not address the requirements for a comprehensive system of fresh-air circulation and methane removal. The plan on which the ventilation was based was merely a brief outline in a feasibility study. A comprehensive engineering study by competent ventilation experts was not completed and documented before approvals were requested. The regulating agency, in this case the Department of Natural Resources, could not assess the efficiency or the safety of the ventilation system of the proposed Westray mine.

Ongoing Ventilation Planning and Control

The essential difference between a mine ventilation system and the ducts that may appear in a surface building is that a mine is a dynamic entity, continually changing. Individual entries change their shape and cross-section as a result of strata stresses as well as movement of equipment and stored material. Stoppings, doors, and other ventilation controls have their leakage characteristics modified through usage and, again, movements of the strata. As the mine progresses, sections become depleted of mineral reserves and are abandoned while new sections are opened up. Throughout the life of an underground mine, it is necessary to maintain ongoing vigilance about the changing nature and geometry of the airflow network. Two separate sets of procedures should be undertaken by engineers responsible for the ventilation of a mine. First, measurements of airflows should be made at relatively short time intervals and at strategic locations. Second, at greater time spans it becomes necessary to undertake full and detailed ventilation surveys of frictional pressure drops and corresponding airflows in order to provide accurate data for the longer-term planning of the mine ventilation system.

Routine Measurements

At Westray, routine measurements of airflow were made at weekly intervals, from February 1992 onward. That should be an acceptable frequency in most circumstances. Additionally, it is prudent to require section supervisors to take airflow measurements at the beginning of each shift. This is a mandatory part of preshift examinations in the United States.[63] The purpose of these weekly and daily airflow measurements is to ensure that all places in which personnel work or travel receive enough air to provide a safe and legal atmosphere. A secondary reason for the weekly measurements is to check that the actual ventilation of the mine follows, and is in reasonable agreement with, the prescribed ventilation plans.

While taking routine measurements, the mine ventilation engineer should also note and make observations on fan pressures, pressure differentials between intake and return entries, and such measurements of

[63] 30 CFR 75.360.

air quality that may be of concern. In a coal mine, the air-quality measurements will include concentrations of methane and, perhaps, airborne respirable dust. Notes should also be made on the conditions of doors, stoppings, regulators, and air crossings. Necessary repair work should then be carried out expeditiously. Those control devices are subject not only to strata stresses, but also to penetration for pipes and cables. Air leakage in such circumstances can reach serious proportions. Auxiliary ventilation systems should also be inspected for damaged and restricted ducts, and for excessive leaks. While such checks and observations were recorded at Westray by Eagles, little action was taken in response to the problems that he reported.

Ventilation Surveys

We have outlined the modern procedures of ventilation planning for a proposed but yet unconstructed new mine. In the absence of hard data, it was necessary to describe the condition of each proposed airway in terms of length, cross-section, and an estimated friction factor that relates to the surface roughness of the airway lining. Friction factors for the various airways are selected from empirically derived values listed in the literature of mine ventilation. All of those geometric parameters are used to assess a *predicted* resistance that each airway will offer to the passage of air. As the main entries of the mine come into existence, it is prudent to measure their *actual* resistance. This is accomplished by conducting a *ventilation survey*.

At Westray, the weekly routine measurements of airflows were misnamed "ventilation surveys." A true ventilation survey is a carefully organized procedure, well managed and subject to quality assurance checks to minimize the chances of error. The procedure involves selecting one or more routes around the structure of throughflow airways, each route commencing and finishing at the same junction (that is, following a closed loop). Measurements are taken with newly calibrated instruments that allow accurate values of air volume flow and frictional pressure drop to be established. A network of the actual mine ventilation system is established as a computer model. The purpose of ventilation surveys is to provide and update the data required for ongoing ventilation planning.

Ventilation surveys should be conducted by personnel who are well trained and experienced in mine ventilation. New surveys are required throughout the life of the mine for a number of reasons. First, as discussed, the geometry and, hence, the resistances of individual entries vary with time and from diverse causes. Second, new airways are added and older ones removed from the ventilation infrastructure as the mine progresses through its life. Third, ventilation controls also change with time and location: doors and stoppings alter their leakage characteristics, and fan performance changes as a result of impeller wear, accretions, and erosion. The interval between surveys depends on the rate at which physical changes occur in the mine, but is typically six months to one year. One further factor that necessitates periodic review of ventilation plans is that

mine development may deviate from the layouts initially intended and on which the original ventilation plans were based.

There were no ventilation surveys, if one uses the term correctly, carried out at Westray. Such surveys should have been conducted at the time the main slopes were completed down to No. 9 or No. 10 Cross-cut, and again following the development of the main airways into the Southwest and North sections. Westray did acquire ventilation network analysis software, and it employed it, between August and December 1991, in an attempt at long-term planning. However, the input was based on geometric and literature values rather than on real measured data. In the event, the haphazard development of the mine rendered such efforts fruitless.

Splitting

Generally, more than one mining crew is working in the mine at any one time. At Westray, at least two crews were working at different areas or working faces. This introduces an added complication in ventilation planning since it is essential that each crew get a constant supply of fresh air. This process of providing a separate air supply to each working face is called "splitting":

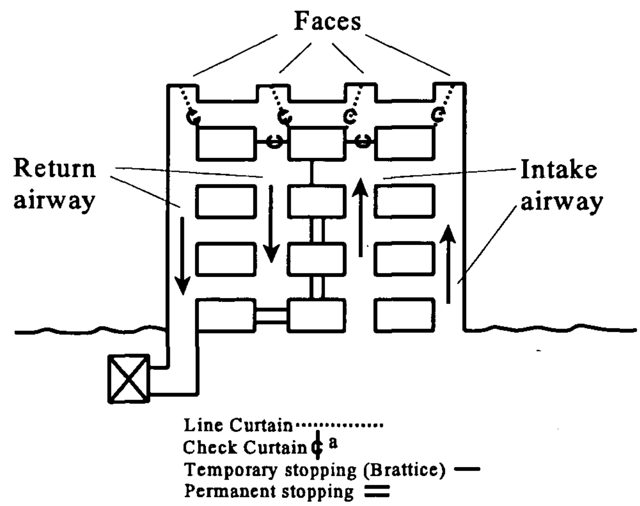
> Splitting the airflow is necessary for safety as well as to minimize power costs. Placing each working section on a separate parallel split insures that each crew will have a fresh air supply, uncontaminated by dust and gas accumulated on a previously ventilated section. . . . [B]y regulating splits, control of the local ambient conditions is possible. Without regulation, the constantly moving sections offer a resistance to the flow of air too variable to allow for reliable ventilation. Within a split, if both development and pillar line must be ventilated, mining should be planned in such a manner that the development is ventilated first and the pillar line last so the return air passes directly into the gob.[64]

Intersections or cross-cuts along the roadway must be controlled both to increase the efficiency of the airflow to the face and to avoid mixing the fresh intake air with the return air. Figure 7.11 shows several methods of controlling air flow to room-and-pillar faces.

All these factors and techniques have as an objective the provision of an adequate fresh air supply to the mine, especially to the working face where dust and methane constitute the most immediate hazard. One might assume that the higher the velocity of the air current, the more air gets into the mine and the better it is for the health and safety of the miner, because the higher velocity will quickly remove methane and thus increase safety. This is not the case. The velocity of the air must be carefully balanced so that it does not unduly interfere with the settling of the coal dust. If coal dust is agitated by the airflow, it will increase the amount of airborne dust and thus degrade the respirable quality of the air. In addition, the more

[64] Robert Stefanko, *Coal Mining Technology: Theory and Practice* (New York: Society of Mining Engineers, 1983), 59.

Figure 7.11 Mine with Controls



Source: United States Department of Labor, Mine Safety and Health Administration, *Mine Ventilation*, Safety Manual No. 20 (Washington, DC: MSHA, 1991).

[a] A check curtain is a temporary stopping (such as the conveyor-belt stoppings used at Westray) that allows the passage of equipment and personnel.

dust that is held in suspension in the air, the more danger of dust-propagated explosions.

Finally, splitting "also has the desirable effect of separating the various portions of the mine into sections with regard to airflow and thereby minimizing the likelihood of an explosion propagating from one section to another."[65] Obviously, this effect did not operate at the time of the Westray explosion since all crews, in all sections, were killed instantly by the blast.

Responsibility for Mine Ventilation and Safety

In some jurisdictions, including the United Kingdom and South Africa, ventilation and safety departments are a recognized, accepted, and separate part of the engineering staff of underground mines. Following a series of mine explosions, similar arrangements are being contemplated in Australia. In North America, with a few notable exceptions, responsibilities for mine ventilation are allocated to engineers who also have duties relating to mine production. This assignment often gives rise to a conflict between those two charges. Recurring inadequate ventilation will inevitably result in loss of production. However, until conditions become untenable, that loss may not be immediate. Mining can continue for a time, and at increased risk, with deteriorating ventilation. Conversely,

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[65] Stefanko, *Coal Mining Technology*, 59.

problems with equipment or roof control are likely to result in immediate cessation of mining. Hence, when a conflict between ventilation and production responsibilities arises, it is far more likely that the production-related problems will receive priority. This was certainly the case at Westray.

In those companies that have structured mine ventilation departments, there should be at least one professional ventilation engineer who is well educated and trained in the discipline. The ventilation engineer should be responsible for the control and maintenance of the mine ventilation system, as well as longer-term planning, and should have assistance as necessary to conduct routine measurements and periodic ventilation surveys. Furthermore, the ventilation engineer should have a labour force sufficient for the routine construction and maintenance of doors, stoppings, and regulators. More labour-intensive but less frequent operations such as the building of air crossings or explosion-proof seals may require additional intermittent assistance from the general mine workforce.

The mine ventilation engineer should report directly to the mine manager or, at large operations, to the senior underground manager. These managers carry the overriding responsibility for the safety and health of all employees at mine level.

Westray was a classic case of the situation that can arise where no dedicated ventilation expertise is available and where ventilation matters are given a low priority in the face of immediate mining difficulties. It shows how such a philosophy can lead to tragic consequences. Airflow measurements and related inspections were carried out by a graduate engineer-in-training from February 1992 onward. He had been employed at Westray since May 1991.[66] His knowledge of mine ventilation was limited to a theoretical course at university and airflow measurement in a gold mine during student summer employment in 1990. He had not previously worked in a coal mine and was not, for example, initially made aware of the phenomena associated with methane layering. Trevor Eagles was conscious of the lack of an experienced ventilation engineer with whom he might discuss such matters at Westray.[67] He had very little authority, and his recommendations were largely ignored.[68] His experience at Westray underlines firmly the need to separate matters relating to safety from the direct control of those whose prime responsibility is for mine production. Eagles concluded: "Safety personnel underground, which includes your mine examiners, . . . ventilation people and . . . rock mechanics people, must be given the authority to shut down workplaces if they see something that's not right."[69]

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66 Eagles (Hearing transcript, vol. 76, pp. 16413, 16415).

67 Hearing transcript, vol. 76, pp. 16427–28.

68 Hearing transcript, vol. 76, pp. 16464, 16515, 16555, 16567, 16641, 16646.

69 Hearing transcript, vol. 76, pp. 16593.

The employment of people wholly engaged in mine ventilation or safety-related matters is not widespread practice in North American mines because those personnel appear not to contribute, directly and in the short-term, to mine productivity. They may be mistakenly regarded as non-essential "overhead" staff. In reality, they are no less essential than aircraft safety personnel employed by an airline. Since many mines in the private sector have shown little inclination to engage full-time ventilation or safety staff, this change will come about only by legislative action directed at mines with labour forces above a specified size.

RECOMMENDATIONS

10 The overriding principle in mine ventilation must be that the mine is properly ventilated at all working times. It is the primary duty of the mine manager to ensure this proper ventilation.

(a) All active working places should be ventilated by a current of fresh air containing not less than 19.5 per cent by volume of oxygen and not more than 0.5 per cent by volume of carbon dioxide.

(b) Each working face should receive fresh air of sufficient volume and velocity to dilute and render harmless all noxious or flammable gases and maintain all working and travelling areas in a safe and fit condition.

11 No mine should start up without a comprehensive ventilation plan approved by the regulator. The ventilation plan should be subject to at least an annual update, and any changes in the interim should be subject to approval by the regulator.

12 The ventilation plan should contain details of the system proposed, or of amendments to the existing approved system, and should indicate:

(a) the limits of the mine property and any adjacent workings, as well as any abnormal conditions;

(b) the location and detailed specifications of all surface fans and all surface openings;

(c) the direction, velocity, and volume of air at each mine opening;

(d) all underground workings, including location of all stoppings, overcasts, undercasts, regulators, doors, and seals;

(e) the method of sealing worked-out areas, provisions for air sampling behind any such seals, and the manner in which such sealed areas will be vented into return air passages (ensuring that no intake air is or could be passing any sealed-off area);

(f) the location of all splits and the volume of fresh air entering each split and of return air at each cross-cut in a room-and-pillar mine and at each working face; and

(g) the locations for the measurement of air in the mine to ensure the proper ventilation at all times.

13 The mine operator should employ or retain the services of a qualified ventilation engineer to assist in the preparation of all ventilation plans or amendments to such plans. The ventilation engineer should sign any ventilation plans or amendments before they are submitted to the regulator.

14 The regulator may submit plans or amendments to a qualified mine ventilation engineer for review, and any fee for such review should be the responsibility of the mine operator. The regulator may require modifications to the plan in the interests of safety.

15 The regulator, in consultation with a qualified ventilation engineer, should draft regulations dealing with main fans and auxiliary fans. These regulations should include:

(a) details of the design, installation, operation, maintenance, and inspections of such fans; and
(b) requirements for instrumentation, the recording of data from such instrumentation, and the filing of this data with the regulator.

16 No booster fan should be installed underground without the approval of the regulator.

17 Every main ventilating fan should be mounted above ground in a fireproof fan house located at a safe distance from any mine opening and offset from any such openings or connections. The fan house should be equipped with a weak wall or explosion door located in a direct line with any possible explosion forces. Every main fan should be equipped with an audible alarm that sounds automatically if the fan stops or slows down.

18 Where any fan used in ventilating a mine stops for any reason, the area affected should be immediately evacuated. No auxiliary fan should be restarted until a qualified person has inspected the area and found it to be safe and free of gas. The area should not be re-entered until the ventilation has been restored to the required level and the area has been found to be safe and free of gas by a qualified person. If any fan remains stopped for more than 30 minutes, the mine operator should report the relevant circumstances to the regulator.

19 The regulator, in consultation with a qualified ventilation engineer, should draft regulations dealing with requirements for ducting, brattice, stoppings, locations of measuring devices, and sealing of abandoned sections of the mine. All brattice cloth, ducting, and materials used for constructing stoppings should be of fire-resistant material.

20 Equipment used to ventilate an underground coal mine should be of a type approved by the regulator and should be installed in an approved manner. Equipment, materials, or procedures not previously approved may be approved if the regulator is satisfied that the same measure of protection is provided to the underground worker.

21 Unless specifically approved in writing by the regulator, no more than one mechanized coal mining unit should operate in each ventilation split. Each split should be provided with a separate supply of fresh air.

22 Ventilating air should not be recirculated without the written consent of the regulator.

23 The mine operator should employ a qualified mine ventilation technician to be responsible for the operation and maintenance of the ventilation system. The ventilation technician should measure the airflow and sample the air quality in the mine at approved intervals of at least once a month for the whole mine and weekly for working areas. The results of ventilation and air quality tests should be recorded and a copy of such record should be filed with the regulator.

24 Workers should be removed from any area in a mine where the concentration of dust or noxious gases in the air exceeds the standards set out by the American Conference of Governmental Industrial Hygienists (ACGIH).

25 Devices used for testing air quality, velocity, and volume should be of a type certified and approved for such use by the Canada Centre for Mineral and Energy Technology (CANMET), the Approval and Certification Center of the Mine Safety and Health Administration (MSHA), the Canadian Standards Association (CSA), or other such equivalent testing body.

8

Methane

To inquire into . . .

(c) whether any neglect caused or contributed to the occurrence;

(f) whether there was compliance with applicable statutes, regulations, orders, rules, or directions

The introduction of methane to mine air is a natural consequence of coal mining. The flammability of methane is not the only hazard it poses to underground coal mine workers. Although methane is a non-toxic gas, if present in sufficient concentration it will depress the oxygen content of the air. A lack of oxygen will produce the physiological effects outlined in table 8.1.

Methane burns in air with a pale blue flame. If a stream of high-concentration methane is emitted into the air and ignited immediately, it will burn in a controlled manner, as natural gas or propane does in the flame of a gas stove's burner. The appearance of a pale blue halo of burning methane immediately above the lowered flame of an oil lamp has provided a means of measuring methane concentrations in mine atmospheres since the early 19th century. This is the principle behind the locked flame safety lamp. Although mostly superseded by the hand-held methanometer, the flame safety lamp is still recognized as a legitimate testing device by section 72(1) of the *Coal Mines Regulation Act.* Section 82 deals with the care and use of the lamp.[1]

If the gas is well mixed into the air *before* an igniting source is applied, the reaction can be very different, depending on the concentration of methane in the mixture. At a concentration of less than 5 per cent, methane will burn only at the points of contact with a surface that is maintained at a sufficiently high temperature. The flame will neither leave that surface nor propagate through the mixture. At a concentration of between 5 and about 15 per cent methane (the latter depending on the proportions of oxygen and other gases present), flame will propagate spontaneously throughout the mixture. At concentrations above 15 per cent, there will be insufficient oxygen to maintain the combustion unless an artificial supply of oxygen has been added to the atmosphere. The speed of the flame increases as the concentration rises above 5 per cent and reaches a maximum at 9.6 to 9.8 per cent. At that level, the gas is at its most explosive. Then, as the methane concentration continues to rise, the flame speed will decrease, the flame being extinguished completely at 15 per cent.

If the combustion takes place in a plentiful supply of air, the methane and oxygen will form carbon dioxide and water vapour. However, if there is insufficient oxygen for complete combustion, the highly toxic carbon monoxide will be formed.

[1] Methane detection devices are discussed in greater detail in the section on detection and monitoring later in this chapter.

Table 8.1 Physiological Effects of Oxygen Deficiency

Oxygen in Air (%)	Effects
20.9	Normal concentration in fresh air – no adverse effects
17	Noticeable increase in rate and depth of breathing – an effect further enhanced by an increased concentration of carbon dioxide
15	Dizziness, increased heartbeat
13–9	Disorientation, fainting, nausea, headache, blue lips, coma
7	Coma, convulsions, and probable death
Below 6	Death

Source: Malcolm J. McPherson, *Subsurface Ventilation and Environmental Engineering* (London: Chapman & Hall, 1993), 375.

Because the total amount of oxygen available for combustion in an enclosed underground space is limited, it stands to reason that, in the case of a fire or an explosion, oxygen will be consumed very quickly. Throughout the long history of fires and explosions in coal mines, the majority of fatalities have occurred as a result of carbon monoxide poisoning, not from burning or blast effects.[2]

Methane in Coal

Methane is a normal bacterial and chemical product of the decay of vegetation. The thick organic sediments that produced peat and (ultimately) coal were a prolific source of this gas. Over millions of years, the metamorphic effects of strata pressure and temperature gradually converted that original vegetation into the black rock we know as coal. Coal is a porous substance. The pores, although numerous, are not visible to the naked eye. Within these exceedingly small pores the methane now resides. Through a process called adsorption, coal can hold far greater quantities of methane than can non-adsorbing rocks.[3]

For gas to be released from coal, there have to be flow paths big enough to accommodate the gas molecules and there must be a region of lower pressure towards which the gas can flow. As mine workings advance into virgin coal, natural fracture planes will open up and new fractures will appear. Meanwhile, the barometric pressure in the workings will be much lower than the pressure in the coal. Methane will therefore migrate from the pores in the surrounding coal towards mine openings.

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2 As we have seen in Chapter 6, The Explosion, 10 of the 11 miners who died in the Southwest section succumbed to carbon monoxide (medical examiner's report, Exhibit 44.0077).

3 The subject of gas adsorption is covered in detail by Dr Malcolm J. McPherson in his book *Subsurface Ventilation and Environmental Engineering* (London: Chapman & Hall, 1993), chapter 12.

Methane Release into Mine Openings

At a working face in a coal mine, methane is released from two main sources. First, methane will emanate from all exposed coal surfaces – rib, roof, floor coal, and the coal face itself. The rate of emission is greatest when the coal surface is first exposed. It then will decrease over time, although the gas flow can continue for long periods. (The rate of decrease depends mainly on the permeability of the surrounding coal strata.) Gas emission from standing faces or ribs can often be heard as a hissing sound, particularly if the surface is wet, and it is not uncommon to observe bubbles of methane emerging from floor sources through standing water. Ray Savidge, a one-time Westray mine surveyor, observed this phenomenon while the main slopes were being driven, stating that "there was water at the face and there was evidence of gas because it was bubbling . . . like a hot spring."[4]

The second main source of gas is at the points of fragmentation in the coal as it is mined from the working face. The rate of gas emission here depends not only on the gas content of the coal, but also on the degree of fragmentation. The gas emission rate at the pick points of a coal mining machine increases as the average size of coal particle decreases. Hence, the use of dull picks, which produce greater amounts of dust, will also result in enhanced gas emission.

In addition to those two primary sources of gas at a working face, other, secondary sources exist. The fragmented coal will continue to emit gas while being transported from the mine. Gas may also come from source seams within the overlying and underlying strata. This occurrence is more probable in longwall systems of mining, which experience greater movements of roof and floor strata.

Methane will continue to emanate within abandoned sections of a coal mine. In most cases, the rate of emission will reduce over time as a result of degassing of the surrounding strata. However, as long as active ground movement continues to crush coal-bearing strata, higher methane emission rates will persist in the abandoned area.

Less common causes of emission are found as well. In heavily faulted regions, pockets of pulverized coal may exist within the seam. These can give rise to outbursts – sudden large emissions of methane, accompanied by an outpouring of dust. Other types of outbursts can occur from localized gas reservoirs in roof or floor strata. If the relaxation of the strata caused by mining results in fractures connecting to large sources of methane, the gas flow can remain at a high level for long periods. In such circumstances, that methane may be commercially viable or provide a source of low-cost energy for local use. Tapping into a fracture network for controlled drainage of methane was suggested for Westray as late as 1991.[5]

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4 Hearing transcript, vol. 22, p. 4335.

5 In a letter to Gerald Phillips dated 14 November 1991, Jeff Schwoebel of Resource Enterprises, Inc., notes the potential for commercial methane recovery from Westray's properties (Exhibit 36c.1). Resource Enterprises was at this time associated with G.P. Isenor

Effects of Barometric Pressure

As a result of short-term variations in local climate, the barometric pressure at the surface of the earth is seldom absolutely constant. In changeable weather, the barometric pressure can alter quite quickly. Such changes are reflected in similar variations occurring throughout the active ventilation system of a mine. Although the effect on the methane emitted from undisturbed solid coal is negligible, the situation is different for gas that has already escaped from the coal and has accumulated in unventilated spaces – including old mine workings that are no longer ventilated. Such was the case in the Southwest 1 section after mining abruptly ceased there following the severe ground control problem in early 1992.

Figure 8.1(a) illustrates a situation in which the barometric pressure in the active ventilation system of a mine is rising. As normally constructed, seals and stoppings in underground mines are not leakproof.[6] Whenever a difference in air pressure exists across a seal, some degree of leakage will occur through or around it. During a transient period when the air pressure outside the seal is greater than that within the old workings, air will leak inward, compressing the mixture of gases that exists there. Figure 8.1(b) shows the opposite effect: a falling barometric pressure will result in expansion of gases in the sealed area, causing some of them to leak outward into the active ventilation system of the mine. The latter effect is the more hazardous with respect to contamination of airflows supplied to working areas. Such outflows of gas resulting from a falling barometric pressure are *additional* to the emissions of gas that continue to occur from the strata in those same abandoned areas.

As the barometric pressure rises and falls according to the weather patterns on the surface, seals can be said to "breathe" inward and outward. The phenomenon results in a mixing of air and methane within a zone inbye the seal. As a consequence, a potentially explosive mixture could form there. The danger from falling barometric pressure is what underlies the requirement to maintain a barometer on the surface of the mine.[7] As well, the outward leakage from old workings requires that intake airways avoid entrances to old workings or other places where the air is likely to be contaminated.[8]

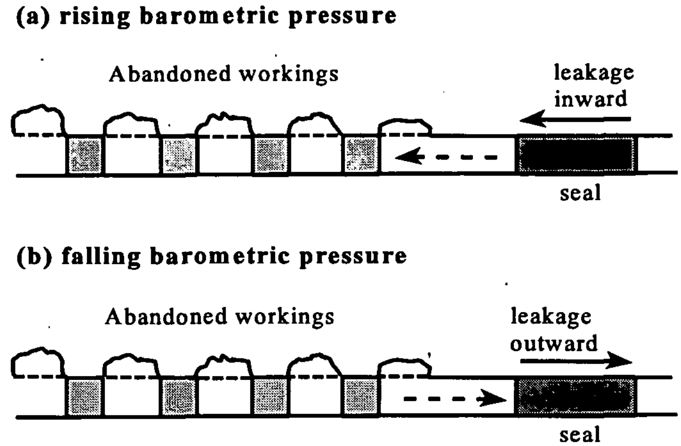
Company Limited of Bedford, Nova Scotia. GPI had recently completed its Coalbed Methane Report, Atlantic Canada, for Petro-Canada Resources (Exhibit 36c.1, s. 5b).

6 "Normally constructed" refers to permanent stoppings comprising double concrete-block walls filled with non-combustible waste material. It does *not* describe the makeshift plywood and plastic structures erected at the openings to Westray's Southwest 1 section.

7 The *Coal Mines Regulation Act,* RSNS 1989, c. 73, requires that a barometer be kept at the surface of an underground coal mine (s. 92(1)) and that underground managers and examiners take regular readings (ss. 36(2), 38(4)). Roger Parry, underground manager at Westray, chose to ignore the importance of both the barometer and the water gauge. Besides placing himself in violation of the act, he showed an appalling lack of common sense or good safety judgement.

8 Section 71(6) of the *Coal Mines Regulation Act* states that "[a]ll intake air shall travel free from all . . . old workings and other places likely to contaminate the air."

Figure 8.1 Seals Can "Breathe"with External Barometric Pressure Change



Source: Prepared by Malcolm J. McPherson for the Westray Mine Public Inquiry.

The Behaviour of Methane in Air

Buoyancy Effects and Methane Layers

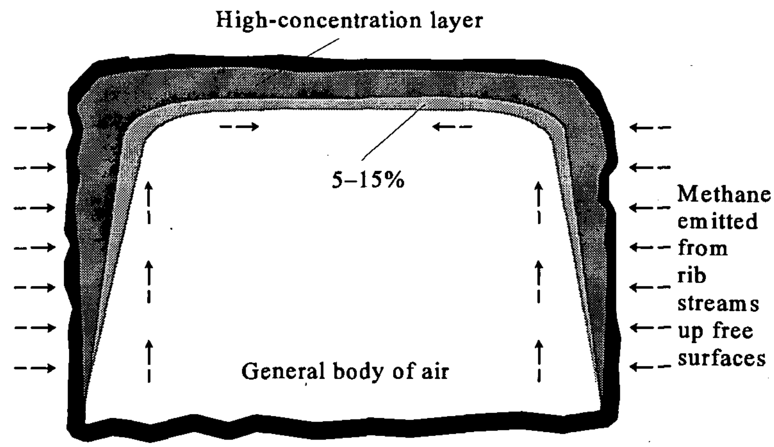
When methane is emitted from the coal or other strata, it is highly concentrated – perhaps in excess of 95 per cent purity. If that gas is to be removed from the mine via the ventilation system, it must be diluted to a safe concentration. It follows that, between the points of emission and the general body airflow, the gas must pass through the flammable range of 5 to 15 per cent. It is important that the space occupied by the flammable mixture be minimized and that the mixing process take place as quickly as possible.

The buoyancy of methane gives it a tendency to move upward and accumulate at roof level, but only while the gas remains at a relatively high concentration. If the gas becomes mixed with the air, the mixture will be homogeneous and there can be no upward streaming. Once mixed with the air, the methane cannot separate out again. Figure 8.2 illustrates the vertical surfaces of coal ribs in an entry with a low air velocity. Methane issues at a high concentration from one or, more usually, many points of emission. The gas immediately streams upward because it is much lighter than the adjacent air. Furthermore, it tends to adhere to the surface rather than pass outward into the air. A similar pattern occurs at a coal face or any other surface emitting methane.

If the velocity of the air is sufficiently high, turbulent eddies will promote good mixing close to the points of emission; neither the vertical streams nor a roof layer of methane will form.

If a methane layer is allowed to form, its behaviour in the airway will be influenced mainly by the velocity of the air under the layer and the

Figure 8.2 Methane Layer Formation



Source: Prepared by Malcolm J. McPherson for the Westray Mine Public Inquiry

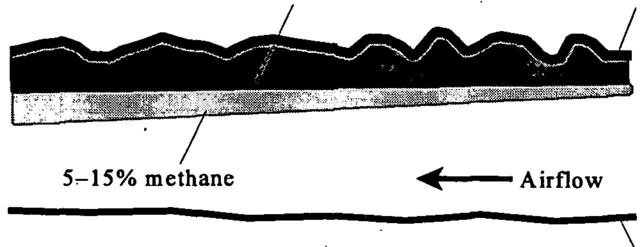
inclination of the airway. If the air is completely stagnant in a level entry, a methane layer will spread along the roof of the entry in both directions. If the air is moving, the lower portion of the layer will be dragged along in the same direction. The upper regions in the layer are similarly induced to move at progressively lower velocities until the gas actually at roof level may be nearly stationary. The eddying interactions between the methane and the underlying air help to promote movement of the layer while at the same time producing a mixing action. The result is that the lower regions of the layer become more dilute and the zone that contains a flammable methane-air mixture increases in thickness (see figure 8.3).

In an inclined entry with no movement of the air, the methane layer flows upward because of its buoyancy. If the air is also flowing upward, the buoyancy and drag forces act together to promote further motion of the gas, lengthening the layer. If the airflow is downward, the buoyancy and drag forces act in opposition, in which case the methane layer tends to move according to the more dominant force or even spread in both directions. The greater relative velocity between the air and a methane layer in downward-ventilated entries causes a greater degree of turbulent mixing.

Methane layers pose a number of dangers:

- They are a means by which methane can propagate along mine entries without rapid mixing, thus remaining at a high concentration.
- The volumes and concentrations of methane in a layer may be sufficient to result in an explosive mixture within the general body if dissipated by increased turbulence or a shock wave.

Figure 8.3 Airflow Induces a Methane Layer to Flow and Thicken



Source: Prepared by Malcolm J. McPherson for the Westray Mine Public Inquiry

- The underside of a concentrated layer provides a continuous path along which a flame can propagate should the methane be ignited at any point.[9]
- If a flame reaches a zone where the 5 to 15 per cent band has thickened significantly, the speed of the flame may accelerate to explosive velocities and produce a shock wave. This shock wave in turn can lead to a coal dust explosion.
- Methane layers may connect into roof cavities, old workings, or other areas where large accumulations of gas may exist.
- Personnel working near roof level may suffer from oxygen deprivation in the presence of a thick methane layer.

At Westray, many entries had uneven roofs because of cavities resulting from roof falls and overbreak. Numerous cavities existed above the tops of steel girders or arches that had been installed to support the roof. The cavities were essentially unventilated and would fill up with gas if they lay in the path of a methane layer. Even in the absence of such a layer, emissions from roof or rib sources may have caused local accumulations of the gas in roof pockets.

Methane layers can be detected only by testing for the gas at roof level. Methanometer extension accessories facilitate the procedure in mines working thick seams. These were not used routinely at Westray, although at least one methanometer extension unit was available in April 1992.[10]

Methane Emissions at Mining Machines

The combination of freshly exposed surfaces of coal and the breaking up of material into small fragments by mechanized equipment can cause the working face to become a prolific producer of gas. On the type of

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9 This point supports the "rolling flame" postulated by Reg Brookes in his hypothesis for the explosion (see Chapter 6, The Explosion).

10 Trevor Eagles testified that he found a methanometer extension and used it for a few weeks (Hearing transcript, vol. 76, pp. 16618–19).

continuous miner used at Westray, a cutting drum with tungsten-carbide–tipped picks rotates on a horizontal axis (see photo 2 in Reference). The machine is moved forward to begin cutting – at either roof or floor level – into one-half the face width. The drum is then moved down or up, cutting and removing the coal to the required height. Three machine-mounted mechanisms help to dilute and remove methane from the vicinity of the cutting drum.

First, the rotation of the drum creates air movement. The direction and magnitude of the air motion depends on the design of the cutting drum and its rotation speed. Second, the water sprays directed at the drum for dust suppression induce a movement of air. The third and perhaps most effective mechanism is the dust extraction system. A mixture of air, dust particles, and gas drawn into openings at the front of the body of the continuous miner – immediately behind the cutting drum – passes along an internal duct system and through a water-assisted dust filter before being ejected towards the rear of the equipment. It appears that the dust extraction system on the continuous miner in the SW2-1 heading was not operating at the time of the explosion.[11]

These mechanisms have little influence on the methane emitted from exposed coal surfaces other than the one that is actually being mined. Methane emerging from the ribs and the block of coal on the other side of the face (the side not being cut) is affected very little by the machine-mounted devices. Furthermore, unless the auxiliary ventilation system for the heading provides both a sufficient quantity of air for dilution and the velocity necessary for efficient mixing at the head end, uncontrolled recirculation in that zone may result in the build-up of unacceptable methane concentrations.

Methane Emissions in the Westray Mine

Predicted Gas Emissions at Westray

In 1980, Algas Resources Ltd carried out a detailed investigation of the methane content of coal seams in the Pictou County coalfield, including the Foord seam, the seam that Westray would later attempt to mine. Known as the Nova Scotia Demethanation Project, the investigation was intended to provide data on the feasibility of extracting methane via surface boreholes for sale as a fuel. The report of the investigation includes the comment: "The Foord seam has had a history of being quite gassy and has resulted in explosions and fires in the mines."[12] This statement stands in stark contrast to the one made in the 1987 feasibility

[11] In debriefing notes following a mine rescue trip underground on 27 September 1992, Don Dooley reported: "Checked the dust collection system on the miner [in SW2-1 Road], in the off position, was not running at the time" (Exhibit 37b.113).

[12] Exhibit 73.3. "Nova Scotia Demethanation Project: A Coalbed Methane Content Evaluation of the Pictou Coalfield – Pictou Co., Nova Scotia" (Halifax: Algas Resources Ltd., 1981), 16.

study on the proposed Westray mine: "Methane will not be a limiting factor in the mine ventilation requirement."[13]

Algas concluded that, throughout the range of coal seams intersected, the gas contents varied from 0 to over 6 m^3/t and increased with depth. The average gas content of the Foord seam at a depth of 263 m was reported as 3.69 m^3/t. The Pictou County coals were also reported as being quite permeable, relative to western Canadian coals.[14] Further testing of coal gas content was carried out by Suncor in 1984. The values of desorbed gas in the majority of samples were reported to be in the 2.5–4.5 m^3/t range, with the highest value found at 5.7 m^3/t.[15]

Methanometers on the Continuous Miners

The Joy continuous miners used at the Westray mine were equipped with on-board methanometers (Model 420d)[16] interlinked with the main power supply. The monitoring head in this system can be installed at any suitable location for detecting methane concentrations in the vicinity of the cutting heads.[17] The digital readout unit of the 420d model is located in the machine operator's cab. Two alarm concentrations may be pre-set: at the Low Alarm concentration, an amber light flashes; at the High Alarm, a red light is also displayed and the continuous miner automatically shuts down. The device cannot be reset until the methane concentration falls below the High Alarm value and is indicated as such on the readout. The methanometer should be calibrated at regular intervals. U.S. regulations require recalibration at least every 31 days.[18] Calibration, which can be done on site, involves exposing the monitor head to known gas mixtures and adjusting the instrument settings as necessary.

The most common cause of methane ignitions in coal mines is frictional sparking at the pick points of mechanized coal-mining equipment.[19] The combined functions of a machine-mounted methanometer are to detect the presence of methane, to give an alarm

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13 Placer Development Limited, "Pictou Project Feasibility Study, volume 2: Mining" (1987) (Exhibit 10.2, p. 18). Chapter 7, Ventilation, addresses the thoroughness of the various feasibility studies as they concern methane and ventilation requirements.
Comment Regrettably, the planning of Westray ignored the lessons of mining in the Foord seam.

14 Exhibit 73.3, pp. 50–51. The dangers of this condition were still being expressed by G.P. Isenor Company Limited as late as September 1991 in its Coalbed Methane Report to Petro-Canada: "The 'gassy' Pictou Coalfield, as identified by the long history of explosions with great loss of life, can not be attributed to a high gas content of the coal, but to areas of the high permeability (fault zones, etc.) that when intersected by mining produced great volumes of methane that 'gassed out' workings. Ventilation was not able to handle this great influx of gas from these naturally fraced zones. *It should be pointed out that the New Westray mine may encounter the same problems*" [emphasis added] (Exhibit 36c.1, s. 4b).

15 Exhibit 73.1.004–06. Suncor interoffice correspondence from Arden Thompson to Edwin Fraser, New Glasgow, NS, 11 September 1984, "Preliminary Results of Methane Gas Content Testing."

16 Manufactured by General Monitors, Costa Mesa, Calif.

17 In U.S. mines, the location of the head is subject to MSHA (Mine Safety and Health Administration) approval. Nova Scotia has no restrictions.

18 30 CFR 75.342(4).

19 See figure 6.2 in Chapter 6, The Explosion.

when it reaches the Low Alarm concentration, and to shut down the machine when the atmosphere becomes dangerous. The methanometer should be well maintained. Mining machinery should never be allowed to operate without the monitoring system in operation.

Methane Problems during Active Mining

Shift foreman's reports and the testimony of miners provide ample evidence of both the presence of methane in the Westray headings and the mining delays that resulted. Methanometer readings did not appear on ventilation reports until 12 April 1992. Table 8.2 provides excerpts from shift foreman's reports that relate to gas problems in the headings during the period 20 March to 7 May 1992.

The foreman's reports indicate ongoing difficulties with gas in the continuous miner headings, escalating in the two weeks before the explosion. Westray discouraged personnel from recording in written reports occurrences of dangerous conditions. Fraser Agnew, a Westray foreman, was asked by Inquiry counsel why he failed to report on his mine examiner reports certain incidences of high gas readings and lack of stonedusting. He replied: "[W]ith the reports, if I had . . . made too many waves, I just wouldn't have been there."[20] Mick Franks, a mine electrician, discussed in testimony an incident in which his colleague Harvey Martin had recalibrated the methanometer on a continuous miner on 6 May after its "trip point" had been raised the previous day. Franks said, "I don't think Harvey would have put it in the book because it didn't look too good, you know. That's not what the company wanted to see."[21] Foreman Don Dooley related an occasion on which he had reported a high methane reading in a working heading. According to Dooley, Roger Parry, the underground manager, told him that "you can't be recording that high a reading on your daily shift reports. The mine inspector won't put up with that."[22] The testimony of mine workers complements and gives additional background to the cryptic entries in the foreman's reports.

Don Dooley described a hazardous incident in one of the North section headings that occurred some two weeks before the explosion. When the members of his crew arrived at their heading at the beginning of the shift, the auxiliary fan had been switched off. The methanometer on the continuous miner indicated a gas concentration of 6.2 per cent, within the flammable range. Before Dooley arrived at the scene, a miner had switched on the fan. About 15 to 20 minutes later, Dooley entered the heading, taking readings on his hand-held methanometer. The general body concentration within his reach remained below 1 per cent, but the machine-mounted methanometer indicated 3 per cent. The crew remained

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20 Hearing transcript, vol. 35, p. 7707.

21 Hearing transcript, vol. 21, p. 4190.

22 Hearing transcript, vol. 36, p. 7851. Trevor Eagles, the engineer-in-training, said that Parry had warned him in early April 1992 "to be careful what you write down on a report, 'It could come back to haunt you' " (vol. 76, p. 16529).

Table 8.2 Gas Problems in Headings, 20 March–7 May 1992

Date (1992)	Shift foreman	Underground Operations Shift Foreman's Report – selected unedited entries
20 March	L. James	Difficult time calibrating methanometer, sensor needs to be changed ASAP
undated	F. Agnew	bolting crew down 20 min for gas.
26 March	A. Smith	Took scoop up SW gassed out half way up
31 March	(unsigned)	methanometer does not work
2 April	B. Capstick	Down clearing gas from section
8 April	B. Capstick	Installed vent tube in A and B headings and degassed. . . . degassing A heading
10 April	R. Ellis	mounted methanometer back in original position (2002 c/m)
16 April	(unsigned)	Sniffer[a] is back in original position 2002 c/m
21 April	A. Smith	Slow mining gassy.
22 April	F. Dewan	Slow mining waiting for CH_4[b] to clear
22 April	O. McNeil	Mining slow – high % of CH_4
23 April	O. McNeil	Mining slow. High CH_4
25 April	F. Agnew	lost a lot of time for CH_4 and moving supplies
27 April	L. James	4¼" × 2" bolts and nuts required to secure CH_4 sensor.
5 May	L. James	Trip point on 2002 c/m 420d raised from 1.2% to 1.5% was requested.
6 May	B. Benoit	Set up c/m gassing out . . . installed fan tube and degassed (SE)
7 May	A. Smith	Sniffer trouble sniffer cable NFG[c] Slow mining gassy.
7 May	B. Benoit	. . . gassing out had to install another fan and vent tube. Not much better . . .
7 May	F. Dewan	Sniffer needs repaired on 2002 c/m.

Source: Exhibit 37b.004–88.

a "Sniffer" refers to the methanometer sensing head
b Chemical symbol for methane
c No _____ good

outside the heading for a further 5 to 10 minutes, after which the machine methanometer reading had dropped to about 0.5 per cent.[23]

This incident involved three matters of concern. The first was that the auxiliary fan had been switched off. Not only was this action highly imprudent in such gassy conditions, as were then very obvious at Westray; it was also in contravention of section 71(9a) of the *Coal Mines Regulation Act*. Apparently, because of the noise they produced, auxiliary fans were not always in continuous operation at Westray.[24] The second dangerous aspect was the presence of a flammable gas-air mixture in a

[23] Hearing transcript, vol. 36, pp. 7832–34.

[24] When Eagles asked a mining ground-support crew why the fan ventilating a heading was not operating, he was told that "they'd turned it off because they were setting steel arches and the ground was working, and they wanted to hear the ground work, so they shut the fan off" (Hearing transcript, vol. 76, p. 16461).

heading and particularly in the vicinity of a continuous miner. The third aspect, switching on the auxiliary fan without initiating a degassing procedure, would involve the considerable risk of drawing a plug of high-concentration gas into the exhaust duct, through the auxiliary fan, and then into the main throughflow airstream. This would spread the zone containing a flammable atmosphere, increasing the probability of an ignition. A degassing procedure, although included in the Westray Manager's Safe Working Procedures, appears not to have been made known to the workforce.[25]

Don Dooley also described the adverse conditions under which mining was being conducted in the 1 Southeast section during the final week of operations.[26] Owing to the practice of series ventilation, exacerbated by uncontrolled partial recirculation, the air supplied to the Southeast section already had a general body methane concentration of 0.5 per cent.[27] On 8 May, an airflow measurement at the 30 kW auxiliary fan exhausting from the 1 Southeast heading gave 7.0 kcfm. Although that in itself was inadequate, the airflow at the inbye end of the duct would have been considerably less. Dooley described the poor condition of the duct: it had holes in it. The mining crew attempted to apply plastic patches held on with rope. This was the location in which a 15 kW forcing fan was used in an attempt to divert additional air into the entrance of the heading. The result of this entire ludicrous situation was that mining was severely inhibited by gas concentrations at the face.[28] As described by Dooley, the continuous miner would operate for a short period, during which time the reading of the machine-mounted methanometer would climb steadily to 1.4 per cent. The jib of the continuous miner would be dropped before the electrical power was automatically cut, and the machine backed out two or three metres from the face. To maintain some semblance of ventilation, the water sprays would be left on – inducing an air movement – until the floor became too wet for traction of the shuttle car. When the gas had cleared sufficiently, the continuous miner would again be advanced to cut a little more coal. The result of this intermittent procedure was that it took 20 to 25 minutes rather than the normal 45 seconds to fill a shuttle car. Under such conditions, the potential for ignition of a flammable atmosphere was very high.

The situation had been no better in the Southwest 1 section. Jay Dooley described the relocation of the methane sensors on each of two continuous miners – from the normal position by the cutting head to a point on the main body of the machine some nine feet back from the face

25 Section D of the Manager's Safe Working Procedures is entitled Manager's Procedures for Stopping and Starting Fans (Exhibit 37a. 120–22). In testimony, Don Dooley was asked whether any kind of written procedure existed for starting a fan in a high-gas situation. Dooley replied: "No sir, there was no written procedure. No, there was none" (Hearing transcript, vol. 37, p. 8275).

26 Hearing transcript, vol. 36, pp. 7835–42.

27 This situation is detailed in the section on throughflow ventilation in Chapter 7, Ventilation.

28 **Comment** This is one more example of the ad hoc, short-sighted, and incompetent undertakings, endemic at the Westray mine, that seemed to fall under the rubric "planning."

and at a fixed height from the floor.[29] The initial reason given for such a dangerous action was that the methanometer cable was being damaged. (It appears that this damage may have occurred because the cable had been situated outside the machine body rather than in its properly shielded location.) The effect of moving the sensor to its new spot was that it would then be too low and too far back to detect methane concentrations at the face, where frictional sparking takes place.[30] A further consequence was that the continuous miner would continue mining coal, without its motors being cut out automatically, when a dangerous gas concentration appeared at the cutting heads. This hazardous situation existed for several weeks before the sensors were moved back to their proper positions.

Other incidents that involved the readjusting of continuous miner methanometers are related in the section of Chapter 6, The Explosion, dealing with methanometer tampering. Repeated gassing out, methanometer breakdowns, and deliberate tampering seemed to focus on the continuous miner in the SW2-1 headings during the final days of the Westray mine.

On 7 May 1992, Wyman Gosbee was roof bolting in SW2-1. The continuous miner was mining the initial opening into the adjoining Lefthander. Gosbee testified that the methane warning light on the continuous miner was flashing almost continuously. He estimated that the machine would cut for no more than about 20 seconds at a time before shutting down.[31] The situation would appear to have been similar to that in the 1 Southeast heading described by Don Dooley.

Later during that day shift, the methanometer on that continuous miner was disabled for almost 24 hours. The following day, Gosbee was again bolting in the SW2-1 heading. He would testify that throughout that morning the continuous miner worked in the Lefthander, without the bolting crew's being asked to throttle the ventilation duct – as had been the case the previous day – to provide extra air to the mining operation.[32]

During the course of the afternoon, Gosbee observed the electrician working on the continuous miner after it had been backed out of the heading. The continuous miner recommenced operations with its replaced methanometer cable, but with an unknown effective set point for cutting power to the machine. Nevertheless, members of the bolting crew were then asked to choke off their ventilation tubing in an attempt to keep the continuous miner operating.[33]

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29 Hearing transcript, vol. 39, pp. 8580–86.

30 This, of course, is the principal safety reason for placing the methanometer sensor at the cutting head in the first place. One wonders whether this act reflected blatant incompetence or was a conscious attempt to sacrifice safety considerations to coal production.

31 Hearing transcript, vol. 25, pp. 5020–22.

32 Hearing transcript, vol. 25, pp. 5027–28.

33 Hearing transcript, vol. 25, pp. 5028–29.

Finding

At Westray, the machine-mounted methanometers and their automatic shut-off feature were regarded as a nuisance to be outwitted or eliminated, rather than as essential safety devices. The deliberate interference with the methanometers makes it clear that production of coal was to be maintained at all costs, and with blatant disregard for safety.

Finding

Any of several situations could easily have resulted in an ignition of methane leading to a coal-dust explosion. It follows, therefore, that the incident that actually caused the ignition in the early hours of 9 May 1992 was not an aberration, but simply one more in a frightening series of events that, sadly, had become commonplace at Westray.

Methane Problems during Roof Bolting

Given the inadequate ventilation in continuous miner headings, it was a frequent practice at Westray to restrict the branch of a tee-jointed duct system that exhausted air from roof bolting operations. (See the section on the use and maintenance of ducting in Chapter 7, Ventilation.) Combined with already inadequate auxiliary airflows and damaged ducting, the situation led to untenable conditions in a number of cases where miners were bolting.

In room-and-pillar mining, as practised at Westray, the working face of a heading would be advanced by a continuous miner. The machine would then be moved to an adjacent heading to repeat the operation. In the meantime, the roof bolting crew would drill holes and set roof bolts in the recently exposed roof of the first heading. The process was cyclic, with mining and roof bolting operations alternating in any given heading. The members of the bolting crew spent much of their time standing on a platform with their heads quite close to the roof and in an area where newly exposed coal surfaces were emitting methane. Given the absence of adequate ventilation, the likelihood was strong that the crew would breathe methane-contaminated air low in oxygen. (The crew would then be subject to the symptoms of oxygen deficiency, outlined at the beginning of this chapter.) A further danger would arise from the roof bolting operations themselves. The jobs of drilling holes and tightening bolts involve risks of sparking.

The roof bolting equipment was not fitted with a machine-mounted methanometer.[34] Members of the roof bolting crews were not generally qualified to carry hand-held methanometers. As Don Dooley explained, "[Y]ou have to have a coal mine . . . examiner's certificate to hold and use a methanometer in a coal mine."[35] Nor were locked flame safety lamps

[34] From conversations with authorities in other jurisdictions, I gathered that it is not standard industry practice to fit bolters with methanometers.

[35] Hearing transcript, vol. 36, pp. 7873–74.

available at Westray.[36] The only times at which bolting crews were able to confirm the presence or concentration of methane at their workplace was when the foreman came by and took a methanometer reading, or when a crew member showed symptoms of oxygen deficiency. Don Dooley testified that on occasion some mine examiners would "try to hide their readout from you."[37]

Lenny Bonner recalled that on 7 May 1992, while he was roof bolting in the SW2-1 heading, the methane concentration was measured at over 2 per cent.[38] The following day, Bonner worked with Wyman Gosbee on roof bolting in SW2-1. The roof was laterally inclined, and Bonner was on the high side. He found it difficult to breathe and excessively hot. At this time, the ventilation ducting had been tied off to provide additional air to the continuous miner in the adjoining heading.[39] Bonner and Gosbee untied the restricted ducting. Some 10 minutes later, the foreman, Arnie Smith, appeared and, at Gosbee's request, took a gas reading. It revealed 3.75 per cent methane. A second reading, showing 3.5 per cent, indicated that the concentration was falling.[40] Bonner's physical symptoms, occurring before the ducting was untied, likely arose from oxygen displacement by methane.

In interviews after the explosion, Doug MacLeod described incidents of "starting to get dizzy, . . . wheezy or sweaty" during surveying procedures when he was standing on the heads of a continuous miner. At times, the methane concentration was as high as 5 per cent.[41] Ed Estabrooks testified that he operated roof bolting equipment on a number of occasions when the methane concentration exceeded 5 per cent.[42] The mine workers were all too aware of the presence of methane, and at least some understood its behaviour.[43] Less certain is the degree to which they had been made conscious of the hazards associated with this explosive gas.

Other Matters of Methane in Headings and Entries

Other instances show the pervasive nature of the methane problem at Westray and the lack of expertise in dealing with it. Wayne Cheverie described the visible and audible indications of methane issuing from the freshly cut coal surfaces in the Southwest 1 section.[44] The coal was wetted

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36 Jay Dooley testified that, to his knowledge, "there was none on the property." He went on to say that by not providing a mine examiner with a locked flame safety lamp, "he cannot test for oxygen deficiency. All he has left for that now is the human body, and the human body should never be used as a tester" (Hearing transcript, vol. 39, p. 8539).

37 Hearing transcript, vol. 36, p. 7881.

38 Hearing transcript, vol. 24, p. 4783.

39 Hearing transcript, vol. 24, pp. 4785–86.

40 Hearing transcript, vol. 24, pp. 4787–88.

41 Inquiry interview, 11 June 1992, pp. 46–7.

42 Hearing transcript, vol. 24, p 4885.

43 In his testimony, Randy Facette, who was bolting in SW2-3 Road on 8 May 1992, spoke of moving the ventilation duct "into the centre of the roadway, so that it would accumulate gas from both sides of the roadway at the same time" (Hearing transcript, vol. 33, p. 7241).

44 Hearing transcript, vol. 21, pp. 4059–60.

by the dust-suppression sprays, leaving the solid faces also in a wetted condition. On entering a heading, Cheverie became conscious of a "whispering sound." He observed bubbles forming and bursting on the wet coal surfaces, a direct indication of methane being emitted from those surfaces. During his shift in the SW2-1 heading on 8 May 1992, Gosbee observed "moisture on the walls and you could see it bubbling."[45]

Westray miner Rick Mitchell described large emissions of methane in faulted areas.[46] The SW2-B heading had entered an area with prevailing roof control problems.[47] During the last night that he worked in the SW2-B heading, Mitchell experienced what he described as a "high burst of gas." After filling a shuttle car, he stopped the motors of the continuous miner, but noticed that the methanometer warning light was flashing. Although no coal cutting was then taking place, the methanometer reading continued to climb. When it reached 4 per cent, Mitchell isolated all power from the machine and left the area. He returned with the foreman. A check with a hand-held methanometer failed to indicate a high concentration of gas.

In addition to testimony by roof bolting crews, others provided indications of methane layering at roof level. Shaun Comish described being dizzy while erecting steel arches. He associated his symptons with an accumulation of methane in areas where the roof had caved.[48] Bryce Capstick spoke of gas concentrations in roof cavities "all over the mine" that would send the reading off-scale on a hand-held methanometer.[49] The prudent procedure to avoid such pooling in coal mines is to fill roof cavities with solid or foam material, or to divert a portion of the airflow with baffles. Although Eagles said that the company experimented using high-expansion foam, it appears that its use did not become common practice.[50]

John Lanceleve described a situation in which workers became dizzy from gas as chocks were being built above the arches. Lanceleve was instructed to go to the surface for a compressed-air venturi "air mover" to be used to blow air into the gas-filled cavity.[51] Employing compressed air to remove methane is expressly forbidden under section 71(10) of the *Coal Mines Regulation Act.*

Jay Dooley testified that, despite the large number of roof cavities in the mine, it was rare to test for gas at roof level outside the headings. The roof was normally out of reach for hand-held methanometers. There seems to have been on site only the one extension probe used briefly by Eagles

45 Hearing transcript, vol. 25, p. 5069.

46 Hearing transcript, vol. 31, pp. 6789–91.

47 Randy Facette testified that "the whole area up there . . . had faults running through it" (Hearing transcript, vol. 33, p. 7237).

48 Hearing transcript, vol. 28, p. 5871.

49 Hearing transcript, vol. 42, p. 9382.

50 Hearing transcript, vol. 76, pp. 16501–02.

51 Hearing transcript, vol. 27, pp. 5549–50.

in April 1992.[52] The apparent nonchalance over the absence of methanometer extension probes indicates a lack of concern over, or knowledge about, the dangers of methane layering.

The Southwest 1 Section

The Southwest 1 section was a significant source of methane, not only throughout the mining activities that took place in that section until 26 March 1992, but also during and after the withdrawal from the section. The wooden stoppings erected in SW1-B and SW1-C1 Roads on 13 April were inadequate as a seal against the escape of methane into the main intake airflow serving the newly developing Southwest 2 section of the mine.

The ventilation map of the Southwest sections at the time of the explosion (map 6 in Reference) shows the extent to which the Southwest 1 section had been developed before abandonment on 28 March 1992. The directions in which headings were driven had not been well controlled. As a result, some of the finger pillars were too narrow to support the roof.[53] Depillaring (pillar recovery) had also taken place in SW1-A Road, SW1-B Road extension, the inbye end of SW1-B Road, and SW1-A3 Road. The map does not show those depillared areas as being mined out. The combined effect was that excessive strata weight was exerted on the whole area back to SW1-3 Cross-cut.[54] As the pillars began to fail, the need for a rapid withdrawal from the area became urgent. Beginning Thursday, 26 March, the company, including all miners and equipment, was literally chased out of Southwest 1 by the failing ground.

The horror story that unfolded during those days is documented in the section on ground conditions at Westray in Chapter 10, Ground Control. Throughout the series of underground operating shift foreman's reports concerning the last days of Southwest 1, only one foreman, Arnie Smith, made reference to gas. In his night shift report of 26 March 1992, Smith noted that a Scooptram "gassed out halfway up" to the heading in SW1-A3 Road, where a continuous miner was stuck behind a collapsed rib. The crew then "repaired stopping at [SW1-A Road]." The report indicates that gas was "still clearing" at the end of the shift.[55] Pillars were failing and the ventilation system was ineffective. The gas emission rates and concentrations must have been elevated, yet, quite remarkably, this is

52 Jay Dooley commented on the lack of a probe: "I strongly feel [it] . . . hindered my performance as far as gas testing" (Hearing transcript, vol. 39, pp. 8537–38).

53 Eagles commented that in the Southwest 1 section, "the drifts were weaving back and forth somewhat and 12 metre pillars ended up being 5 and 6 metres in some areas." Eagles attributed this sloppiness to poor supervision. "It doesn't really take any longer to drive a drift on line than it does to drive it off line," he told the Inquiry, "It's the shift boss's responsibility" (Hearing transcript, vol. 76, pp. 16471–72).

54 In Eagles's opinion, "the depillaring was very sporadic and unorganized." The weight that should have been taken by a properly depillared cave area was instead taken by the existing pillars, which weren't substantial enough. (Hearing transcript, vol. 76, pp. 16473–75).

55 Exhibit 42f.0174.

the only comment on gas in the foreman's reports during the withdrawal period.

The lack of reference to gas concentrations in the foreman's reports has left little quantitative information on what the methane levels actually were during the final days of mining and the withdrawal from Southwest 1. There is a great deal of anecdotal evidence on the gas emissions that took place in Southwest 1 before and after the withdrawal. Ray Savidge gave evidence of having found over 5 per cent methane in SW1-4 Cross-cut, the return from the active headings, during a time when mining was going on in that section.[56]

Abandonment

The withdrawal from Southwest 1 was fraught with danger for the entire workforce present in the mine. The combination of failing pillars, high levels of gas emissions, operating mechanized equipment, and mining up to the last possible moment added up to a potent recipe for disaster. It seems that the production of coal, coupled with the reclamation of equipment, took precedence over the safety of the workforce.[57] These priorities gave rise to grave concerns expressed by David Waugh, the engineering superintendent.[58]

Following the withdrawal from the Southwest 1 section, the area continued to fill up with methane, commencing in the higher-elevation areas and moving downhill. On 29 March 1992, Eagles measured a methane concentration of 5 per cent, the limit of his methanometer, in SW1-4 Cross-cut inbye SW1-B Road.[59] On 28 March, Roger Parry telephoned mine inspector Albert McLean, informing him that weight had come down in SW1-A1 and SW1-A2 Roads. McLean visited the Southwest section on 31 March. His subsequent memorandum to his boss, Claude White, director of mine safety, on 2 April 1992, does not indicate the route of his inspection.[60] He wrote of methane concentrations of 1 to 4 per cent having been recorded, but did not indicate that he, personally, took any methanometer readings. His memorandum includes the sentence: "The methane is coming in waves." The seriousness of what had occurred and was ongoing appears not to have been appreciated by the inspectorate.

Shortly after the abandonment of Southwest 1 and before the stoppings were built in SW1-B and SW1-C1 Roads, probably within the first few days of April 1992, Roger Parry asked Jay Dooley to check gas and

56 Hearing transcript, vol. 22, p. 4339.

57 According to Eagles, "[t]hat day when the place started falling apart and we were getting high gas levels, the mine should have been evacuated" (Hearing transcript, vol. 76, p. 16645).

58 Eagles knew that Waugh was upset about the way the Southwest 1 had been abandoned (Hearing transcript, vol. 76, p. 16635), and that Waugh had had an argument with Roger Parry about how the area was depillared (p. 16505).

59 Hearing transcript, vol. 76, pp. 16519–20. Knowing that a significant amount of methane was in this relatively low part of Southwest 1, Eagles said, "[U]p in the top part of the area, it was filling up with gas, so I assume there were really high levels of methane in the high part [to the North and West]" (p. 16476).

60 Exhibit 73.4.

ventilation conditions in that area. Dooley, who had a high-range (0 to 100 per cent) methanometer, was accompanied by Owen McNeil.[61] Inbye SW1-3 Cross-cut on SW1-B Road, the air movement was outward – towards the mains – and the general body gas concentration was 0.3 to 0.4 per cent. Air was issuing from SW1-4 Cross-cut into SW1-B Road at 0.3 to 0.4 per cent methane. On moving up SW1-4 Cross-cut to the intersection with SW1-A Road, the general gas concentration remained between 0.4 and 0.6 per cent, indicating that an airflow circuit had been maintained around SW1-8 Cross-cut and back through SW1-A Road. However, a methanometer reading in SW1-4 Cross-cut just inbye SW1-A Road gave a concentration that was at least 60 per cent, indicating that there was no airflow circuit in existence inbye SW1-A Road. At this time, the observers left the area promptly. They were impressed that the concentration could change from 0.6 to over 60 per cent within such a short distance. This was, in fact, a normal consequence of the buoyancy of methane and the upward inclination of SW1-4 Cross-cut.

The Stoppings in SW1-B and SW1-C1 Roads

Following the abandonment of the Southwest 1 section, the entrances to it – SW1-B and SW1-C1 Roads – remained open. A third entrance, through 2NA Road, was inaccessible because of a roof fall. A measurement taken on 2 April 1992 indicated that the airflow entering the Southwest 1 section at that time was approximately 21 kcfm (see table 7.1 in Chapter 7, Ventilation). The observations by Dooley and McNeil indicate that the probable route of this airflow was in through SW1-C1 Road, across SW1-5, SW1-6, and SW1-8 Cross-cuts to SW1-A Road, returning via SW1-A Road and SW1-4 Cross-cut to SW1-B Road. A wood-and-plastic stopping had been erected in SW1-B Road inbye SW1-4 Cross-cut.[62] The rate of airflow to ventilate the Southwest 1 section was inadequate, even if the pillars and stoppings within the section had not been collapsing. However, that same airflow would have promoted the flow of methane, as a roof layer, from the intersection of SW1-A Road and SW1-4 Cross-cut, towards and out through SW1-B Road.

The stoppings in SW1-B and SW1-C1 Roads inbye SW1-3 Cross-cut, built on 13 April 1992, were first reported in Eagles's ventilation reports on 15 April.[63] The stoppings comprised ¼-inch plywood sheets nailed to the chocks that had been built as additional roof support at those locations.[64] The ground control difficulties had also necessitated setting steel arches in SW1-B Road all the way from the stopping to beyond the

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61 Hearing transcript, vol. 39, p. 8598.

62 Exhibit 37a.076.

63 Exhibit 37a.084.

64 Jonathan Knock described the construction of the stopping (Hearing transcript, vol. 26, pp. 5285–86). Don Dooley, who was responsible for building some of those chocks, testified that he "didn't know that it was going to be a stopping. I was under the impression that I was just trying to support this intersection" (vol. 36, p. 7957).

intersection with SW1-3 Cross-cut.[65] A large fall had previously occurred at the junction of SW1-B Road and SW1-3 Cross-cut.[66] Quite apart from the flimsy nature of the stopping, there was adequate space for a methane layer to flow over the arches at the stopping and out along SW1-B Road. Wayne Cheverie was sufficiently concerned about the state of the roof that he was reluctant to enter the part of SW1-B Road leading to the stopping.[67]

No sealant or cement was used in the construction of the plywood stoppings. Eagles described the gaps as large enough to "fit your hand through."[68] These stoppings reduced the airflow in Southwest 1 to the quantity that could leak through them, allowing the high-concentration gas to fill up the entries in SW1-A Road and SW1-4 Cross-cut and encroach on the back of the stopping in SW1-B Road. That stopping was incapable of resisting the escape of methane into the Southwest 2 intake. *Prudent practice would have dictated the construction of explosion-proof seals in each of the three entrances to the abandoned section.* Each seal would have consisted of two concrete-block or masonry walls several metres apart and keyed into roof, floor, and sides, with the intervening space filled tightly, from floor to roof, with inert material.[69]

The presence of a methane layer emerging from Southwest 1 was illustrated by reactions of personnel working in SW1-B Road. During the construction of the chocks, one worker became dizzy and fell when he was near roof level.[70] Jay Dooley knew of no checks for methane having been made in the vicinity of the stopping.[71] Aaron Conklin said that one of his fellow workers passed out during the building of the SW1-B Road stopping, when the airflow around Southwest 1 would have been decreasing.[72] The gas concentration would have risen and may have reached high levels as the plywood was progressively applied.

The failure of pillars in Southwest 1 caused ground movement at least as far out as SW1-3 Cross-cut, which did not cease when the section was abandoned. The already leaky stoppings in SW1-B and SW1-C1 Roads became even less capable of controlling the outflow of methane. The load on the chocks in SW1-B Road forced them into the floor, causing the immediate floor strata to fail. A crack appeared in the floor at the front of the stopping.[73] The convergence of roof and floor caused the plywood to buckle, and a seam opened up "about seven feet off the floor . . . about four to six inches in length . . . and an inch, maybe two inches wide."[74]

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65 Exhibit 45.7.

66 Exhibit 45.15.

67 Hearing transcript, vol. 21, p. 4035.

68 Hearing transcript, vol. 76, p. 16480.

69 This preferred construction is in stark contrast to the flimsy plywood-and-plastic structures that were put in place.

70 Harvey Martin observed this incident (Hearing transcript, vol. 23, pp. 4538–39).

71 Hearing transcript, vol. 39, p. 8770.

72 Hearing transcript, vol. 28, p. 5965.

73 Jay Dooley described "a crack in the floor approximately two inches" and "about five to six feet away from the stopping" (Hearing transcript, vol. 39, pp. 8613–14).

74 Jay Dooley (Hearing transcript, vol. 39, p. 8615).

The buckling of the stoppings was recorded in Eagles's weekly ventilation reports of 23 April and 29 April.[75] Eagles described the holes in the buckled stoppings as ones that "you could, if you really wanted to, probably stick your head through."[76]

A wealth of evidence exists on the emission of methane from Southwest 1 along SW1-B Road both before and after the stopping was built. On 2 April, Eagles measured a methane concentration of 2.5 per cent seven feet above the floor at the location where the SW1-B Road stopping would be built. He also observed what he described as a "pothole" in the roof, which may have reached 15 feet from the floor. Using a methanometer extension probe, he measured 9 per cent methane in that cavity, close to the maximum explosibility of a methane-air mixture and an indication of methane layering.[77] On 8 April, at approximately the same location, Eagles measured 4 per cent methane at about 7.5 feet from the floor. The roof was some 12 feet high.[78] Again, this measurement strongly suggests methane layering. By 29 April, an airflow estimated at 5 kcfm was observed leaking through the SW1-B Road stopping, with general body gas concentrations at arm's height varying between 1.25 and 2.5 per cent at a location 3 m from the stopping.[79]

During an inspection of the SW1-B Road stopping, Jay Dooley found 0.4 to 0.5 per cent methane from SW1-3 Cross-cut towards the stopping. Within an arm's length of the stopping, his methanometer reading climbed rapidly. To prevent damage to the methanometer, he switched it off when the reading reached 3 per cent.[80] Dooley became anxious about the extent to which methane was emerging from the Southwest 1 section and, at the end of his shift, voiced his concerns separately to Roger Parry and Gerald Phillips.[81]

Other workers in the mine were concerned about the emission of methane from the old workings. Mine examiner Fraser Agnew measured 3.5 per cent methane at the SW1-B Road stopping and discussed this reading with Parry. However, Agnew considered it to be such "common knowledge to Roger and everybody else" that it required no mention on his examiner's report.[82] Electrician Harvey Martin described accompanying Owen McNeil to the SW1-B Road stopping and finding a gas concentration that exceeded the limit of a 0 to 5 per cent methanometer.[83] Mick Franks described a similar experience when

75 Exhibit 37a.087, 074, respectively.

76 Hearing transcript, vol. 76, p. 16599.

77 Hearing transcript, vol. 76, pp. 16525–26.

78 Hearing transcript, vol. 76, pp. 16537–38.

79 Exhibit 37a.074.

80 Dooley explained that, with the hand-held methanometer that measures 0 to 5 per cent, "if you let the needle go to 5 per cent, the machine is taken out and recalibrated. It won't give you a proper reading" (Hearing transcript, vol. 39, pp. 8615–18).

81 Hearing transcript, vol. 39, pp. 8619–20.

82 Hearing transcript, vol. 35, pp. 7697, 7704–05.

83 Hearing transcript, vol. 23, pp. 4489–90.

accompanied by his foreman, John Bates.[84] Franks also observed "polythene sheet" having been wedged into the gaps around the SW1-B Road stopping in a vain attempt to reduce the gas outflow.[85]

Methane Emission from the Abandoned Southwest 1

From the actions and observations described, we can infer movements of high-concentration methane in the abandoned Southwest 1 section. At the time of Jay Dooley's trip into Southwest 1, on about 2 April 1992, the stoppings in SW1-B and SW1-C1 Roads had not yet been built. The situation is illustrated in figure 8.4. An airflow of approximately 21 kcfm entered Southwest 1 through SW1-C1 Road. It traversed a route that encompassed SW1-8 Cross-cut, SW1-A Road, and SW1-4 Cross-cut before exiting via SW1-B Road. This airflow route enabled Dooley to reach the intersection of SW1-A Road and SW1-4 Cross-cut without encountering unduly high concentrations of methane in the general body of air. However, all areas to the high west side of that route had become filled with methane. It was at the fringe of this large body of gas in SW1-4 Cross-cut, at the intersection with SW1-A Road, that Dooley encountered methane in excess of 60 per cent. Although the general body gas concentration was acceptable outbye that point, a layer of methane flowed along the roof out to SW1-3 Cross-cut. It was this gas that created difficulties for the builders of the chocks and, later, the stopping in SW1-B Road.

Figure 8.5 illustrates the situation that developed after the construction of the stoppings in SW1-B and SW1-C1 Roads. In the absence of an effective ventilation circuit in Southwest 1, the high-concentration methane encroached on SW1-B Road from the higher-elevation entries. A small amount of air continued to leak through the SW1-C1 stopping, discouraging methane from emerging at that location. The leakage, which had increased to about 5 kcfm by 29 April because of buckling plywood on the stoppings, was still insufficient to prevent high-concentration methane from reaching the rear face of the stopping in SW1-B Road. Brian West of the Bank of Nova Scotia testified to visiting the stopping with Phillips, who estimated the gas concentration behind the stopping to be about 80 per cent and, therefore, inert.[86]

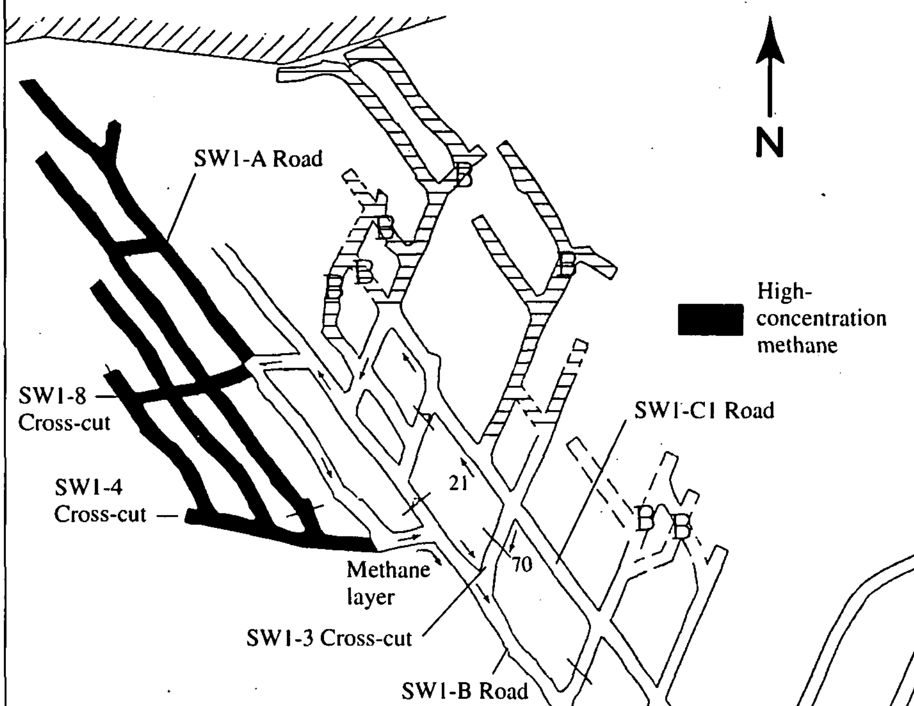
The rapid increase in methane concentration observed close to the outer face of the SW1-B Road stopping was due to the upward free-streaming effect (discussed earlier and illustrated in figure 8.2). SW1-B Road had little air movement inbye SW1-3 Cross-cut after the stopping was erected. Although some of the methane would diffuse into the air, increasing the general body concentration, the majority of it rose to the

84 "John took his spotter and put it back against the plywood and . . . the needle just buried itself" (Hearing transcript, vol. 21, p. 4151).

85 Hearing transcript, vol. 21, p. 4149.

86 Hearing transcript, vol. 49, pp. 10752–53.

Figure 8.4 Methane in Southwest 1, 2 to 13 April 1992



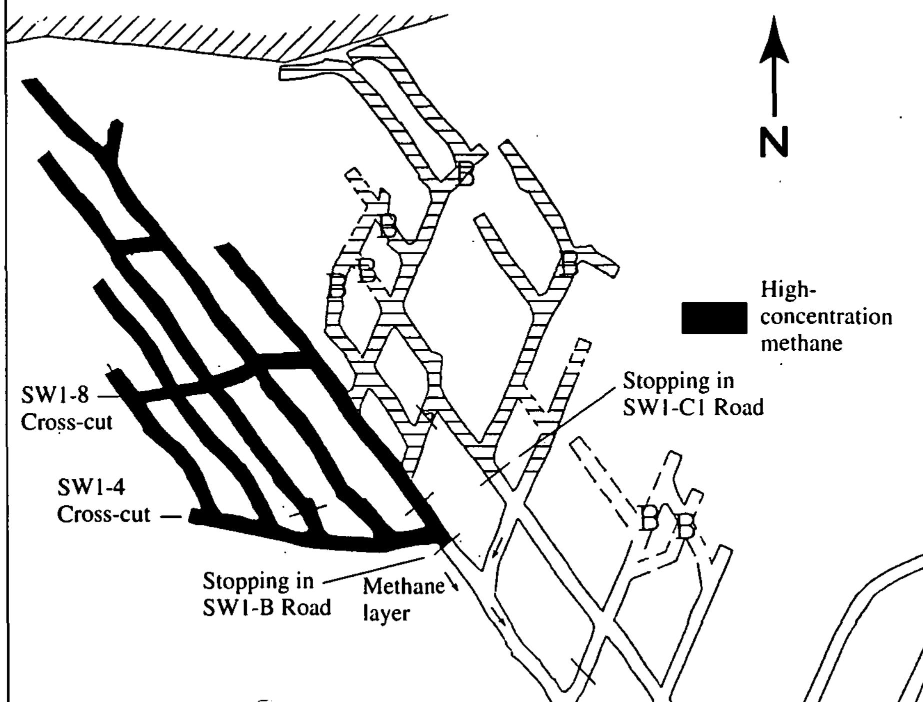
Note: Ventilation airflow quantities are given in kcfm.

Source: Prepared for the Westray Mine Public Inquiry by Dr Malcolm J. McPherson.

roof and flowed outward as a methane layer towards SW1-3 Cross-cut (see figure 8.6).

Once the high-concentration methane had reached the back of the stopping, the total rate of emission into the main ventilation system would have been approximately the same as before the stopping had been built, apart from small variations due to fluctuations in barometric pressure. However, the important difference was that the methane now emerged primarily as a high- concentration roof layer, with much less mixing into the general body than had been the case before the stoppings were built. The effect was observed by mine examiner Bryce Capstick, who testified that "when the temporary seals went up into those sections [Southwest 1], that's when we started having the gas problems when we started into the

Figure 8.5 Methane in Southwest 1 after Stoppings Built [a]



Source: Prepared for the Westray Mine Public Inquiry by Dr Malcolm J. McPherson.

a The stoppings in SW1-B and SW1-C1 Roads were built on 13 April 1992.

Southwest 2."[87] Capstick's observation was an indication that the methane layer from Southwest 1 reached and extended into the Southwest 2 development.

The rate at which methane was produced in, and escaped from, Southwest 1 can be assessed for the date of 2 April 1992. Observations made by Eagles and recorded in his report for that day indicate that the airflow proceeding inbye on SW1-C1 Road beyond SW1-3 Cross-cut was 20.9 kcfm.[88] Because this figure does not take into account any air that passed over the fall in 2NA, the airflow returning from Southwest 1 via SW1-B Road would have actually been somewhat higher. That return air had a general body concentration of 2.5 per cent, while a reading in a roof cavity showed 9 per cent. Using the general body concentration only, the volume of methane emerging from Southwest 1 was at least 522 cfm (0.246 m^3/s).[89]

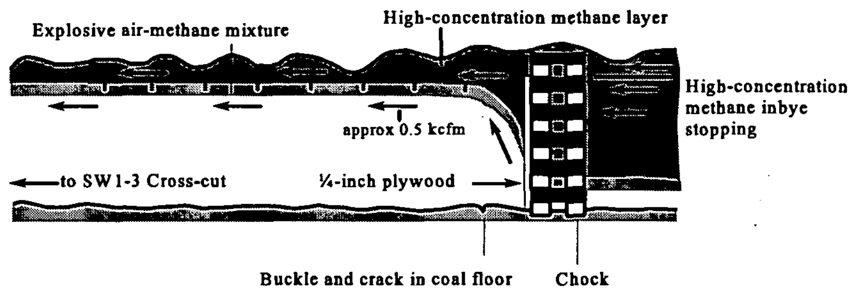
Chapter 6, The Explosion, discussed the effects of falling barometric pressure in the hours preceding the explosion. That factor added a further

87 Hearing transcript, vol. 42, p. 9429.

88 Exhibit 37a.075.

89 This is calculated by the formula $2.5/100 \times 20{,}900$ cfm = 522.5 cfm.

Figure 8.6 Section across Plywood stopping in SW1-B Road End of April 1992



Source: Prepared by Malcolm J. McPherson for the Westray Mine Public Inquiry.

18 cfm of methane to the volume emerging from Southwest 1. The rate of gas emission due to expansion, although small compared with the amount of gas being produced on 2 April 1992, was significant. The importance of the barometric changes is that they assisted rather than inhibited the emission of methane from Southwest 1 for almost two days prior to the explosion. The rate of emission in old workings normally declines slowly over time. The rate of decline depends primarily on the permeability of the strata and the gas content of the coal. We know that the Foord seam was highly permeable and that the workings in the Southwest sections were close to faults. This proximity likely further increased the permeability of the strata and allowed gas to migrate towards the openings from greater distances. In such circumstances, the emission rate from the Southwest 1 section would remain substantial for an extended time. Apparently, mine management had some discussion about draining methane from the Southwest 1 section. At one point, Jay Dooley understood that Phillips "was going to initiate the methane drainage system over top of 4 Cross-cut."[90] On 8 April, Phillips told Colin Benner, Curragh's president of operations, that "plans were to install an exhausting system to bleed the methane-laden air out of there."[91]

The methane layer that came from the stopping in SW1-B Road flowed along the roof and in cavities above the arches to arrive at the junction with SW1-3 Cross-cut, where a large fall had occurred.[92] The methane would fill the cavity in the roof, while the natural incline of the roof would protect the methane layer against disturbance from the air arriving through the cross-cut.

90 Hearing transcript, vol. 39, p. 8622.

91 Benner (Hearing transcript, vol. 73, pp. 15866–67). Eagles also recalled a discussion about "possibly drilling a hole into the area to try to drain it from the top side, which never happened" (vol. 76, p. 16530).

92 Map 8 in Reference documents roof falls and overbreak in the Southwest section.

The layer would proceed outbye along SW1-B Road until it reached SW2-B Road, the ascending intake to the Southwest 2 section. The roof of that entry was also inclined laterally, having a height of 14.5 feet on one side and 11.5 feet on the other.[93] The layer would ascend SW2-B Road, favouring the higher side of the entry. There can be little doubt that a large layer of methane flowed up the roof of the SW2-B Road, carrying the gas towards the active headings.[94] It is probable that this situation existed from the time the stopping in SW1-B Road was built.

The Explosive Environment at Westray

Finding

The problems associated with methane gas at the Westray mine originated with a failure to recognize the significance of the permeability of the Foord seam, and in not giving due consideration to the mining history of the Pictou coalfield. They ended with the explosion on 9 May 1992. Between those two points in time, there is a sad litany of causal factors relating to the emissions of methane at Westray and the attempts made to maintain coal production within poorly and incompetently managed ventilation systems. The following circumstances, which existed at various times and at various locations throughout the mine, coupled with the apparent management attitude of "coal production at any cost," provided the environment that would convert a spark at the continuous miner heading into a rolling methane fire and explosion:

- **failure to plan adequately for substantial emissions of methane or to take into account the historical evidence of such emissions;**
- **continued mining in areas where pillars were crushing, hence producing higher quantities of gas;**
- **falling barometric pressure for 42 hours prior to the explosion and the resulting increase in gas emission;**
- **failure to maintain a barometer on the surface of the mine to track changes in atmospheric pressure;**
- **insufficient ventilation in headings to dilute methane efficiently;**
- **inadequate air velocities to promote mixing of the gas or to inhibit the formation of methane layers;**
- **use of series ventilation, which resulted in a loss of air quality;**
- **uncontrolled partial recirculation of air within the ventilation structure;**
- **failure to keep auxiliary fans operating continuously;**
- **failure to employ a degassing procedure before switching on an auxiliary fan when a flammable atmosphere had been observed in a heading, contrary to company guidelines;**
- **inadequate ventilation ducting, which was allowed to fall into disrepair;**

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93 Exhibit 45.07.

94 Malcolm McPherson has calculated that air velocity in SW2-B Road would have had to be at least 715 feet per minute to prevent methane layering if the gas emissions remained at the 522 cfm measured on 2 April 1992. The actual velocity measured on 23 April was less than half that, at 322 feet per minute (Exhibit 37a.085). The method for calculating air velocity to prevent methane layering is detailed in McPherson, *Subsurface Ventilation.*

- **obstruction or constriction of ventilation ducting in headings being roof bolted, to keep the continuous miner from gassing out in adjoining headings;**
- **travelling of intake air past the entrances to old workings – particularly the Southwest 1 workings, which were known to contain large volumes of methane and were improperly sealed;**
- **relocation of machine-mounted methanometer monitor heads away from their correct location on the continuous miner jibs, thus defeating their purpose;**
- **interference with the set points or readouts of continuous miner methanometers so that the machine would operate in higher concentrations of methane;**
- **operation of a continuous miner with no machine-mounted methanometer;**
- **operation of roof bolting equipment where methane layers existed to the extent that workers near roof level presented symptoms of oxygen deficiency;**
- **failure to keep dust scrubbers operating at all times when a continuous miner was working;**
- **use of compressed air equipment to remove methane from a roof cavity;**
- **failure to provide roof bolting crews with the means of detecting methane;**
- **failure to contain methane accumulation in an abandoned area by adequate seals, or to control it by adequate ventilation;**
- **failure to detect and control a layer of methane issuing from an abandoned area;**
- **inclined workings that promoted methane accumulations in the higher elevations without the necessary air velocity to disperse this accumulation;**
- **falls of ground that left roof cavities in which methane could accumulate without any attempt to clear those cavities or fill them;**
- **inclined entries that facilitated the upward progression of methane layers;**
- **failure to check for methane layers or to provide the equipment necessary to perform such searches; and**
- **an appalling lack of safety training and indoctrination, especially respecting new underground miners, on the general properties of methane and its propensity to rise to the roof and form layers that at some point would be explosive.**

It should be understood that not all these conditions were necessary, at any one time, to provide the explosive environment that was present on 9 May 1992. They are all listed here to give some indication of the laxity, or the incompetence, or the apathy, or the carelessness that seemed to permeate Westray management and in turn to have a negative effect on the underground workers, who were lulled into a sense of "it can't be all that bad."

The attitude of Gerald Phillips towards the methane problem is both difficult to understand and dangerous: difficult to understand because his early training in the United Kingdom would have trained him in the perils

of dealing casually with methane; dangerous because his casual attitude permeated Westray management, creating and perpetuating a serious safety defect. Phillips, by his training and experience, must have known better.

Methane Control

Detection and Monitoring

Since methane is a colourless and odourless gas, it is impossible to detect it with the eye or the nose. Therefore, some method to alert the miner to the presence of methane in the mine, and to give the workforce the chance to take remedial action, had to be devised. The earliest detectors were the open flames that miners used for lighting underground. All too often, the flame would cause an explosion.

Several other testing devices received varying degrees of acceptance until the introduction of the locked flame safety lamp. As described by one training handbook:

> The locked flame safety lamp is the principal monitoring and detection instrument that mine examiners and shotfirers have at their disposal. . . .
>
> Locked flame safety lamps were originally developed to provide a safe means of illuminating coal mines. However, soon after their introduction for this purpose, it was discovered that the lamp flame responded in characteristic ways to both the presence of methane and the absence of oxygen.[95]

Normally, the flame of the safety lamp burns yellow. When methane is present in the air, the flame will burn with a bluish cap on the yellow flame, and the flame will become more elongated. Since the length of the flame is in direct proportion to the concentration of methane in the air, it presents a good testing mechanism for the presence of the methane. The glass globe of the lamp may be marked with gradient rings so that the user can read the percentage of methane in the atmosphere. The safety lamp is also used to test for oxygen deficiency. The lamp will not burn at all below 16 per cent oxygen in a methane-free atmosphere and loses about two-thirds of its light output at 19 per cent oxygen.

In Nova Scotia, section 72(1) of the *Coal Mines Regulation Act* directs the use of a "locked flame safety lamp or other gas tester of type or pattern approved by the Minister." In Nova Scotia, the threshold limit value (TLV) for methane is 1.25 per cent.[96] At the Devco operations in Cape Breton, which are governed by regulations made pursuant to the *Canada Labour Code*, the TLV is also 1.25 per cent.[97] The TLV of 1.25 per cent

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95 Cape Breton Development Corporation, *Mine Examiner/Shotfirer Training Programme,* Module C/MO 4/3 (1987), 11.

96 For the purpose of this discussion, we use the term "threshold limit value" to mean the percentage of methane in the air above which, by regulation, diesel and electrical equipment may not be operated. The relevant sections in the act are section 84, rule 5(d) and section 85(2), rule 2.

97 Canada, *Coal Mines (CBDC) Occupational Safety and Health Regulations*, SOR 90–97, s. 130.

is by no means an arbitrary percentage. I have been informed that this limit was dictated by the fact that the locked flame safety lamp could not register a lower methane reading.[98]

In the United States, the TLV is 1.0 per cent. It is also noteworthy that in the United States the locked flame safety lamp has been authorized only for supplementary testing for oxygen deficiency.[99] It may be assumed that in the United States the TLV was lowered as a result of the introduction of more accurate methane detection devices capable of recognizing concentrations lower than the 1.25 per cent. The various digital solid state methane detection devices now on the market are referred to generically as methanometers. They are smaller, more compact, safer, and more accurate than the locked flame safety lamp. The MSA Spotter illustrated in photograph 10 in Reference was used by supervisors at Westray. This portable hand-held device accurately measures 0 to 5 percent methane in the tested air.

The Spotter can be fitted with a detachable probe that extends up to 21 feet (6.4 m) so that gas concentrations in roof cavities and other remote areas can be detected and measured. The Spotter and similar devices are designed to measure varying concentrations of methane (another common range is 0 to 100 per cent) on a "spot" basis. That is, the operator holds the sensing head or probe in the air to be sampled, presses a button, and reads the result on a needle scale or digital output. Other devices are designed to measure oxygen, carbon monoxide, or any combination of the threes gases.[100]

Other gas monitors are designed to sample the air continuously, usually giving a visual or an audible alarm beyond a pre-set limit. Such monitors are either portable and can be hung temporarily in a working area, or they can be permanently mounted on equipment such as the continuous miner or electrical switchgear. The latter are often capable of opening an electrical circuit to shut down equipment.

The modern coal mine is also equipped with electronically controlled remote sensors strategically located throughout the mine to take continuous readings of methane, oxygen, smoke, and noxious gases. The sensing devices have audible alarms at the site, and the readings are transmitted to a central control monitor and recorder. The system installed at Westray is described in Chapter 5, Working Underground at Westray.

Degasification – Methane Extraction

The problem of methane control in coal mining has been of paramount importance throughout the world's coal mining community, with both

98 Conversation with Ian Plummer, provincial coordinator, Ontario Ministry of Labour, Mining Health and Safety Program; since confirmed by other consultants and officials.

99 30 CFR 75.320(d).

100 I was introduced to an impressive array of gas-testing instruments during my visit to the National Mine Health and Safety Academy in Beckley, West Virginia. At one time, coal miners commonly used canaries to detect carbon monoxide. Special cages enabled the birds to be resuscitated from exposure to CO with a shot of oxygen.

government and industry devoting considerable time and resources to its study. Methane control has been the subject of many conferences, seminars, and symposiums. The amount of written material, including learned papers, scientific studies, and industry reports, is overwhelming.

One area of continuing study and research concerns the extraction of methane prior to mining. Coalbed methane (CBM) extraction is technologically advanced and has both a safety and an economic component. Russell A. Carter, western field editor of the periodical *Coal*, wrote that "CBM has been recognized as a potential energy source since the mid-1970s and is commonly extracted for its fuel value in Europe and elsewhere."[101]

Carter quotes Charles Dixon, vice-president of mining engineering for Jim Walter Resources (JWR): "If we didn't have a degasification program, we couldn't operate our mines economically." Dixon's company is a 50 per cent partner in Black Warrior Methane Corp. (BWMC) of Brookwood, Alabama. BWMC made its first delivery of commercial-grade methane to the Southern Natural Gas Company in February 1982. Between then and April 1996, BWMC produced over 135 billion cubic feet of pipeline-quality methane extracted from wells in the vicinity of the four JWR underground coal mines in the Brookwood area. Sixty-five billion cubic feet of that gas (worth $250 million) came from gob wells alone, gas that otherwise would have had to be removed from mined-out areas via the mines' ventilation systems, at greatly added expense. The other 70 billion cubic feet came from "standard" vertical coalbed methane wells drilled from surface years ahead of mining, and from horizontal degasification in advance of longwall mining.[102]

Dixon, in a paper presented to a 1987 symposium on coalbed methane, expressed enthusiasm for JWR's experience with degasification:

> The improvements in continuous miner productivity which have resulted from horizontal degasification, and have been noted previously, have been significant. However, the greatest effect has been on the longwall faces. The benefits have been from (1) increased face production resulting from less downtime from high methane concentrations and from high cutting rates [and] (2) longer face lengths which have been allowed because of the reduced methane content of the coal.
>
> The management of JWR is convinced that horizontal degasification is a viable, efficient, and economical technique and is committed to a mining system where it is an integral part.[103]

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101 Russell A. Carter, "Methane Fever Flares in 1990," *Coal* (November 1990): 65–68.

102 This information is from materials supplied to me by BWMC. Gerry Sanders, president of BWMC, told me that commercial-grade methane extraction from the JWR mines accounts for less than half the methane produced by the mines. The remainder is cleared from the mines through normal ventilation.

103 Charles A. Dixon, "Coalbed Methane – A Miner's Viewpoint," *Proceedings* of the Coalbed Methane Symposium (Tuscaloosa, Ala. 1987)

The advantages of gas drainage are more than economic. As stated in a 1985 paper from Australia:

> There are three reasons for considering seam gas drainage.
> 1. To pre-capture normal seam gas emissions before their mixture with mine atmospheres exceeds the statutory maximum.
> 2. To minimize dangers arising from intermittent sudden and large volumes of seam gas being liberated into openings.
>
> . . .
>
> 3. To exploit the seam gas commercially.[104]

In commenting on the results of tests on seam gas drainage at the Metropolitan colliery in Australia's Sydney Basin, the authors stated:

> In all five pre-drained headings, substantial reductions in the working face gassiness were recorded, totally obviating the necessity for shotfiring. In contrast, the undrained control heading required continuous full face firing as a result of consistently high gas emission values. Results provided strong evidence that in certain circumstances, pre-drainage under suction . . . greatly improved mining conditions by significantly reducing seam gas content, providing greater roadway stability and allowing a much more acceptable advance rate.

According to a European handbook, "[s]ystematic drainage of firedamp [methane] began at Mansfield Colliery in the Ruhr in 1943."[105] Methane drainage clearly had an economic component:

> [T]he principal direct use of firedamp occurs at or near the centre of production with firedamp being burnt in colliery and power-station boilers or drying kilns. In view of the scarcity and cost of energy, however, these applications [traditional natural gas users] are still attractive and are again on the increase.

But safety remains the principal consideration in the removal of methane from coal mines. As the European handbook stated:

> There must be no doubt, however, that the main reason for firedamp drainage continues to be for safety, because it makes a substantial contribution to the improvement and safety of underground mining by reducing firedamp concentrations in return airways, working areas and travelling roadways of the mine. It also provides increased safety during the working of high-output faces, because it is practicable to extract large quantities of gas which would otherwise have to be mixed with large volumes of air. It would be extremely difficult to circulate such large quantities of air through most working places without raising clouds of dust, inconsistent with health standards currently in use.[106]

This point raises an important issue. High-volume coal extraction methods, such as longwall or room and pillar, can be impeded by an inability to dilute the methane produced at the mining face to safe levels.

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104 Alan J. Hargraves and Leszec Lunarzewski, "Review of Seam Gas Drainage in Australia," *Proceedings of the Australasian Institute of Mining and Metallurgy* 290 (February 1985): 55–70.

105 Coal Directorate of the Commission of the European Communities, *Firedamp Drainage – Handbook for the Coalmining Industry in the European Community* (Essen, Germany: Verlag Glückhauf GmbH, 1980), 20 [*Firedamp Drainage*].

106 *Firedamp Drainage*, 20–21.

In other words, production slows down, so that the volume of released methane can be properly and safely dissipated. This facet of the problem is well known in the industry. The following is taken from the *SME Mining Engineering Handbook:*

> Typically, as methane emissions increase on a section, more air is directed to the section to dilute the gas. However, as coalbeds with higher gas contents are exploited in conjunction with the demand for ever-increasing production rates, the mine ventilation engineer may find that it is not possible to direct a sufficient amount of air onto the section to ensure the safe extraction of the coal. To enable the mine to maintain production, various techniques were developed to remove gas from the coal. These techniques include drainage from horizontal, vertical, and directionally drilled boreholes.[107]

In recent years, the thrust in the United States seems to have been to exploit coalbed methane, not only for the purpose of making coal mining safer and more efficient, but for the economic value of the gas itself. A 1987 article in the *Journal of Petroleum Technology* identified six major coalbed basins of interest in the United States:

> The current level of activity and interest in coalbed methane development is focused in six basins. These include three eastern basins with shallow coals (Northern Appalachian, Central Appalachian and Warrior) and three western basins with deep coals.[108]

Charles Byrer, one of the authors of that article, is a geologist with the U.S. Department of Energy (Unconventional Gas Projects branch). He said in conversation that the Nova Scotia coalfields such as the Cumberland basin and the Pictou coalfield are geological extensions of the Appalachian basins and that they would therefore have similar geological characteristics, including faulting and methane content.[109]

Coalbed methane control and exploitation in Nova Scotia go back several decades. Gary Ellerbrok, a Devco project manager, reported in 1984 that methane drainage for safety reasons commenced in the Sydney coalfield in 1969 at the No. 12 Colliery.[110] In his abstract to the paper, the author stated:

> Methane gas, produced as a byproduct of underground coal mining, is now being treated in a new light in the Sydney Coalfield, off Cape Breton Island, Nova Scotia. Until recently, the emphasis was on diluting the gas to tolerable concentrations or collecting the gas and discharging it at points underground where dilution was easily accomplished.

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107 *SME Mining Engineering Handbook*, 2nd ed., vol. 2, ed. Howard L. Hartman (Littleton, Colo.: SME, 1992), s. 22.5.1, p. 1939.

108 Charles W. Byrer, Thomas J. Mroz, and Gary L. Corvatch, "Coalbed Methane Production Potential in U.S. Basins," *Journal of Petroleum Technology* (July 1987): 821–34.

109 **Comment** This is not news to the mining community in Nova Scotia. I include these comments only to indicate what is being done in other, geologically similar, areas respecting the control and exploitation of coalbed methane.

110 Gary Ellerbrok, "Lingan Colliery – Methane Extraction and Utilization Project," presentation to the Mining Society of Nova Scotia (Sydney, 1984). Roy MacLean, mining consultant to the Inquiry, suggested that methane drainage at Dominion Coal commenced earlier than this.

> Lingan Colliery, belonging to the Cape Breton Development Corporation, is in the process of constructing a methane extraction system consisting of a network of underground pipelines to the surface and a surface methane extraction plant. Upon reaching the surface, the gas will be prepared for delivery to a consumer.

Two studies completed in 1981 – both reports of the Nova Scotia Demethanation Project – focused on the commercial recovery of coalbed gas in the Pictou coalfield by various drilling techniques.[111] In a summary report on the Demethanation Project, consulting geologist Greg Isenor noted that the project included two wells that produced "sub-economic amounts of gas."[112] Isenor did state that further evaluation of the drilling prospects should be conducted. In an article submitted to the Chamber of Mineral Resources of Nova Scotia, Isenor stated:

> Excellent potential exist[s] in the Cumberland, Pictou and Sydney coal basins of Nova Scotia and throughout Prince Edward Island to commercially extract and utilize coalbed methane. The driving force behind the development of our coalbed methane resources in Atlantic Canada is the lack of the availability of conventional natural gas and the high cost of competing energy sources compared to Western Canada and the United States. It will be only a matter of time before the CBM resources of Atlantic Canada are exploited and utilized.[113]

Interest in the exploitation of methane in the Pictou coalfield was revived in the early 1990s. A joint venture of Nova Scotia Power Corporation (NS Power) and Resource Enterprises Inc. of Salt Lake City, Utah, is exploring the methane potential. According to Bill Hearn, special projects advisor for NS Power, three boreholes were sunk in the Stellarton area.[114] Drilling technology has improved over the years, and the holes are being fractured after drilling to obtain more accurate test results. Hearn said that more drill holes are being considered in the area under lease.[115] Depending on the outcome, the gas could be used to fuel the Trenton generating plant or could be diverted to the natural gas pipeline currently under consideration. The joint venture expects to continue drilling and anticipates results by 1999.[116]

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111 Algas Resources Ltd., "A Coalbed Methane Content Evaluation of the Pictou Coalfield – Pictou Co., Nova Scotia" (1981); A.J.P. Thompson, "A Coalbed Methane Content Evaluation of Selected Coalfields of Nova Scotia" (1981).

112 G.P. Isenor, "The Nova Scotia Demethanation Project Summary Report" (1981).

113 Greg Isenor, "Coalbed Methane," submitted to the Chamber of Mineral Resources (Halifax, October 1993).

114 Telephone conversation, 7 February 1997.

115 The area under lease does not include any of the Westray mine site, including the abandoned underground workings.

116 **Comment** Even if the project determines that gas extraction is not economically viable, it may still be feasible as part of any future coal mining operation. Methane extracted before, during, or after mining could be used to power or heat the mine infrastructure, or it could be sold to NS Power in exchange for electrical power. According to Charles Dixon, Jim Walter Resources can cover its total electric power cost from the sale of methane to Black Warrior Methane Corp. Electric power is a significant overhead cost in underground coal mining.

Although we have discussed mainly gas drainage in advance of mine development, active drainage during mining is common. Devco, at its various mines in Cape Breton, routinely carries out methane drainage. The Devco process is described in its training manual, Duties and Responsibilities of a Mine Examiner/Shotfirer:

> The purpose of the methane drainage system is to extract as much methane from the strata above and below the working seam as possible, and deliver it to safe areas in the return or to the surface. This greatly reduces methane emission into the ventilation system at the face and at the top of the wall.[117]

The manual describes various methods for drilling boreholes and for installing casings, pipes, valves, and so on. The captured methane is released eventually into the atmosphere at the surface. The objective is safety and health, without consideration of any economic side benefits.

A complete methane drainage system was installed in Devco's Lingan mine. The company planned to fire a generator with the methane produced and sell the power to NS Power. However, in early 1993, before the methane drainage system was fully operational, the Lingan mine was abandoned as a result of uncontrollable flooding. There is a suggestion that the drainage plant could process the methane from other Cape Breton collieries such as the Donkin. A methane extraction study of the Donkin colliery has produced optimistic results. Core samples were collected from a horizontal hole drilled to estimate the gas content in virgin coal. A paper on that project, presented to a 1993 symposium on coalbed methane, reported that "[t]he Harbour Seam has the potential for commercial coal natural gas production from in-mine boreholes. The economic return is estimated to be 3 to 4 times the cost of the boreholes and production facilities if a market for the gas is available."[118]

Obviously, degasification methods currently in use can substantially decrease the danger of methane accumulation in an underground coal mine. If pre-mining degasification results in a safer underground working environment, it ought to be seriously considered before any underground coal mining resumes in the Pictou coal basin. If there is an economic benefit to such a program, so much the better. Even if the gas were used on site for heating or power generation, it could result in some, if not total, cost recovery.

Conclusions

Methane is an integral part of coal and coal mining, a by-product of the natural geological and decaying forces that caused the coal to form. My recommendations address issues of monitoring and control, as well as degasification. With respect to the former, the U.S. ventilation

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117 Cape Breton Development Corporation, *Mine Examiner/Shotfirer Training Programme*, Module C/MO 4/1 (1987), p. 33.

118 M. Mavor et al., "Assessment of Coalbed Methane Resources at the Donkin Mine Site, Cape Breton, Nova Scotia, Canada," Coalbed Methane Symposium (Birmingham, Ala., 1993): 471–81.

requirements, set out in 30 CFR 75, provide an excellent reference point. I have been greatly influenced by their specificity, which I have considered in the context of the terms of reference of this Inquiry as set out in the Order in Council.

In the area of degasification, it may be an advantage to consider both a pre-mining program and a system to operate while mining. My recommendations do not, however, consider any deleterious effect that the release of methane could have on the ambient air or on the earth's ozone layer – aspects well beyond the purview of this Report.

RECOMMENDATIONS

Monitoring and Control

26 **The level of methane in an air intake to the working face of the mine should not exceed 0.5 per cent by volume.**

- **(a) If the methane level exceeds 0.5 per cent by volume, the ventilation technician or other qualified person must take steps to adjust the ventilation system to dilute the methane to acceptable levels.**
- **(b) If the methane level in any part of a mine reaches or exceeds 2 per cent by volume, all workers must be evacuated from the affected area.**
- **(c) The airflow throughout the mine, including the mine face, should be such that methane will be diluted to a level below 0.5 percent by volume, as measured at least 30 cm from the roof or ribs.**
- **(d) The velocity of air throughout the mine should be sufficient to prevent the formation of methane layers.**

27 **Each crew at the working face of a mine should include a person trained in the use of a methanometer. This person should carry, while in the mine, an approved device or devices capable of testing for both methane and oxygen, and capable of testing at the roof and in roof cavities for layering.**

28 **The mine operator should provide suitable testing and calibrating facilities on the mine surface. Methanometers should be tested for accuracy before each shift and calibrated as required.**

29 **If the locked flame safety lamp is used at all, it should be handled only by persons who have received adequate training in its assembly and operation. No lamp should be reignited underground unless the methane content in the ambient air is 0 per cent, as determined by a methanometer.**

30 **If the methane level in the area reaches or exceeds 1 per cent by volume, any electrically operated equipment in use should be shut down, and any shotfiring being carried out should be discontinued.**

- **(a) In addition to other safety devices, any electrical equipment operating at the mine face or in reasonable proximity, as established by the regulator, should be equipped with a device capable of continually monitoring the methane content of the air.**
- **(b) If the methane content exceeds 1 per cent by volume, the methane monitoring device should automatically shut down the electrical equipment.**

(c) The electrical equipment should not be re-energized until a qualified person certifies that the methane content in the air has been diluted to a safe level. (30 CFR sets out this requirement as it applies to mines under the jurisdiction of the U.S. Mine Safety and Health Administration.)

(d) The methane monitors installed on electrical equipment should be kept operative at all times and tested weekly for accuracy. Sensors should be affixed to the equipment as close to the working face as practicable.

31 The operation of mobile diesel-powered equipment underground should be regulated to ensure that the health and safety of the workforce is not endangered or impaired by such operation.

32 The regulator may require, as part of the mine development plan, a plan for the installation of a remote system for monitoring the mine atmosphere, with appropriate audible alarms and recording devices. Such a monitoring plan should include the provision that a qualified person must be at the remote monitoring station at all times that the mine is operating.

Degasification

33 As a prerequisite to the resumption of underground coal mining at Westray or elsewhere in the Pictou coal basin, the province should require the completion of a study into the safety and economic factors involved in drainage of the coalbed methane in the mining area concerned.

34 Every mine development plan should include complete details of any program or process designed to drain methane from the coal seam before, during, and after mining. The regulator could waive this requirement if satisfied that the program or process would be impractical and that general mine safety would not be compromised.

9

Dust

To inquire into . . .

(c) whether any neglect caused or contributed to the occurrence;

(f) whether there was compliance with applicable statues, regulations, orders, rules, or directions

On 24 February 1979, approximately 150 Devco underground miners were at work in No. 26 Colliery at Glace Bay, Nova Scotia. Barometric pressure was high and steady, indicating that methane emissions would be normal; the section (12 South) had been examined and declared safe; the ventilation system was operating effectively; and nothing unusual had been reported during the shift. Shortly after 4 AM, an explosion in Section 12 South killed 12 of the miners at work in that section.

A Commission of Inquiry was constituted, with R.H. Elfstrom as chairman. In due course, the commission filed its report, concluding that inadequate stonedusting was the most probable cause of the methane fire's propagating into a low-grade dust explosion.

There are both similarities and differences between this explosion and the one at Westray. Elfstrom found that pick ignition at the face was the most probable cause of the explosion:

> The most probable sequence for the explosion begins with methane produced from the coal being cut, becoming ignited by incendive sparking produced by the action of the shearer's steel picks while cutting for five seconds and a distance of seven inches into a high ITP quartzitic sandstone intrusion.[1]

One of the report's principal conclusions addressed coal dust in areas close to the working face: there had been an "accumulation of coal dust without appropriate treatment (. . . no stonedusting under the top brushing, in the brusher's gob and in the 'alleyway' alongside the bottom level, no wetting down or clean up)."[2]

Elfstrom's most telling comment about stonedusting appears early in the report: "The flame traversed the brusher's gob and the area under the brushing *that was not stonedusted* and out the top (return air) level where it died out 70 feet from the wall face after being quenched by stonedust" [emphasis added]. Both Roy MacLean and Reg McIntyre, senior Devco managers at the time, stated that, had the fire and explosion not been quenched by the stonedust and confined to a relatively small area, the entire mine complement of 150 miners would, in all probability, have become victims.[3]

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1 Canada, Commission of Inquiry into the Explosion in No. 26 Colliery, Glace Bay, Nova Scotia, on February 24, 1979, *Report* (Ottawa: Department of Labour, April 1980) (Chairman Roy Elfstrom) [Elfstrom Report], 10. High ITP (incendive temperature potential) means that the rock has a high quartz content and consequently a greater chance of producing sparks hot enough to ignite a flammable air-methane mixture.

2 Elfstrom Report, viii. It is not necessary to understand the mining terminology to realize that stonedusting in the vicinity of the ignition source was inadequate.

3 Conversation in Sydney, Nova Scotia, 30 October 1996.

The No. 26 Colliery explosion occurred less than 250 km from Plymouth, Pictou County. It occurred less than 13 years before the Westray disaster. The deaths were attributed largely to inadequate stonedusting in Section 12 South. Survivors were spared thanks to stonedusting beyond Section 12, which "quenched" the explosion. While embarking on a discussion of the adverse coal dust conditions at Westray, one is prompted to pose the anguished question: *Do we ever learn?*

The Hazards of Coal Dust

Many dusts of mineral origin cause physiological reactions in the human body, which in turn lead to respiratory and heart diseases that can be debilitating or fatal. Some dusts, including those produced from coal, become explosive when mixed in sufficiently high concentration with air.

In Nova Scotia, particularly in the Glace Bay, Pictou County, and Springhill areas, the long-range deleterious effects of coal dust are well known and have been well documented. Black lung disease, or coal worker's pneumoconiosis, is one of the most widely known diseases associated with coal mining. Although much can be said about the problems of long-term exposure to coal dust, that particular problem is beyond the purview of this Report. In the context of this Inquiry, coal dust is significant as a factor in the overall safety of the Westray mine and as an integral component of the elements that led to the massive explosion on 9 May 1992.

Coal dust, like most other organic materials, is explosive when suspended at high concentration in air. The lower flammability limit of coal dust may be in the concentration range of 50 to 100 grams of dust per cubic metre of air, depending on the volatile content of the coal and the presence of methane. Such concentrations, which produce a suffocating and near-opaque atmosphere, do not occur during normal mining operations.

For a coal-dust explosion to occur in an underground mine, there must be a preceding event that (1) generates a shock wave capable of raising settled dust into the air in high concentration, and (2) produces a temperature high enough to ignite the dust. These two conditions are fulfilled by a methane gas explosion. The majority of coal-dust explosions in mines have been initiated by a gas explosion. As we concluded in Chapter 6, The Explosion, this was the case at Westray. Although high airborne concentrations of coal dust are required to propagate a dust explosion, such concentrations can arise from even a thin film of dust that has previously settled on surfaces within a mine airway. Inquiry expert Don Mitchell said in testimony that "[t]he amount of coal dust you need to propagate an explosion is minuscule. . . . [I]f I can write my initials on a rib or on a piece of metal in a mine and I can see my initials, I've got more than enough dust to propagate an explosion. We talk in terms of five-

hundredths of an ounce per cubic foot [almost exactly 50 g/m³] . . . the thickness of one or two sheets of paper" [4]

The Explosive Power of Coal Dust

During a visit to the Coal Research Laboratory, operated by the Canada Centre for Mining and Energy Technology (CANMET) in Sydney, Cape Breton, I was given a demonstration of the explosive properties of methane and coal dust. The results were both graphic and startling.

The test was conducted in a 17 L transparent cylinder with a remote sparking device. Its top was a bolted rim with a replaceable foil centre. A measured quantity of methane – enough to create a highly explosive mixture of 9 to 10 per cent by volume in air – was introduced into the cylinder from a pressurized gas bottle. When a spark was applied, a rather violent explosion – sufficient to rip the foil cover apart – resulted. I was surprised that such a small quantity of methane would cause such a blast.

The second demonstration had the same components as the first, plus a quantity of coal dust spread out on top of the foil cover. At the spark, the methane exploded, broke the foil cover, and ignited the coal dust. There was no perceptible delay between the methane and the coal dust exploding. The coal dust seemed to have a synergistic effect in that the intensity of the resulting explosion seemed to be greater than if the two components had been ignited separately. The explosion was deafening and of such force that one of the doors to the demonstration room was blown open violently. The flameburst reached the ceiling, and soot was liberally distributed throughout the room.

The third demonstration consisted of the same setup, with a liberal quantity of stonedust (powdered limestone) mixed with the coal dust on the foil cover. When the spark was ignited, there was a loud pop that seemed to have less intensity than the first, methane only, blast. There was very little concussive effect, and the coal-dust–stonedust mixture did not ignite.

This series of demonstrations clearly illustrated to me three points of great significance in coal mine safety:

1 Methane, of itself, is a highly explosive gas when mixed with air in certain concentrations.
2 Coal dust, even when not initially airborne, seems to increase the magnitude of the methane blast disproportionally.
3 A sufficient quantity of stonedust, mixed with the coal dust, will totally neutralize the explosive potential of the coal dust.

Coal Dust Production in Underground Mines

Coal dust is produced whenever coal is broken, compressed, or moved through a mine. The greatest producer of dust in a coal mine is normally the mining process itself, at the working face. In modern underground coal

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4 Hearing transcript, vol. 17, pp. 3007–08.

mines, mechanized equipment breaks the coal from the seam and loads it onto a conveyor or a shuttle car. Because the output from coal mines is produced primarily for electrical power generation, coal mining machines such as the continuous miner are designed to produce small fragments, typically not more than 5 cm long. Such fragmentation generates large amounts of dust, which, unless controlled by dust suppression techniques, may enter the atmosphere as airborne dust particles. The dust is formed where the pick points of a machine's cutting head crush the coal immediately in front of them. As each fragment of coal breaks away, some of the crushed coal is ejected as dust into the atmosphere, the remainder staying on the surfaces of the coal fragments. If the pick points are worn and blunt, the zone of crushing ahead of the pick will be enlarged, thus increasing the amount of dust produced.

Water sprays on the mining equipment should dampen the coal as it leaves the working face. As the coal is transported from the mine, however, natural drying of the coal, combined with further breakage, results in continued generation of dust. In the room-and-pillar system of mining, as practised at Westray, dust is produced at many stages: during the loading and unloading of each shuttle car; at the feeder-breaker; along the length of each conveyor because of vibration of the belt as it passes over each roller; at each conveyor transfer point; and wherever the belt passes through an opening in a stopping, regulator, or airlock – where the air velocity over the immediate belt surface is likely to be high. Spillage left on the bottom (return) belt will be crushed against rollers and accumulate under the conveyor. If not removed by scrapers, dust adhering to the belt surfaces will be carried back on the bottom belt to add to accumulations beneath the conveyor.

Dust production by compression and abrasion occurs under the tires or metal tracks of vehicles. The amount of dust produced by such mechanisms depends not only on the weight and design of the vehicle, but also on the nature and inclination of the floor. At Westray, the natural floor material within working areas was coal, a relatively weak material. The inclination of the entries often resulted in slippage of the tires or tracks of moving equipment, creating a significant source of dust in the mine. Dust also comes from the crushing of roof and rib material against steel supports and from roof falls.

Measurement and Control of Dust in Mines

Sampling and measuring dust for health hazards require methods quite different from those used for determining explosion hazards. A number of types of instruments measure airborne respirable dust. Some operate over a complete 8-hour shift to give an average dust concentration; more recently, instruments have been designed to give instantaneous readings for direct indication and recording.

Sampling coal dust to measure the explosion hazard is a relatively unsophisticated procedure. Small quantities of settled dust are collected

manually from the floor, ribs, and roof of mine entries. Because only the most recently deposited dust contributes to the propagation of an explosion, the samples should be taken from the top 6 mm (one-quarter inch) of the dust layer and passed through a sieve to remove the larger particles. The sampling locations should be distributed throughout the ventilated airways in the mine and generally may be either spot sources or specified lengths of entry. Section 70(7) of the Nova Scotia *Coal Mines Regulation Act* specifies:

> (a) representative samples of the dust shall be collected from the floor, roof and sides, respectively, over an area of road not less than fifty yards in length, and shall comprise the dust collected on the roof and sides and to a depth not exceeding one quarter of an inch on the floor;
> (b) each sample collected shall be well mixed and a portion of the mixture shall be sieved through a piece of metallic gauze, having a mesh of twenty-eight to the lineal inch.[5]

The samples go to a laboratory, where a representative fraction is weighed, dried, and reweighed to determine the moisture content. The dried sample is then placed in an oven, where the combustible material is burned away. The further loss in weight represents the combustible fraction of the dust; the moisture loss from drying is combined with the weight of the remaining ash to give the incombustible fraction. Section 70(7c) of the act addresses this procedure:

> (c) a weighed quantity of the dust which has passed through the sieve shall be dried at two hundred and twelve degrees Fahrenheit, and the weight lost shall be reckoned as moisture, and the sample shall then be brought to red heat in an open vessel until it no longer loses weight and the weight so lost shall be reckoned as combustible matter for the purpose of the test.

Where the sampled dust contains carbonates such as occur in limestone dust, section 70(7d) requires that the high-temperature method be employed and that a chemical treatment be used to determine, separately, the loss in weight due to the evolution of carbon dioxide.

Controlling the Dust

The most effective way to minimize airborne dust is to prevent particles from becoming airborne in the first place, thus reducing the rate at which dust settles in the mine. Wherever coal is broken in a mine – at continuous miners or feeder-breakers, for example – water sprays should be used. The water should first be applied as a jet directed at or behind the pick points of a continuous miner, further sprays or dribbler bars being used at strategic locations along the coal-transport system. The purpose is to keep the material damp, but not so wet that it becomes hard to handle.

Various systems available to remove airborne dust can be used within ventilation ducts or along with dust-producing equipment. Water-assisted systems (*wet scrubbers*) are common in underground mines. Typically,

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5 RSNS 1989, c. 73.

they involve passing the dust-laden air through a bank of finely divided sprays or through a coarse, wetted filter. A wet scrubber built into each continuous miner at the Westray mine drew in air at the front of the machine and ejected the filtered air at the rear. Unfortunately, those scrubbers (according to testimony) were likely switched off most of the time.[6] Furthermore, notes made at the time of the RCMP's re-entry into the mine in September 1992 suggest that the dust extraction system on the continuous miner in the SW2-1 heading was not operating at the time of the explosion.[7]

Section 70(1) of the *Coal Mines Regulation Act* sets out a procedure for dust control, "[u]nless the floor, roof and sides of the road and working places in a mine are naturally wet throughout . . ." Section 70(2) requires that continuous mining machines, coal-cutting machines, coal-loading machines, conveyors, mine cars, and landings be treated with water sprays or jets in order that the coal be sufficiently wetted.

A method of controlling the formation and dispersal of dust on the floors of mine roadways is known as roadway consolidation. Roadway consolidation involves the application of a combination of stonedust, moisture-absorbing materials (such as calcium chloride or magnesium chloride), and a binding agent. This treatment binds the dust and maintains the floor in a firm but moist state. The procedure must be carried out at intervals, according to traffic and atmospheric conditions. No attempts at roadway consolidation were ever made at Westray.

Where airborne dust concentrations are kept down, the rates of dust deposition in mine entries will also be reduced. It is still necessary to remove accumulations of dust. Mechanized systems can be used on vehicular travel roads, but they may be impractical in conveyor entries, where dust can deposit at a higher rate. Belt maintenance crews should routinely clean dust and debris from underneath conveyors, particularly in the vicinity of gearheads and return rollers.

Stonedust

Diluting coal dust with fine dust from incombustible rock is an accepted way to suppress the propagation of coal-dust explosions in mines. The technique, called stonedusting, is now required in coal mining throughout the world. Section 70(3) of the *Coal Mines Regulation Act* states:

> The floor, roof and sides of every road or part of a road, that is accessible, shall, if deemed necessary by an inspector, be treated in one of the following ways:
>
> (a) they shall be treated with incombustible dust in such manner and at such intervals as to ensure that the dust on the floor, roof and sides,

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6 Westray overman Jay Dooley estimated that 75 per cent of the operators on his shift ran the continuous miners with the dust collectors turned off (Hearing transcript, vol. 39, pp. 8674–78).

7 In his debriefing on 27 September 1992, draegerman Don Dooley reported that he had "[c]hecked the dust collection system on the miner, [and it was] in the off position, [and] was not running at the time" (Exhibit 37b.113).

respectively, shall always consist throughout of a mixture containing not more than thirty-five per cent combustible matter, or such other greater or less percentage as an inspector upon investigation may deem proper, and where methane gas is present, the percentage of incombustible dust shall be increased by ten per cent for each one per cent of methane in the air current, as determined by analysis of an air sample from the section;

(b) they may be treated in such other manner as the Minister may approve.

Limestone or dolomite is the most common source of stonedust (often called rock dust) for underground coal mines. Stonedust mixed in sufficient quantity with settled coal dust in mine entries will help suppress a coal-dust explosion in at least two ways. First, the shock wave that races along a mine entry in advance of the flame of an explosion disperses settled dust into the air. In the more common burning type of explosion, each burning particle of coal is hot enough to ignite neighbouring particles, an event that happens exceedingly fast, propagating the flame along the entry. With sufficient stonedust to dilute the airborne coal dust, the particles of coal dust will be spread further apart, reducing the chance of ignition between particles.

Second, the stonedust particles absorb some of the heat generated in the explosion flame. The heat loss has a quenching effect on that flame.[8] As well, carbon dioxide may be produced as the stonedust reaches a high temperature within the flame of an explosion. This incombustible gas will combine with the gaseous products of combustion to lower the oxygen content of the air and inhibit burning.

To be effective, stonedust must be applied either continuously or at short and regular intervals; coal dust settles continuously downstream from dust-producing sources, and it is the topmost layer of settled dust that contributes to a coal-dust explosion.[9] The stonedust should be applied evenly on all surfaces of the roof, floor, and ribs of underground roadways. The most effective method is to use trickle dusters, which emit stonedust into the air at a continuous and controlled rate. The stonedust mixes with the airborne coal dust and settles with it on all surfaces. Trickle dusters are particularly beneficial when used downstream from coal-dust sources and in conveyor entries. Other stonedusting devices emit the dust through a length of flexible hose that may be manually directed towards roof and rib surfaces. The oldest method of stonedusting is completely manual: shovelling directly from bags of stonedust. It relies on the skill and diligence of the worker to coat all surfaces adequately. This technique is much less effective than mechanized means because often some surfaces are missed. Untreated areas can sustain an explosion.

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8 This is precisely the result found in the Elfstrom Report, and to which we briefly referred earlier. Stonedusting is a practical and proven method of countering the explosive potential of coal dust.

9 "Downstream" refers to the direction of airflow.

The entries of an adequately stonedusted coal mine will be light grey.[10] Although the combustible content of the dust can be known accurately only by sampling and laboratory analysis, the colour of surfaces in coal mine entries can be a good indicator of the need for additional stonedusting. In contrast to coal dust, which absorbs most of the light that falls on it, stonedust is quite reflective. Visibility is enhanced in a well-stonedusted roadway; light from fixtures, vehicles, and miners' cap lamps carries farther. The improved visibility reduces the potential for accidents and makes for a less claustrophobic environment.

Barriers

The stonedust barrier is an additional (though not alternative) method of using stonedust to combat potential coal-dust explosions. Although common in the United Kingdom and elsewhere in Europe, barriers are not widely used in North America. The traditional and simplest stonedust barrier is a series of boards mounted across a mine entry near the roof, supported on pivots at each end. (These are *passive barriers*.) Stonedust is piled on the boards to a weight of 30 to 60 kg per metre of board length. When hit by the shock wave of an explosion, the boards become dislodged from their pivots, and stonedust disperses into the air as a highly concentrated cloud of inert material, which may prevent the following flame front from propagating. Stonedust barriers do not prevent the initiation of an explosion. They have been shown, however, to be effective in reducing the probability of the explosion's propagation throughout the mine. Stonedust barriers are most effective in conveyor entries and return airways, where coal dust is particularly likely to settle.

Water barriers consist of water-filled, easily fractured trays hung near the roof in similar configuration to stonedust barriers.

Triggered barriers are activated either by the shock wave pressure or by radiation from the flame. With the aid of a dispersal apparatus, which consists of a compressed cylinder of inert gas or a small explosive charge embedded in the barrier, a length of airway can be instantly filled with stonedust or a fine water spray and water vapour. Westray did not have any stonedust or water barriers.[11]

Barrier systems must be placed in the proper perspective when discussing mine safety and explosion prevention or suppression. As stated in a major report prepared for CANMET on the subject, "[b]arrier systems

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[10] This is consistent with my observations while visiting the Skyline mine in Helper, Utah, and the Phalen mine in New Waterford, Nova Scotia. At the Jim Walter Resources mine in Brookwood, Alabama, the floors, ribs, and roofs of the entries were almost white.

[11] Ray Savidge, a one-time Westray surveyor, testified that no barriers were installed at Westray. When he brought up the subject with the engineering department, he was told that "they're out of date." This was contrary to Savidge's experience at Kaiser Resources in British Columbia, where "the manager would always have a stonedust barrier in proximity to development" (Hearing transcript, vol. 22, p. 4343).

are the fourth and last line of defence."[12] To emphasize this point, the report observes that:

> The initial explosion is generally a result of the failure to adequately complete any or all of the *first three lines of defence* . . . (1) The reduction in the amount of dust produced and made airborne. (2) The reduction of the possibility of ignition by effective ventilation, mining practices and maintenance of equipment. (3) The use of inerting methods such that the deposited coal dust is made harmless.[13]

Figure 9.1 shows a typical stonedust barrier as used in the Cape Breton collieries of Devco. In its Phalen Mine, Devco uses for water barriers lightweight, and easily fractured, rectangular plastic tubs mounted to the roof of the mine as shown in figure 9.2.

Passive barriers have not achieved the same level of acceptability in the United States as they have in other parts of the world. Inquiry mining consultant Roy MacLean suggests that this is due in some measure to the height of the drives and entries and the roof configuration in U.S. mines. Generally, the U.S. mine has a lower, flat ceiling, as opposed to a dome or arch configuration. In such a mine, the presence of roof-mounted passive barriers may impede equipment and miner mobility. These comments are consistent with my own observations of the height and shape of the drives and entries in the Skyline mine in Utah.[14] Also, MacLean suggests that, since the U.S. mining industry does not generally use the single-entry longwall mining technique, activating the passive barriers becomes more problematic, because the shock wave produced by the initial methane explosion may dissipate into intervening cross-cuts and airways and thus lack the force necessary to displace the shelves or fracture the water tubs. Furthermore, for room-and-pillar mining, in which the locations of the active mining faces are continually changing, locating and relocating barriers would be especially problematic and labour intensive.

The triggered barrier, as opposed to the passive barrier, is mechanically or electrically activated and need not await the shock wave. The triggered barrier would resolve the problem of a slowly propagating coal dust explosion that may not produce a shock wave of sufficient intensity to activate the barriers. The development of the triggered barrier is quite recent, and there is a relatively small amount of research material on the subject. In its Summary and Conclusions, the Mountford Report makes the following observations respecting triggered barriers:

> Experimental work to date indicates that triggered barriers are effective in suppressing explosions near to their point of initiation, i.e., before the explosions have been able to develop much momentum and energy. There is some question as to whether they can suppress well developed, violent

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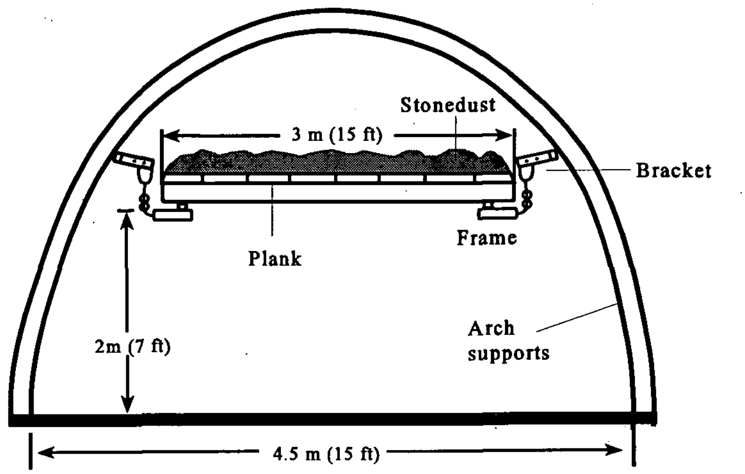
12 Brian Mountford and Associates Ltd, "Passive and Triggered Barrier Systems for Canadian Underground Coal Mining Conditions – Final Report" (Vancouver, BC: Brian Mountford and Associates Ltd, 1983) [Mountford Report], 1-4.

13 Mountford Report, 1-9.

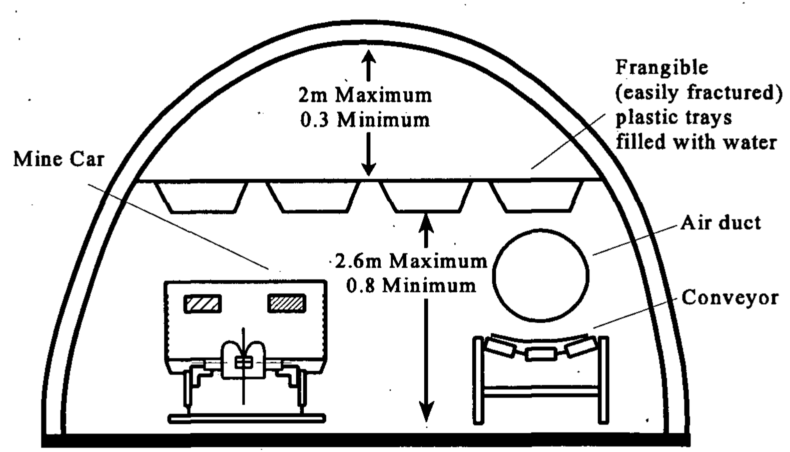
14 See the section on mine visits in Chapter 16, The Inquiry, for an account of my visit to the Skyline and other mines.

Figure 9.1 Typical Stonedust Barrier Installation



Source: Cape Breton Development Corporation, *Mine Supervisor/Overman Training Programme* Module C/MO 3/14 (Sydney, NS, 1984).

Figure 9.2 Typical Water Barrier Installation



Source: Cape Breton Developmentt Corporation, *Mine Supervisor/Overman Training Programme*, Module C/MO 3/14 (Sydney, NS, 1984).

explosions. In view of this it is questionable whether regulations can be developed at this time for their installation in Canadian mines. Their principal advantages over passive barriers are in their compactness and portability and their ability to suppress weak explosions at their point of initiation. Therefore, consideration may be given to their use at the coal face or at points where explosions are most likely to be initiated.

The Mountford Report, though somewhat dated, provides a good starting point in developing a policy for the use of barriers in underground coal mines.

Coal Dust at Westray

Mine workers were consistent in their evidence about dust conditions in the Westray mine. They spoke of large amounts of coal dust being present in the mine, of the inadequacy of stonedusting, and of the haphazard manner in which stonedust was applied.

Airborne Dust

The primary sources of airborne dust in the Westray mine were the continuous miners. For much of the time, the dust scrubbers on the machines were switched off. According to Jay Dooley, the operators "would rather listen to the roof than to the dust collection system." The operators also told Dooley that the ventilation air tended to carry the scrubber exhaust back towards the operator's position.[15]

Miners often wore disposable dust masks. Although this precaution is normal and acceptable practice at the working face, Shaun Comish, a continuous miner operator, told the Inquiry that "they'd get so clogged, you couldn't breathe and you'd have to take it off." Comish said he always wore face masks when he was mining, as many as six to ten masks per shift.[16] That number may be considered indicative of excessive concentrations of airborne dust.

A second consequence of the levels of airborne dust in the mine was the speed with which stonedusted areas were covered by coal dust. Mine workers testified that certain areas would be covered over periods of a few hours to a few days. David Sample described what it was like to come back into the mine after having stonedusted the previous day. On the ribs, "[y]ou would just see remnants of the stonedust that hadn't been covered up by the previous shifts' production of coal." On the floor, "you wouldn't be able to tell."[17] Shuttle car operator Dave Matthews described his attempts to control dust near the Stamler feeder-breaker by using a hand-held hose to water the road while his shuttle car was emptying.[18]

Airborne dust in the Southwest 2 section became noticeably worse during the last week of operations.[19] Lenny Bonner was roof bolting in the Lefthander on 8 May when he stopped and began "watering down the roadways and the ribs. Whatever I could hit with the water." He explained that he had got off the bolter "[b]ecause the dust in the section that particular shift was just too much. And it was so hot and dusty that I

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15 Hearing transcript, vol. 39, pp. 8675–76.

16 Hearing transcript, vol. 28, p. 5816.

17 Hearing transcript, vol. 30, p. 6489. Others who made similar observations included Clive Bardauskas (vol. 23, p. 4704), Rick Mitchell (vol. 31, p. 6751), Tom MacKay (vol. 32, p. 7127), and Randy Facette (vol. 33, p. 7248).

18 Hearing transcript, vol. 31, p. 6590.

19 Wayne Cheverie (Hearing transcript, vol. 21, p. 4011), Mick Franks (vol. 22, p. 4240), and Wyman Gosbee (vol. 25, p. 5018) commented on the increase in dust. Cheverie noted that the dust in the air was "[f]airly heavy, especially along the belt road . . . Southwest 2-B Road."

couldn't stand it any more." Bonner had seen plenty of dust in the mine, "but in that particular place it's been about the dustiest that I've seen it."[20]

Dust was produced by vehicle tracks and wheels grinding into the coal floor. Bryce Capstick, a Westray foreman, observed that "it was quite prominent, the coal dust. Well, all our machinery, the bolters and the Joy miners . . . every time they move, they just grind everything into powder."[21] A particularly bad area was in the No. 1 Main slope between No. 9 and No. 11 Cross-cuts.[22] The road here, used both as a main intake airway and as an access route, was extremely steep. Vehicles travelling through this zone raised such high concentrations of airborne dust that the drivers, unable to see ahead, were forced to look sideways at the steel arches for guidance. Bonner described "a wall of dust" proceeding in front of the vehicle that was going downslope in the same direction as the airflow, further decreasing visibility.[23]

Accumulations of Coal Dust

Testimony during the Inquiry was filled with references to large accumulations of coal dust throughout the mine. Ed Estabrooks described the mine as "a black mine."[24] Westray geologist Arden Thompson recalled a conversation underground with John Bates, who was to die in the explosion. Bates had said: "'This is the blackest hole I ever worked in. . . . Somebody is going to buy it here big.'"[25] The dust was a common topic of complaint by the workforce.[26] The depth of accumulated coal dust on the floors of entries varied throughout the mine from a few centimetres on the travelling paths to a metre or greater at the sides, with the North and Southeast sections being particularly affected.[27] A number of the miners

20 Hearing transcript, vol. 24, p. 4792.

21 Hearing transcript, vol. 42, p. 9348. Jay Dooley made the same point, noting that most of the roads underground "are in the coal" (vol. 38, p. 8474).

22 Ray Savidge (Hearing transcript, vol. 22, pp. 4360–61), Shaun Comish (vol. 28, p. 5817), and Randy Facette (vol. 33, p. 7191) commented specifically on the extreme dust conditions in this area.

23 Hearing transcript, vol. 24, p. 4806. Cheverie described the same phenomenon (vol. 20, p. 3938).

24 Hearing transcript, vol. 24, p. 4882. Others who commented on this feature included Dave Matthews (vol. 31, p. 6577) and John Lanceleve (vol. 27, p. 5519).

25 Hearing transcript, vol. 40, p. 8852.

26 Jay Dooley testified: "I do have knowledge of all the men that worked in the mine voicing their concerns [about cleaning up coal dust] to the people that operated the mine" (Hearing transcript, vol. 41, p. 9053). Dooley (vol. 38, p. 8484), Steven Cyr (vol. 25, p. 5190), and Trevor Eagles (vol. 76, pp. 16436–37) talked of specific and general concerns of the miners.

27 Many witnesses attested to the depth of coal dust on the roadways and conveyor entries. A brief sampling: Ed Estabrooks: "an inch or two below the knee" in the 2 East Road (Hearing transcript, vol. 24, pp. 4879–80); Steven Cyr: "chest high" at the discharge of the end of the conveyor in No. 2 Main (vol. 25, p. 5120); Wayne Cheverie: "Anywhere from . . . nine or ten inches deep" in the SW2-B belt road to 20 or so inches in the No. 9 Cross-cut air crossing (vol. 20, pp. 3937–38); Dave Matthews: "up to 12 inches" in the North Mains and more "in some places" (vol. 31, pp. 6606–07); Fraser Agnew: "ankle deep or more" (vol. 35, p. 7709); Jonathan Knock: "average six to eight inches" and "deeper on the hills" (vol. 26, p. 5280); Rick Mitchell: "It was over the ankles, for sure" in SW2-A Road (vol. 31, p. 6701); Shaun Comish: "deep enough to bury a bundle of rock bolts" on the side of the rib in the North A, B, and D Roads (vol. 28, p. 5818); Doug MacLeod: "eight, ten inches sometimes" in the intersections (vol. 27, p. 5670).

spoke of difficulty walking through such depths of coal dust, and of the dust dispersed into the air by foot travel. Harvey Martin, a Westray electrician, described walking through SW1-C1 Road as "heavy," especially in the intersections: "It was up, you know, almost to the top of your boots but maybe not over it in all the places. But every time you walked, there would be a cloud of dust come up from your feet."[28]

The floor dust also made it difficult to drive mobile equipment. In the working areas, shuttle cars became stuck in the dust. In the last weeks before the explosion, drag bars were fitted to shuttle cars in an attempt to avoid deep ruts in the roadways. Those devices, however, did little more than smooth out the surface of the floor dust and push dust from the travelway towards the sides of the roadways. Miner Buddy Robinson didn't see the drag bar as being very useful "because they just dragged it one way and coming back they'd drag it the other way."[29] In active headings, attempts were also made to push the dust towards the face, where it could be gathered by the continuous miner.[30] Bonner described the situation in 2 East, where "the coal dust was very deep and, like, the tractor would bounce up and down in the coal dust trying to make it up. You would sometimes have to push it with the dozer."[31]

The travel situation was eased by moving the floor dust with dozers or Scooptrams, but little effort was made to remove that dust from the mine. The dust was either simply pushed to the sides of roadways or deposited in cross-cuts or abandoned entries, where it might reach a metre or greater in depth. Steven Cyr described the situation in 3 North Main: "When they cut the road down, 3 North Main was considerably higher than 1 East. And when they set the steel, they just kept pushing the coal dust down that road to kind of get it out of the way." When asked if he ever saw coal dust being taken out of the mine, Cyr replied, "No, the only time I ever seen coal dust and coal cleaned up was when it was around the box end [of the conveyor belt]. And that was just to keep it from catching on fire."[32] When Jay Dooley was asked about using Scooptrams for moving dust from the mine, he explained that the equipment was always in use and seldom made available for that purpose.[33]

No serious attempts were made to remove accumulations of coal dust from under belt conveyors. The belt crews removed the larger material that

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28 Hearing transcript, vol. 23, p. 4479. Mick Franks said the dust "would be sucking at your boots" (vol. 21, p. 4157); John Lanceleve spoke of having to empty his boots every day when he got into the workplace (vol. 27, p. 5508); and Lenny Bonner, who taped his coveralls to his boots, found the dust "quite hard to walk in" (vol. 24, p. 4736).

29 Hearing transcript, vol. 30, p. 6331.

30 Lanceleve described pushing coal dust to the face with a dozer (Hearing transcript, vol. 27, pp. 5508–09).

31 Hearing transcript, vol. 24, p. 4795. Jonathan Knock said that the boom truck often got stuck in coal dust (vol. 26, p. 5267).

32 Hearing transcript, vol. 25, p. 5123. Similar tales of dust being piled up in the mine but not removed were related by Jonathan Knock (vol. 26, pp. 5281–84), Fraser Agnew (vol. 35, p. 7710; vol. 37, p. 8055), Ed Estabrooks (vol. 24, pp. 4880–82), and Aaron Conklin (vol. 28, p. 5977).

33 Hearing transcript, vol. 41, pp. 9043–44.

had fallen from a conveyor, but dust clean-up was limited to what was necessary to prevent the belt from actually pulling through dust. As Cyr noted, the latter situation could have caused frictional heating and ignition of the coal dust.[34] Neither was coal dust always cleaned up after a conveyor had been moved. Savidge recalled that "the first signal to me that something was not right was when they pulled the belt end forward for the first time and they left a pile of compressed coal in situ, without cleaning it up."[35]

Stonedusting at Westray

The company procedures for stonedusting at Westray were set out in the Manager's Safe Working Procedures:[36]

1. The locations covered by this plan are all coal driveages, the Rock Slope including conveyor drift.
2. This plan shall apply for any coal driveage to within 50 m of the working face.
3. (1) The floor, roof, and ribs of each coal road that is accessible shall be treated with incombustible dust to ensure that the floor, roof, and ribs will always contain not less than 65 percent of incombustible matter as prescribed in the Coal Mines Regulation Act, Section 69, Paragraph 6, unless[37]
   (2) Where flammable gas is present in the ventilating current, the minimum amount of 65 percent of incombustible matter prescribed by subsection (1) shall be increased by one percent for each one-tenth of one percent of flammable gas in the general body atmosphere.
4. Before a part of the road is dusted for the first time with rock dust, it shall be cleaned as thoroughly as practical of all combustible dust.
5. The incombustible dust used for the purpose of this plan means the pulverized inert material of light colour,
   (a) of which 100 percent passes through a 20 mesh sieve
   (b) of which approximately 43 percent passes, when dry, a 200 mesh sieve and 79 percent passes a 100 mesh sieve
   (c) which does not contain more than 5 percent of combustible matter or 4 percent of free and combined silica
   (d) this being a product that is readily available in Canada and being used by other underground mines in Canada.

These procedures reflect the mandatory requirements set out in the *Coal Mines Regulation Act*. I emphasize that these safety procedures were established prior to the opening of the Westray mine and in anticipation of active coal mining. These are the requirements established by *Westray management* and enshrined in the Manager's Safe Working Procedures.

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[34] Among the underground workers who testified about dust accumulations around conveyors were Cheverie (Hearing transcript, vol. 20, pp. 3941–42), Knock (vol. 26, p. 5296), and Conklin (vol. 28, p. 5994).

[35] Hearing transcript, vol. 22, p. 4361.

[36] Exhibit 37a.123–25.

[37] These section references do not correspond to the current regulations (as cited throughout this Report) because the regulations were renumbered in 1989.

What is remarkable is that the evidence proclaims, for all to hear, that these company safety procedures were meticulously and studiously disregarded by the very management that had compiled them. What is equally remarkable, as we will see from the following narrative, is that the provincial mine inspectorate did little or nothing to ensure compliance, either with the safe working procedures or with the legislation on which the procedures were patterned.

From September 1991 onward, the provincial mine inspectorate made repeated demands and requests to Westray management about the lack of a stonedusting plan or sampling. (The record shows that such demands were usually met by vague or bland assurances from Gerald Phillips or Roger Parry that these matters would be looked into and remedied. These assurances seemed sufficient to appease mine inspector Albert McLean and his boss, director of mine safety Claude White, since little was ever done to follow up on them.) This concern, however, appears not to have been made known to the workforce.[38] No schedule or procedure was in place for applying enough stonedust to render the coal dust inert. Harvey Martin told the Inquiry that "there was nobody ever assigned to do stonedusting throughout the mine. There was no regular stonedusting schedule in our mine that I know of anyway."[39] There were no persons whose specific duty it was to apply stonedust.[40]

Stonedusting first became necessary at Westray when the development of the main slopes reached the coal seam. At that time, miners were asked to volunteer to remain after their 12-hour shifts to apply stonedust.[41] Unfortunately, although this practice continued as the mine expanded, it became increasingly ineffective. As Rick Mitchell said when asked by counsel whether the volunteer system was adequate, "No . . . It's got to be continually done."[42] As working sections opened up and production increased, the amount of coal dust increased. The miners became more reluctant to stay behind after their normal 12-hour shifts. Miner Ron MacDonnell told the Inquiry: "[Y]ou work 12 hours underground in a rat hole like that, you're going to want to get the hell out of there as fast as you can. After 12 hours, you just don't feel like staying for another hour."[43]

The miners gave at least two reasons for becoming unwilling to engage in voluntary after-shift stonedusting. The first was that, after 12 hours of

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38 Jay Dooley was not aware of the inspectorate's concerns (Hearing transcript, vol. 39, p. 8743).

39 Hearing transcript, vol 23, p. 4483. Jay Dooley testified that "there was never a permanent plan for stonedusting of the mine" (vol. 38, p. 8401).

40 Buddy Robinson (Hearing transcript, vol. 30, p. 6329).

41 Jay Dooley (Hearing transcript, vol. 38, p. 8473); Shaun Comish (vol. 28, p. 5828).

42 Hearing transcript, vol. 31, p. 6745. Jay Dooley put it this way: "As the mine branched out . . . the temporary plan of stonedusting between shifts just was not combating the dust that was in the mine" (vol. 39, p. 8723).

43 Hearing transcript, vol. 29, p. 6117. Bryce Capstick told the Inquiry: "It was hard to get the men to stay. . . . the first shift back, you could maybe get one or two men, but after the first . . . 12-hour shift, they were just too beat to stay between shifts and stonedust" (vol. 42, p. 9353).

work in the deteriorating mine, the men were tired and anxious to leave. As Steven Cyr put it, "I was finding the 12-hour shifts were too much. . . . By the time you got to your third and fourth day on the set, you'd be pretty wore out."[44] The second reason was that, although the system of voluntary after-shift stonedusting was inadequate, mine management would not allow time for stonedusting during the normal shift.[45] This refusal appears to have caused resentment, further decreasing the number of employees willing to stonedust on overtime. Cyr probably put it most succinctly: "So if they didn't want to stop production, we weren't staying between shifts."[46]

The Application of Stonedust

All the mine workers questioned on the matter testified about the gross inadequacy of stonedusting in the mine. Randy Facette, who regularly stayed on to stonedust with Rick Mitchell and David Sample, admitted that "it would have taken a lot more bags to bring the combustibility level down."[47] As noted earlier, workers offered testimony on the blackness of the mine and the resulting loss of visibility. Savidge commented: "[I]n a coal mine I wouldn't say it should be white, but it should be a light grey. So that when your light, your cap lamp, gives you a pretty good picture when you look. At times there, if you didn't shine your light directly on what you wanted to see, you couldn't see it."[48]

There appears to have been only one occasion on which the mine was properly stonedusted. This was for the grand opening of Westray on 11 September 1991. Mick Franks remembered that day: "[W]e came down and it was just like Christmas day down there, you know. Everything was white. But that's the only time I ever seen any."[49] A number of senior officials and dignitaries visited the underground workings at that time, and there seems to have been little productive work done during those visits. Wayne Cheverie told the Inquiry that the miners "were just cutting when the different loads of dignitaries came into the mine to show them the

44 Hearing transcript, vol. 25, p. 5128. Don Dooley, referring to the ground conditions in the mine, said, "these men were concerned about the roof. They didn't want to stay that extra 45 minutes" (vol. 37, p. 8236).

45 Rick Mitchell (Hearing transcript, vol. 31, p. 6747).

46 Hearing transcript, vol. 25, p. 5127. Don Dooley's crew was giving him the same message (vol. 36, pp. 7798–99).

47 Hearing transcript, vol. 33, p. 7249. In the nine months that Wyman Gosbee worked at Westray, he estimated that he had seen evidence of dusting only "maybe three times" (vol. 25, p. 5002). Ray Savidge, a mine surveyor with a British background and plenty of underground coal mine experience, reckoned there was never enough stonedust in the mine (vol. 22, p. 4344). Buddy Robinson, an experienced coal miner, said, "I don't ever remember seeing any serious rock dusting getting done . . . Actually, they didn't have the equipment there to do it" (vol. 30, p. 6329).

48 Hearing transcript, vol. 22, pp. 4341–42. Clive Bardauskas, another British-trained miner, echoed Savidge's comments. When asked if he'd ever seen the Westray mine grey, he replied: "No. . . . Never." (vol. 23, pp. 4641–42).

49 Hearing transcript, vol. 21, p. 4159. Franks went on to say, "But, no, it wasn't the general policy to stonedust, that's for sure." Ed Estabrooks testified that "on just one occasion I can say that the mine was fully stonedusted." That was 10 September 1991, "just the day before the grand opening" (vol. 24, p. 4882).

mining process but, other than that, they weren't working."[50] Additional stonedusting was carried out on other occasions, when particularly important visitors travelled underground.[51]

It is not uncommon in coal mines for extra stonedusting to be carried out if it is known that a visit by an inspector is imminent. Some mine workers testified that this happened at Westray, although still on an after-shift basis. Jay Dooley told the Inquiry that Roger Parry would ask for stonedusting because an inspector was coming: "He has said that there will be an inspector coming, to make sure that the areas are stonedusted in the next couple of shifts." But Dooley went on to say that he didn't think "anyone stayed because the inspector was coming." When asked if the mine did get stonedusted, he replied, "Sometimes it did; sometimes it didn't."[52] Some thought that such pre-inspection stonedusting was little more than cosmetic. As Lenny Bonner said, "I certainly don't think it would impress the mines inspector."[53] The standard of stonedusting apparently deteriorated through the early months of 1992, as did efforts to apply stonedust before inspections.[54]

Very little stonedusting was done in the North sections.[55] A stonedusting machine was kept in the Southwest area, and some stonedusting was carried out in the Southwest 1 and Southwest 2 sections. Facette testified that "we only had the one stonedusting machine in the mine. And that never left the Southwest section the whole time I was there."[56] The amount done was inadequate, however, and sometimes the job was done manually, which is inefficient. Trevor Eagles told the Inquiry that foreman Ferris Dewan would regularly stonedust by hand, "spread it around with the shovel, just throwing it up into the back and on the ribs and around on the floor with the shovel."[57] On rare occasions,

50 Hearing transcript, vol. 21, p. 4009. Cheverie guessed that perhaps mining was not going on as normal so as "to not subject the dignitaries to heavy dust, coal dust" (p. 4010). This seems to be another example of the "all for show" attitude alluded to by Inquiry mining expert Don Mitchell, including the modern and attractive surface infrastructure, which stood in stark contrast to the conditions underground (vol. 17, pp. 3033–34).

51 A number of witnesses observed or took part in stonedusting prior to seeing prominent visitors such as Premier Cameron, Westray president Marvin Pelley, and potential buyers or investors: Shaun Comish (Hearing transcript, vol. 28, p. 5829); John Lanceleve (vol. 27, pp. 5589–90); Tom MacKay (vol. 32, pp. 7112–13); Arden Thompson (vol. 40, pp. 8806–07); Doug MacLeod (vol. 27, p.5672); Fraser Agnew (vol. 35, p. 7713).

52 Hearing transcript, vol. 38, pp. 8449–51.

53 Hearing transcript, vol. 24, p. 4847. Fraser Agnew suggested there was just enough stonedust "to whiten things up a bit." When asked if he thought the inspector would have been fooled, Agnew said, "Oh, I don't think you could fool Albert [McLean]; he's been around too many years" (vol. 35, p. 7714).

54 Lanceleve (Hearing transcript, vol. 27, p. 5519).

55 Fraser Agnew wasn't aware of any at all (Hearing transcript, vol. 35, p. 7712); neither was Randy Facette (vol. 33, p. 7185) or Dave Matthews (vol. 31, p. 6579). According to Don Dooley, "in the North Mains it was non-existent. It wasn't worse; it wasn't done" (vol. 38, p. 8315).

56 Hearing transcript, vol. 33, p. 7185. Mitchell (vol. 31, p. 6748) and Sample (vol. 30, p. 6487–89), along with Facette, dusted the Southwest working roadways as much as they could.

57 Hearing transcript, vol. 76, p. 16441. Clive Bardauskas described a method that involved "pouring stonedust onto the back of a tractor and standing at the back of it and throwing it by hand" (vol. 23., p. 4688).

when the boom truck operators were caught up with their work of hauling supplies, Jay Dooley would ask them to stonedust in a return airway, but not in intakes.[58]

The stonedust was supplied to Westray by Mosher Limestone Co. Ltd of Upper Musquodoboit, Nova Scotia. Between 29 May 1991 and 9 May 1992, Mosher delivered 180 tonnes of dolomite dust to Westray.[59] Transporting stonedust into the mine was not a priority,[60] and much of the stonedust taken underground was not used for its primary purpose of diluting coal dust. Rather it was usual for many of the bags of stonedust to be unloaded at electrical stations or at a compressor. Dave Matthews, discussing a safety walk reported in February 1992, told the Inquiry that the only places that had been stonedusted were around the transformers and places like that.[61] The *Coal Mines Regulation Act* requires that such stations be adequately stonedusted.[62] Unfortunately, much of the stonedust remained within bags in those locations, and those unused bags would often become covered in coal dust or be broken. Said Ed Deane, who delivered stonedust underground: "The majority of the stonedust that I placed by the switches remained where they were . . . A lot of the bags would get wet . . . but in general the bags stayed there and the coal dust would just keep building on top."[63]

Section 70(5) of the act requires that "[n]ot less than twenty bags of stonedust shall be stored in every working section for emergency within a reasonable distance of the working face and in room and pillar sections, a suitable amount of stonedust shall be kept within easy access of the working faces." This requirement seems to have been largely ignored. Don Dooley had stonedust available in his section only "[o]n some occasions."[64]

The last real effort to stonedust was made by Facette, Mitchell, and Sample, who remained behind after their night shifts on 1–4 May 1992.[65] They had done the same thing some 10 to 13 times during April. They felt some obligation since two of their number were members of the safety committee, which had complained repeatedly to the mine management

58 Hearing transcript, vol. 38, p. 8455. Dust carried by the ventilating air was bothersome to anyone working downstream.

59 Exhibit 139.12.062. 180 tonnes of stonedust is about 0.5 kg per tonne of coal mined. Devco uses about four times that amount in much less dusty conditions. Inquiry mining expert Roy MacLean estimated that Westray could have used at least 4 kg per tonne.

60 Don Dooley described the difficulty in getting even mining and ground support supplies delivered underground. He felt that management priorities and a shortage of utility vehicles led to regular shortages of stonedust underground (Hearing transcript, vol. 36, pp. 7803–04).

61 Hearing transcript, vol. 31, p. 6577.

62 Section 85(2), rules 2, 151, 154.

63 Hearing transcript, vol. 26, p. 5376. John Lanceleve saw "lots of rock dust in the mine, but I never seen it being used" (vol. 27, p. 5515). Steven Cyr delivered lots of stonedust underground: "I know there was a lot of broken bags around the switches that we had to replace" (vol. 25, p. 5185).

64 Hearing transcript, vol. 36, p. 7800. Bryce Capstick testified that there was stonedust "around all electrical equipment," but "it wouldn't be within general reach" of the working faces in his section (vol. 42, pp. 9450–52).

65 Mitchell (Hearing transcript, vol. 31, p. 6828).

about the lack of stonedusting.[66] However, they felt that their efforts were not sufficient to produce satisfactory conditions.[67]

Starting in January 1992, Westray mechanic Clive Bardauskas would, at the end of his shift, "couple up the stonedust machine to the scoop provided there was a scoop available."[68] Don Dooley explained to the Inquiry that, generally, three men did the stonedusting. One operated the Scooptram, one dumped bags of stonedust into the machine, which sat in the bucket of the Scooptram, and the third directed the stream of stonedust with an attached hose.[69] A pallet held about 40 bags of stonedust. The crew would normally load 40 to 60 bags into the Scooptram at one time.[70] These operations were sporadic, however, occurring only when workers could be persuaded to stay on after their normal shifts.[71] Mechanical problems and shortage of equipment further limited opportunities for stonedusting.[72]

The conveyor slope, No. 2 Main, was stonedusted with a hydraulically powered device that had been built at the mine. Known as "the sandblaster," it did not seem very efficient. Aaron Conklin, who led the belt crew that used the sandblaster, testified that it "only blew a fine coat of dust; it wasn't the proper machine for it."[73] Stonedusting was carried out along those sections of slope that could be reached by a 50- or 100-foot (15 or 30 m) length of air hose from three or four cross-cuts. The extent of the sections of the slope that were stonedusted were further limited, since the stonedust could only be directed downstream.[74]

The Scooptram-mounted stoneduster was not normally used on the conveyor slope because of very limited access. On the two reported occasions that it was used, access was through the doors in No. 5 and No. 7 Cross-cuts. No. 5 Cross-cut had a single set of doors only, and would therefore short-circuit the ventilation system of the whole mine when opened. As Conklin told the Inquiry, "when you would open them doors, you would short-circuit the air . . . so they weren't getting the air down below."[75]

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66 Facette (Hearing transcript, vol. 33, pp. 7246–47).

67 Mitchell (Hearing transcript, vol. 31, p. 6751); Facette (vol. 33, p. 7249).

68 Hearing transcript, vol. 23, p. 4639.

69 Hearing transcript, vol. 36, p. 7791.

70 Sample (Hearing transcript, vol. 30, p. 6536).

71 Tom MacKay, a miner on Bryce Capstick's crew, estimated that he stayed over to stonedust as many as 10 times. He said he didn't mind, since he lived close to the mine, but "a lot of guys didn't want to stay, and a lot of guys travelled together [car pooled]" (Hearing transcript, vol. 32, pp. 7074–75).

72 Ed Estabrooks described an equipment breakdown that prevented stonedusting the only time that he stayed over (Hearing transcript, vol. 24, pp. 4883–84). Clive Bardauskas would set up the Scooptram for stonedusting only when both he and the equipment were available. Even then, "I could set the machine up, but the guys may not want to work over, so it was never done" (vol. 23, pp. 4639–40).

73 Hearing transcript, vol. 28, p. 5940.

74 Conklin described the process of stonedusting in No. 2 Main. It was inefficient because the crew had to carry the equipment (the "sandblaster" had wheels) and the stonedust up and down the slope (Hearing transcript, vol. 28, pp. 5947–48).

75 Hearing transcript, vol. 28, p. 6011.

Conklin said that stonedusting was not a regular part of his crew's duties, nor was it included in training. Indeed, the crew would occasionally stonedust to fill time rather than be put on roof support work.[76] He stonedusted "no more than a couple of dozen" times during his time at Westray.[77] Sample spent three months on the belt crew, during which time he stonedusted only twice; he did not engage in removing coal dust on the belt line.[78] Matthew Sears worked 12 shifts on the belt crew in August 1991 without ever seeing a bag of stonedust.[79] Jonathan Knock spent three months on the belt crew without doing any stonedusting.[80]

Complaints by the Workforce

A safety committee had been formed at Westray. Members would walk through the mine with a member of management at approximately monthly intervals and note matters relating to safety. Some records of those safety walks, and the actions taken, are in evidence to the Inquiry. Table 9.1 shows matters relating to stonedusting, a frequent cause for complaint.[81]

The safety committee had no authority, and little was done by management other than to give undertakings to apply some stonedust. Dave Matthews felt that as a member of the committee he had no input into solutions for the matters that were brought up: "The major things that we would bring up, they would not get done." When asked what things were major, he replied that one of them was "the rock dusting which wasn't being completed."[82] Roger Parry's response was to institute the volunteer system for stonedusting, which, as we have seen, was ineffective.

In addition to criticism from the safety committee, individual complaints were made concerning the lack of stonedusting, but with little or no result. Jay Dooley had taken complaints to Parry, but he saw "no evidence of the complaints being attended to."[83] Foremen were not allowed to have their crews do stonedusting during normal shift hours. Bryce Capstick told the Inquiry that, even as a supervisor and mine examiner, he had no control over his working environment. He said that if he had stopped production to stonedust, "you would be removed from

[76] Hearing transcript, vol. 28, p. 5939.

[77] Hearing transcript, vol. 28, p. 5943.

[78] Hearing transcript, vol. 30, pp. 6538–39.

[79] Hearing transcript, vol. 29, p. 6051.

[80] Hearing transcript, vol. 26, p. 5223. Knock worked on the belts under both Conklin and Andrew Gill, from November 1991 to February 1992.

[81] Dave Matthews (Hearing transcript, vol. 31, p. 6622), Rick Mitchell (vol. 31, pp. 6721–22), and Randy Facette (vol. 33, p. 7184) were committee members who testified about the reports of safety walks that they took part in.

[82] Hearing transcript, vol. 31, pp. 6583–84.

[83] Hearing transcript, vol. 39, pp. 8714–15. Dooley recalled a meeting with his crew underground in which he told them, "I don't think he [Parry] acknowledges that we have [a] coal dust problem . . . he doesn't want to do anything about it" (vol. 38, p. 8502). Don Dooley "would speak about it to Roger just about every day" (vol. 38, p. 8346). Mitchell had tried twice to get an answer from Parry before he turned to the mine inspector (vol. 31, p. 6722).

Table 9.1 Dust-related Matters Extracted from Safety Walk Reports

Date	Matter noted	Steps taken[a]
7 Oct 1991	• No rock dust near transformer or switches in Southwest 1 • Rock dusting to be started and dusted daily between shifts [Exhibit 73.08.012]	• Twenty bags of stonedust installed at each substation • One shift in every set; men to be asked to work between shifts to stonedust section [Exhibit 73.08.010]
5 Nov 1991	(No comments re dust) [Exhibit 120.223]	
13 Jan 1992	• Rock dusting should be done in SW section and in the main slopes [Exhibit 120.227]	• Rock dusting to be done in SW section and in the mains [Exhibit 120.229]
24 Feb 1992	• Rockdusting required throughout [North] section • Rockdusting throughout [Southwest] section [Exhibit 120.235]	• Rockdusting to be carried out as soon as possible • Rockdusting to be carried out [Exhibit 120.237]
6 Apr 1992	• Rock dust needed at drive on #4 belt • All transformers and switches to be set up with fire extinguishers and rock dust • Rock dusting in sections [throughout mine] needs to be given more attention [Exhibit 120.238–39]	(No report)[b]

a From Safety Walk Follow-up Meeting reports, which are separate from the Safety Walk reports.
b There is no record of a follow-up meeting to the 6 April report.

that position." He said that every decision had to be confirmed with upper management – "you had to answer to Roger."[84]

Despite the concerns, little on stonedusting appeared on the Underground Operations Shift Foreman's Reports since, as Don Dooley put it, "it was . . . talked about continuously."[85] Underground manager Parry did not seem to regard coal dust as a hazard, and mine workers were concerned about jeopardizing their jobs if they were seen as complainers. Wyman Gosbee identified a couple of miners who had gone to Parry or Phillips and "brought up issues, and they were treated unfairly because of it."[86] The workers also felt that inspectors could not possibly have failed to observe the lack of adequate stonedusting. Many of the witnesses suggested that it should have been unnecessary to tell mine inspector

[84] Hearing transcript, vol. 42, pp. 9299–9300. Fraser Agnew, also a mine examiner, said that if he "had done anything without permission . . . I would have been fired. I didn't have the authority" (vol. 35, p. 7681). Don Dooley stated that, if he had stopped production to stonedust, "I would have lost my job" (vol. 36, p. 7968).

[85] Hearing transcript, vol. 38, p. 8310.

[86] Hearing transcript, vol. 25, p. 5013.

Albert McLean about the lack of stonedusting. Tom MacKay, for example, said, "I'm sure he could see that himself."[87]

Production took priority over the treatment of dust. When Don Dooley was promoted to shift foreman (mine examiner), Parry told him that "[s]tone dusting was to be done between shifts, never stop production to stonedust, in those words, in those terms."[88] Dooley testified that production requirements "far exceeded what could be met"; with production falling short of management's goals, work schedules certainly allowed no time to engage in stonedusting activities during the 12-hour shifts.[89]

Prior to the explosion, Aaron Conklin thought that stonedust was intended simply to improve visibility in the mine.[90] Conklin's impression here is not really surprising in light of the Westray training program. As with most other safety-related matters, the miners received little or no training or instruction on the hazards of coal dust and the related need to treat it adequately with stonedust. Harvey Martin, for example, had been an underground electrician at Westray for a year before he learned the purpose of stonedusting: "Near the end of it . . . I found out that this is what it's supposed to be for, and it just wasn't being done."[91]

Actions of Mine Inspectors

Throughout the active life of the mine, the conditions pertaining to dust – and the failure to implement procedures for stonedusting or sampling – were a concern to the mine inspectors. Table 9.2 is a compilation of quotations from inspectors' reports, minutes of meetings, and other documentation.

During the meeting of 5 September 1991, mine manager Phillips promised to provide a stonedust plan to the Department of Labour by the end of that month. The fact that such a plan already existed in the Manager's Safe Working Procedures, but was not being implemented,

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87 Hearing transcript, vol. 32, p. 7117. About McLean, Don Dooley said, "He is entering into this mine to do his inspections. . . . He is seeing the dust condition. . . . He would have to be walking around with a blindfold on . . . not to see it" (vol. 36, p. 7999). Arden Thompson hadn't spoken to McLean because "the amount of dust that was in the mine would be obvious. There were various things I think that he would see as being an experienced miner" (vol. 40, pp. 8987–88). Buddy Robinson had even challenged McLean, saying to him: "You can't walk around that mine and be a mine inspector and not see what was going on" (vol. 30, p. 6352).

88 Hearing transcript, vol. 36, p. 7780.

89 Hearing transcript, vol. 36, pp. 7811–13. Dave Matthews, referring to his roof bolting crew, said, "No, we wouldn't stop our regular routine to go stonedusting" (Hearing transcript, vol. 31, p. 6633). Ron MacDonnell told the Inquiry: "You wouldn't have the time [to stonedust]. You were pretty well rushed there . . . at Westray" (vol. 29, p. 6117).

90 Hearing transcript, vol. 28, p. 5949.

91 Hearing transcript, vol. 23, p. 4482. Underground mechanic Wayne Cheverie had never been taught about coal dust. He knew "[o]nly that it was flammable. And that, again, is just what I learned on my own" (vol. 20, p. 3922). Jonathan Knock became a boom truck operator in March 1992, having worked on the belt crew for three months. At that point he knew that coal dust was explosive, "but I didn't know the factors that it took to ignite it or what could prevent it" (vol. 26, p. 5238).

Table 9.2 References to Dust by Inspectors

Date	Document/author	Quotation (unedited)[a]
6 Jun 1991	DOL[b] Assessment Report (Albert McLean)	Stonedust has arrived and some will be sent underground and placed around the transformers and switch gear. [Exhibit 139.01.032]
5 Sep 1991	DOL Assessment Report of meeting at Westray (McLean)	Mr. Phillips said he will have a stonedusting plan in place by Sept. 30, 1991. [Exhibit 73.08.002]
16 Sep 1991	DOL memo re minutes of meeting at Westray 4 September 1991 [actually took place 5 September] (John Smith to Claude White)	4. Stonedust Plan: *G. Phillips promised to have a plan in the Department's hands by the end of September, 1991.* 5. Explosion Barriers: This item was not discussed in any detail. 11. Housekeeping: This item was not discussed in detail but G. Phillips acknowledged that the underground workings should be tidied up. [Exhibit 73.08.005]
26 Sep 1991	DOL Assessment Report (McLean)	Stonedust was very good on roof, sides and floor. Housekeeping – Good. [Exhibit 73.08.009]
19 Oct 1991	DOL memo re minutes of 15 October meeting at Westray (Smith to White)	A. McLean stated that there was a noticeable improvement in stonedusting. *The company's stonedusting scheme will be forwarded to the Department by the end of the month.* [Exhibit 79.08.012] [In the original handwritten notes by Smith, the last sentence read:] However, a copy of the company's stonedusting scheme had still not been received. [Exhibit 79.08.001]
29 Oct 1991	DOL Assessment Report (McLean)	Stonedust along #1 Slope is fair. A new stoneduster will arrive by November 15; the Manager has agreed to have someone put some stonedust in each area until the new duster arrives. [Exhibit 73.08.015]
29 Oct 1991	Letter re meeting held at Westray on 18 October 1991 (White to Gerald Phillips)	6. *Westray agreed to forward details of a stonedust scheme by November 15, 1991* – as per our telephone conversation of October 29, 1991. [Exhibit 119.204]
4 Dec 1991	DOL Assessment Report (McLean)	Stonedust was spread throughout the mine. [Exhibit 73.08.017]
27 Dec 1991	DOL memo re minutes of meeting at Westray 17 December 1991 (Smith to White)	6. Stonedust. G. Phillips said they had two machines to spread stonedust underground. *Following some discussion, C. White was assured that the stonedust scheme would be filed by the end of January, 1992.* [Exhibit 73.08.019.]

Date	Document/author	Quotation (unedited)[a]
		[In the handwritten version of those minutes, the corresponding excerpts read:] G. Phillips said that they had two machines to spread stonedust underground. However, C. White wanted to know what stonedust sampling was being done to ensure that 85% non combustible existed in those sections of road travelled by the 'tractors.' Following some discussion, C. White was assured that the stonedust sprays would be in operation by the end of January 1992. [Exhibit 139.01.89g]
22 Jan 1992	DOL Inspection Report (McLean)	Stonedust needs to be spread on a more regular basis. Mr. Parry agree to see to this. [Exhibit 73.06.(001)]
13 Feb 1992	DOL Inspection Report (McLean)	Items discuss with General Manager Gerald Phillips and supervisor Glyn Jones. Rock Dust – need in different areas of the mine. House cleaning needed. Both agree to have these items corrected. [Exhibit 73.06.(003)]
26 Feb 1992	Minutes of meeting at Westray	5. Rock Dusting. G.J. Phillips reported that rock dusting would be ongoing, with sampling procedures and stations in place in the immediate future. Samples would be taken in conjunction with weekly ventilation examinations and results posted. *A. McLean requested that these systems be in place by the end of March with written procedure and system submitted to the Department of Labour.* [Exhibit 73.08.023]
2 Mar 1992	DOL memo re meeting at Westray on 26 February 1992 (McLean to White)	5. Stonedust – Two new machines are working good and dust samples will be in place by March 15 [Exhibit 73.08.026]
17 Mar 1992	DOL Inspection Report (McLean)	Items of concern. House cleaning needs to be attended to. Stonedusting needs to be attended to. Mr. Parry agree to look after the items of concern. Also stated that a plan for stonedusting is being put in place. [73.06.(006)]
29 Apr 1992	DOL Inspection Report (McLean)	Verbal orders were given to Mr Parry and Mr Phillips about Stonedusting [and] House cleaning. Also an order was issue to Mr Parry. Order no. 02915–02916. [Exhibit 37a.228]

Date	Document/author	Quotation (unedited)[a]
29 Apr 1992	DOL Order Form	1. (Sec. 69-1 CMRA[c]) Floor, roof and sides of roadway shall be clear of accumulation of coal dust and systematically steps should be taken to apply some stonedust to prevent explosions of coal dust occurring, and to comply with the Regulations and other agreements. 2. (Sec. 69-5 CMRA) Not less than 20 bags of stonedust shall be stored in every working section for emergency within a reasonable distance of the working face. 3. (Sec 9-1A CMRA) The manager shall develop a systematic plan acceptable to the safety officer for applying stonedust to prevent coal dust explosion and to meet the requirements of the regulations and other agreements. 4. (Sect 9-1A CMRA) The manager shall develop a plan exceptable to the safety officer for the purpose of sampling coal dust to ensure the health and safety of persons at or near the workplace. *Orders 1 and 2 shall be carried out immediately.* Orders 3 and 4 shall be carried out on or before May 15, 1992. [Exhibit 37a. 229–230]

a All emphasis (italics) added
b Department of Labour
c *Coal Mines Regulation Act*

seems to have been overlooked by all parties at that time.[92] That meeting was followed one week later by the grand opening, for which occasion the mine was well stonedusted. An inspection report on 26 September indicated that stonedust on the roof, sides, and floor was very good. Nevertheless, this item was followed by one on 19 October that there had been a noticeable improvement in stonedusting, implying that there had been room for such improvement. The stonedusting plan promised for 30 September had not been received, but the company said it would be provided by the end of October. However, the new date for submitting the plan was further delayed to 15 November, by which time a new stonedusting machine was supposed to have arrived.

The inspection report of 4 December noted that stonedust was spread throughout the mine.[93] At a meeting on 17 December, director of mine

92 Claude White acknowledged the existence of that plan and in testimony said that, as far as he knew, the company had been following it (Hearing transcript, vol. 63, p. 13908). John Smith, the electrical-mechanical inspector, spoke to the Inquiry of "a blue book . . . 'Managers Safe Procedures' or something, and there was some things laid out in there" (vol. 58, p. 12670).

93 This item may appear to conflict with testimony detailed earlier about the lack of stonedusting in the mine; that testimony may have been more applicable to early 1992, when dust conditions deteriorated markedly. Don Dooley, referring to development in the Southwest,

safety Claude White was yet again assured that a stonedust plan would be filed – this time by the end of January 1992. Inspection reports for 22 January and 13 February both indicate dissatisfaction with the standards and extent of stonedusting. "House cleaning" was also required. This term is often, but not necessarily, associated with accumulations of dust.

At a meeting on 26 February 1992, mine manager Phillips promised that stonedusting would be ongoing and that sampling procedures and stations would be in place very shortly. Inspector McLean requested that documentation be provided to the Department of Labour on these matters, this time by the end of March 1992. The next inspection was on 17 March. Once again, concerns were expressed about house cleaning and stonedusting. Underground manager Parry agreed to look after those matters and stated that a plan for stonedusting was being put into place.

Despite these assurances, the conditions in the mine with respect to dust had become even worse by 29 April 1992.[94] The inspectors finally lost patience, and McLean issued orders orally, followed on the next day (but dated April 29) by the four written orders shown as the last main entry on table 9.2.[95] Those orders were posted on the mine bulletin board.

In the eight months from September 1991 through April 1992, the inspectorate made repeated requests for the mine to implement procedures for stonedusting and dust sampling (see the following section of this chapter), and to improve housekeeping. The responses from Westray management were promises with no action. Trevor Eagles told the Inquiry that "[t]hey had given us several orders to clean it up and apply stonedust, but there was never a follow-up by the Department insisting that we did it."[96] Even following the issuance of the 29 April orders, little action was taken. Fraser Agnew testified that as a supervisor he was not given any instructions either in response to the order or to do anything differently in relation to stonedusting, between 29 April and 9 May.[97] Mine management did install a water-line down the centre of No. 1 Main along the roof from No. 7 Cross-cut to No. 10 Cross-cut, with garden-type sprays at intervals. The purpose of the water line and sprays was to dampen the dust on a length of slope that was particularly dusty from vehicular traffic.[98] This

said that stonedusting "was much better than it was at later times, but . . . it was still not adequate" (Hearing transcript, vol. 38, p. 8307). He went on to say that by February–March 1992, the level of stonedusting "just totally deteriorated" (p. 8308).

94 Claude White had gone underground on this inspection tour. He told the Inquiry that "prior to April 29th, I really never had a sense that there was a particular – a severe problem of coal dust. I would always expect some kind of a problem with coal dust in the mine, but not to the extent that we saw on April 29" (Hearing transcript, vol. 63, p. 13887).

95 "I gave them the written order the 30th" (Hearing transcript, vol. 57, p. 12441).

96 Hearing transcript, vol. 76, p. 16443.

97 Hearing transcript, vol. 37, p. 8010. Don Dooley said, "It's my firm belief that they [management] had no intention of complying with them [the orders]" (vol. 36, p. 7813).

98 Jay Dooley (Hearing transcript, vol. 38, pp. 8467–68) first heard about this sprinkler system from Parry on 1 May, and Wayne Cheverie described the installed system to the Inquiry (vol. 20, pp. 3958–59).

work took place 1–8 May 1992. By no measure could it be construed as compliance with the orders issued by the inspectorate on 29 April 1992.[99]

On 6 May, McLean was at the Westray mine site to invigilate an examination taken by assistant underground superintendent Glyn Jones. McLean spent the afternoon at the mine for that purpose. *He stayed overnight in the area and left the following morning without revisiting Westray* – despite the fact that the first two orders issued on 29 April carried the directive that they "shall be carried out immediately."[100] McLean should have made a special follow-up trip to Westray. To have come to the mine on other, less urgent business, and departed without checking on compliance with the orders, can only be regarded as abdication of responsibility on the part of McLean.

Testifying at the Inquiry, the inspectors defended their actions in two ways. First, they suggested that, prior to 29 April, coal dust was not a problem in the mine; that the settled coal dust was not as deep as others had claimed and was being removed from the mine; and that stonedusting was being carried out.[101] These weak defences of their conduct really strain one's credulity, especially when contrasted with their own comments in inspection reports and minutes of meetings, and with the mass of evidence presented by mine workers. Only electrical-mechanical inspector John Smith seemed prepared to accept some of the incontrovertible evidence when he admitted that there were accumulations of coal dust and that the Department of Labour had been lax.[102]

Second, the inspectors claimed that their references to and requests for a stonedusting plan were not, in fact, in relation to stonedusting, but to sampling of the settled dust.[103] While some looseness in terminology may have occurred, separate references to stonedusting (or "rock dusting") and sampling appear in the documentation (see table 9.2). The orders issued on 29 April also separately required – and clearly distinguished between – a plan for sampling coal dust and a plan for applying stonedust.

A somewhat disturbing exchange between Inquiry counsel John Merrick and director of mine safety Claude White seemed representative

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99 Other than some stonedust being sent underground, Don Dooley saw no evidence of compliance with the orders during the week prior to the explosion (Hearing transcript, vol. 36, p. 7813).

100 McLean (Hearing transcript, vol. 57, pp. 12445–46).

101 Claude White, in testimony, said that "other than the coal dust that was there on that particular day [29 April] . . . there was nothing to suggest that the coal dust was a problem" (Hearing transcript, vol. 63, p. 13900). According to Albert McLean, "some of them testified to a great amount, and I can't agree with that" (vol. 57, p. 12391). Even though he admitted that he had never heard of or observed coal dust being removed from the mine, McLean was adamant: "They were removing coal dust from the mine" (p. 12556). He was equally sure about stonedusting, despite not knowing how it was being done: "I knew they were dusting" (p. 12452).

102 Smith knew that the mining method produced a lot of dust, but he wasn't aware of what was being done about it or how it was being treated (Hearing transcript, vol. 58, pp. 12754–55). He could not think of any explanations for the inspectorate's not following up on its own requests and orders (p. 12761).

103 White (Hearing transcript, vol. 63, pp. 13903, 13921–26, 13960–61); McLean also kept trying, somewhat confusedly, to change the subject to sampling while being questioned about stonedusting (vol. 56, pp. 12184–89).

of other evidence by employees of both the Department of Labour and the Department of Natural Resources. It started with Merrick's comment: "It strikes me as difficult to believe that you could have only been talking about a sampling program on that date if you used the words 'stonedusting' and 'dust sampling.'" What then follows over the next 10 or so pages of transcripts is an ill-conceived, shallow, and stilted attempt by White to rationalize and explain away ineptitude, apathy, and incompetence in the most extraordinarily facile manner.[104] His credibility was irreparably damaged as a result.

Leroy Legere, minister of labour, did believe that the inspectorate had asked for a plan on how stonedust was to be applied. "I know," Legere testified, "that they were looking for . . . a stonedusting plan."[105]

Dust Sampling at Westray

The Westray Manager's Safe Working Procedures prescribed sampling methods for determining the combustibility of coal dust. Based on the relevant sections of the *Coal Mines Regulation Act*, these procedures included:

> 6. Dust shall be sampled at one or more representative places in each mining area
>   (a) these areas being:
>   (1) from 10 to 60 m from the working face
>   (2) will be stated later, when mine plan is completed
>   (b) during each calendar month, and
>   (c) wherever by visual inspection, the dust in a part of a road appears to contain sufficient coal dust to make the incombustible content less than 65 percent.
>
> 7. (1) Separate samples shall be taken from the floor and from the roof and ribs of the road.
>   (2) The sample from the floor shall be taken . . . in a groove 15 cm wide, from rib to rib in the loose, fine material.
>   (3) The sample from the roof and ribs shall be taken using a brush over a 15 cm wide strip.
>   (4) Sample test procedure is as follows:
>   (a) the sample shall be air dried and screened at 30 mesh and all undersize material shall be weighed to determine the approximate amount of dust per lineal 15 cm.
>   (b) the sample shall be mixed and split to produce a one gram sample for testing.
>   (c) the one gram sample will be placed in an oven for two hours at 500°C. At the end of two hours, it is weighed and the percentage of incombustible material is then calculated.
>
> 8. (1) A report of each test shall:
>   (a) be recorded in a book which shall be kept at the mine for that purpose, and

[104] Hearing transcript, vol. 63, pp. 13919–28.

[105] Hearing transcript, vol. 71, p. 15606.

(b) show the mine area and location in the mine area at which each sample was taken
(c) methane measurement shall be recorded.
(2) Copies of the report shall be:
(a) posted at the mine, and
(b) forwarded to the Local Inspector on or before the 12th day of the next calendar month.[106]

Despite these company procedures and the requirements of section 70(7) of the act, there is little evidence that any dust sampling was done before the end of April 1992. No organized procedure or regular schedule for sampling was in place. As Don Dooley told the Inquiry, "[T]here was absolutely no scheduled sampling plan."[107] Dooley, as a supervisor, expressed concern about this lack of a sampling plan. The fact that stonedusting was not being done adequately "was a concern, but at the same time you need those facts to back you up."[108] Indeed, knowing the combustible content of settled dust would have confirmed the concerns of the workforce about accumulations of potentially explosive dust.

From the records, it appears that the first dust samples were collected by Trevor Eagles on 29 April 1992.[109] Following the procedure laid down in the regulations, he took samples from the ribs and floor at two locations. The samples were delivered to an independent laboratory on 4 May 1992, where they were analysed the following day. The analysis was not conducted strictly according to regulations, since the samples were dried before the initial weighing. (The moisture content could not, therefore, be determined.) For calculating the combustible content of the dust samples (see table 9.3), the moisture content was set at 3 per cent.[110]

The combustible content of the samples far exceeded the limits set in the *Coal Mines Regulation Act,* the results simply confirming what many Westray personnel had determined by observation. Eagles commented on the significance of the sampling results, observing that "basically the numbers confirmed what a lot of people suspected . . . Anybody that was down there should have and did realize that we had a dust problem. This put a number to what most people already knew."[111]

He took four more samples on 8 May 1992, the day before the explosion. These samples, being the last evidence of the condition of the coal dust in the mine prior to the explosion, were divided into five parcels and sent to five different laboratories for analysis. Because the laboratories used two different methods of analysis and a variety of reporting styles, the analysis and results were given to Inquiry ventilation

106 Exhibit 37a.124–25.

107 Hearing transcript, vol. 38, p. 8306.

108 Hearing transcript, vol. 38, pp. 8348–49.

109 There is nothing to indicate whether this sampling was prompted by the visit of the inspectorate that generated the four orders previously referred to (on the same date), or if it was purely coincidental.

110 Based on samples taken 8 May 1992.

111 Hearing transcript, vol. 76, p. 16451.

Table 9.3 Combustible Content of Dust Samples Taken 29 April 1992 (%)

Location	Ash	Combustible matter
No. 2 Main outbye No. 9 Cross-cut: floor	23.76	73
No. 2 Main outbye No. 9 Cross-cut: rib	39.74	57
SW2-A Road inbye SW2-1 Cross-cut: floor	41.33	56
SW2-A Road inbye SW2-1 Cross-cut: rib	33.33	64

Source: Exhibit 37a.193. Dust samples analysed by SGS (laboratory) on 5 May 1992.

Notes: Samples taken according to *Coal Mines Regulation Act* over 50 m distances; combustible matter calculated to nearest 1 per cent, assuming 3 per cent moisture. High-temperature method of heating samples may understate ash content, depending on the amount of carbonate material (from stonedust). Hence, combustible content may be exaggerated. The increased values given by the high-temperature method of analysis, for corresponding samples, is due to the disassociation of carbonate material and to the resulting loss of carbon dioxide at the elevated oven temperature.

expert Dr Malcolm McPherson to develop a simplified version of the results, as shown in table 9.4.

To simplify the results and to avoid the complication of high-temperature loss of carbon dioxide, table 9.4 compares the low-temperature analyses of combustible values produced by the four laboratories where such tests were conducted. (The fifth did not conduct a low-temperature analysis.) The consistency of the results reported by the different laboratories supports their reliability. The most significant point among the results is that, with one exception, each analysis reported from the 29 April and 8 May 1992 samples shows combustible contents in excess of the mandated 35 per cent (or less, depending on methane concentration in the air), those in the North Main approaching twice the legal limit.

The ash content of Westray coal mined in 1992 was in the range of 30 to 50 per cent, with average values of 35 to 40 per cent.[112] It is evident that, in those areas where samples indicated more than 60 per cent combustibles, very little stonedusting had been done. Analysis of the dust samples provided quantified confirmation of the lack of stonedusting in the Westray mine.

Summary of Dust Problems at Westray

The problems arising from dust in the Westray Mine can be categorized into five related topics: airborne coal dust, accumulations of coal dust, inadequate stonedusting, management resistance to dust control and stonedusting, and the uncertain role of inspectors.

Airborne Coal Dust

The system of two 12-hour shifts per day, with active mining on both shifts, resulted in continuing production of airborne dust. This was exacerbated by failure to use consistently the dust scrubbers on continuous miners. Airborne dust produced throughout the

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[112] Westray Coal production summaries (Exhibit 15.0016–27).

Table 9.4 Combustible Content of Dust Samples Taken 8 May 1992 (%)

Laboratory[a]	No. 1 Main outbye No. 10 Cross-cut (floor)	No. 1 Main outbye No. 10 Cross-cut (rib)	3 North Main outbye 2 East (floor)	3 North Main outbye 2 East (rib)
CBDC[b]	41.23	32.54	66.57	62.25
CANMET[c]	41.70	36.68	61.96	60.06
Labour Canada[d]	42.31	36.62	67.13	63.62
TSRE[e]	42.75	35.5	67.70	65.20
TSRE[f]		35.1		
Average	**42.00**	**35.29**	**65.84**	**62.78**

Source: Malcolm J. McPherson from analyses submitted by individual laboratories (see footnotes for exhibit references).

a The results in this table are from low-temperature analysis only. The fifth laboratory, Central Research Establishment (CRE), did not perform a low-temperature analysis and is not represented in the table. TSRE performed two analyses on one sample.
b Cape Breton Development Corporation (Devco), Sydney, NS (Exhibit 37a.198)
c Canada Centre for Mineral and Energy Technology, Fuels Characterization Research Laboratory, Ottawa (Exhibit 37a.210–13)
d Government of Canada (Exhibit 37a.218)
e Technical Services and Research Establishment, British Coal Corporation, England (Exhibit 37a.202)
f Exhibit 37a.205.

coal transportation system – from the shuttle cars, the Stamler feeder-breakers, and the belt conveyors – added to the accumulation. Lacking threshold limit values for airborne dust, the Nova Scotia coal mining regulations provided no incentive to mitigate the high levels at Westray. Not only did this airborne coal dust constitute a health hazard, but it also resulted in large quantities settling out of suspension and producing excessive accumulations. Even when stonedusting was carried out, the benefit was negated by the layers of coal dust that so rapidly covered the stonedust.

A second prolific source of coal dust at Westray was the scrubbing and grinding action of both tracked and wheeled vehicles over inclined coal floors.[113] Thick layers of floor dust accumulated along sections of the intake roads used for the transport of personnel and materials. Dust raised into the air by vehicular movement was carried into the working sections by the ventilating airflow, resulting in the dispersal of dust throughout the mine.

Accumulations of Coal Dust

Coal dust at least ankle deep accumulated on many of the underground roadways in the Westray mine, making foot travel laborious at times. When floor dust gave rise to difficult travelling conditions for vehicles and mechanized equipment, attempts were made to alleviate the situation by

113 At both the Phalen mine in New Waterford, Nova Scotia, and the Jim Walter Resources mine in Brookwood, Alabama, personnel, equipment, and supplies are transported to the working areas by rail. Some vehicles are also outfitted with stonedust reservoirs and sprayers so that the floors, ribs, and roofs may be readily stonedusted as required. On my visits to these mines, it appeared that vehicles with tracks or wheels were restricted to the working face areas, which would be cleared and stonedusted as the face progressed and as more rail was laid.

pushing the dust to the sides or into unused entries. Little effort, however, was given to removing dust from the mine. Coal dust also accumulated under conveyors. Again, dust was removed only to the extent necessary to prevent the bottom belt from running through it and becoming a frictional fire hazard.

Inadequate Stonedusting

The manner, extent, and regularity of applying stonedust were all deficient. Westray had only two mechanized stonedusting devices underground, one of them of questionable effectiveness. Although the mine manager had drawn up procedures for both dust sampling and stonedusting, they were not put into practice. The application of stonedust was left to voluntary overtime by miners who had already worked a 12-hour shift in conditions that became increasingly arduous through the early months of 1992. Management made no attempts to organize stonedusting activities into a procedure that would effectively combat even normal fallout of coal dust. Stonedusting was sporadic – and was completely inadequate. The high levels of airborne coal dust that led to large and uncleared accumulations of settled coal dust, combined with insufficient stonedusting, created an environment favourable to the propagation of a coal-dust explosion.

Management Resistance to Dust Control

Management's seemingly irrational unwillingness to remove accumulations of coal dust, and to follow accepted and legislated procedures for sampling and stonedusting, is inexplicable. Despite the concerns expressed and the pressures exerted by both the workforce and the inspectorate, management was obstinately unwilling to take effective measures. The quality of dust control, ventilation, and gas removal all deteriorated in the final two months of the life of the mine. The drive to maintain production and the struggle with ground control took precedence over all other matters. And yet, the urgency of those matters would not have been compromised by management's enforcing the use of the dust scrubbers that were fitted to the continuous miners, or providing trickle dusters in return entries and conveyor roads. The belt crews would have found maintenance of the conveyors facilitated by regular manual removal of dust from beneath the bottom belt. Productivity would have been enhanced, not reduced, by satisfactory travelling conditions for personnel and machines – and by a working environment conducive to good labour relations and a contented workforce.

The problems arising from coal dust were cumulative. Had the early system of voluntary after-shift stonedusting been replaced by a properly managed and enforced procedure to clear accumulations of coal dust and to apply stonedust systematically, the mine would have become a safer, healthier, and less arduous place in which to work. As it was, the coal dust accumulated to such levels that it would have required a concerted effort,

possibly with some days of lost production, to clean it to a safe condition. Management, in the absence of a stop-work order from the inspectorate, was clearly unwilling to take such action.

Uncertain Role of Inspectors

Why did the inspectors tolerate, for so long, the lack of response from the mine management with respect to their concerns about coal dust? The orders that McLean eventually issued on 29 April 1992 addressed the same matters raised repeatedly during the preceding eight months. Why did the inspectors not take much stronger action, and take it much sooner? The defence offered by inspectors during their testimony – that the conditions did not warrant more than continued admonitions – does not correlate with either their own documentation or the volume and consistency of mine workers' evidence. Although the prime responsibility for the dust conditions at Westray must lie with the mine management, the inspectorate, by not applying effective sanctions much earlier than 29 April 1992, failed in its duty to safeguard the workforce.

Finding

Mine management, led by Gerald Phillips and Roger Parry, had the primary responsibility to keep the mine safe. With regard to coal dust, safety measures included:

- **removing coal dust from the mine;**
- **ensuring that the mine floor, ribs, and roof were adequately stonedusted so as to render inert any remaining coal dust; and**
- **regularly collecting and testing coal-dust samples to monitor combustibility.**

Management was aware of these duties, as evidenced by the schemes set out in the Manager's Safe Working Procedures, yet it failed to discharge these responsibilities by ignoring its own procedures as well as the requirements of the *Coal Mines Regulation Act*. Westray management seemed to have adopted a cavalier attitude towards mine safety generally and the treatment of coal-dust hazards in particular.

Finding

The Department of Labour inspectorate knew, or ought to have known, that management was continually out of compliance with even the most basic safety requirements of the act in respect to treatment of coal dust in the Westray mine.

In spite of the continued failure of mine management to comply with requests and demands respecting treatment of coal dust, the inspectorate made no effort to enforce those demands. This failure to enforce the law

was painfully and tragically evident when the orders of 29 April 1992 were ignored, even though two of them required immediate action, and even though an inspector was at the mine site on 6 May 1992. The inspectorate was derelict in its responsibility to safeguard the welfare of the underground miners at Westray by failing to ensure compliance with the housekeeping and treatment requirements of the *Coal Mines Regulation Act* respecting coal dust.

Conclusions

Coal dust is a major health and safety hazard in underground coal mines. When the hazard of methane is combined with excessive and untreated coal dust, the potential for disaster, as tragically demonstrated at Westray, is very real.

In Nova Scotia, section 70(1) of the *Coal Mines Regulation Act* requires that the floor, roof, and sides of the road and working places in a mine "shall be systematically cleared so as to prevent, as far as practicable, the accumulation of coal dust. . . ." Section 345 of the Alberta *Coal Mines Safety Regulations* requires that "[b]efore a part of a road is dusted for the first time with rock dust, it shall be cleaned as thoroughly as possible of all combustible dust."[114] The U.S. regulations go into more detail respecting this "housekeeping" function, stating that "[a] program for regular cleanup and removal of accumulations of coal and float coal dusts, loose coal, and other combustibles shall be established and maintained. Such program shall be available to the Secretary or authorized representative."[115]

The first line of defence in the battle to neutralize the coal dust seems to be good, old fashioned housekeeping.

RECOMMENDATION

35 **Every coal mine operator should prepare a program for the regular clean-up and removal of coal dust and other combustibles from the floor, roof, and ribs of roadways and work areas in the mine. A copy of the program should be filed with the regulator, who may require changes in the clean-up program if it does not comply with accepted industry standards.**

It is prudent that all areas close to the working face and areas in which coal is transferred from one device to another be wetted so as to maintain the coal dust in an incombustible state. Such areas are the cutting surface of the face, the location of the transfer of the coal to the conveyor, and transfer points from one conveyor to another. It is not practical to stonedust these areas.

[114] Alberta, *Coal Mines Safety Regulations*, (Edmonton: Queen's Printer for Alberta, 1977), Alberta Regulation 333/75.

[115] 30 CFR 75.400-2

RECOMMENDATION

36 **Sufficient water should be provided in the mine to ensure that an adequate supply is available to wet the coal being mined and transported within the mine.**

(a) All coal-cutting picks should be equipped with water-spray jets of sufficient number and size to ensure that the areas of the coal face being worked are maintained in a damp condition so as to render any coal dust incombustible.

(b) All transfer points where coal is moved from one mode of transport to another should be equipped with water-spray devices sufficient to render any coal dust incombustible.

My research on barriers, whether stonedust or water, passive or triggered, has led me to conclude that their use is somewhat problematic, especially in room-and-pillar mining. Barriers may, in some circumstances, serve as supplemental explosion suppressors but ought not to be seen as diminishing the need for adequate stonedusting.

RECOMMENDATION

37 **The Department of Labour and the Department of Natural Resources should consider active research in the development and use of passive and triggered stonedust and water barriers for the drives and entries of underground coal mines. This research should be aimed at the development of such techniques for use in room-and-pillar mining operations.**

If the development of barrier technology indicates that substantial safety benefits may accrue, the regulator could order a mine operator to install water or stonedust barriers in the mine.

After basic "housekeeping," the most widely accepted method of controlling coal dust is to render it inert by mixing it with finely ground incombustible rock, such as limestone or dolomite. It would seem from our review that stonedusting requirements in the *Coal Mines Regulation Act* are not far off the mark from any industry standard. Nevertheless, a discrepancy between the legislative requirements and the actual practice occurred and has persisted.

RECOMMENDATIONS

38 **All underground areas of a coal mine should be stonedusted to within 12 m of the working face and all cross-cuts less than 12 m distant from the face should be stonedusted. This would not apply to those areas within the mine containing sufficient moisture to render the coal dust incombustible or for which the regulator, after examination, has granted exemption.**

39 A mine operator should file with the regulator a copy of the stonedusting program for the mine, including the method and frequency of testing; the type of testing equipment used; the type and number of dust-spreading machines used; the frequency of dusting; and the location and quantity of stonedust stored in the mine for emergencies (as opposed to normal usage).

40 The material used for stonedusting should be of a type approved by the regulator for that purpose and should meet accepted industry standards as to size, composition, and incombustibility.

41 Dust samples should be taken at least once a week using a method approved by the regulator for that purpose. Samples should be taken according to a regularly updated and approved plan. The regulator may require additional testing and may grant exemptions, providing that the overall safety of underground workers is not compromised.

10

Ground Control

To inquire into . . .

(d) whether there was any defect in or about the Mine or the modes of working the Mine;

(e) whether the Mine and its operations were in keeping with the known geological structures or formations in the area;

(f) whether there was compliance with applicable statutes, regulations, orders, rules, or directions

Coal mining has been described as the equivalent of "trying to get the filling out of a layer cake – without disturbing the layers."[1] From my reading and research on the subject, that is an apt description.[2] Maintaining the "layers" while extracting the coal "filling" encompasses the science of ground control – also referred to variously as strata control or roof control.[3] A somewhat technical definition of ground control is:

> the science that studies the behaviour of rock mass in transition from one state of equilibrium to another. It provides a basis for the design of support systems to prevent or control the collapse or failure of the roof, floor, and ribs [walls] both safely and economically.[4]

Less technically, strata control may be defined as:

> that which encompasses control and prediction of strata behaviour during development and extraction operations. This definition includes a wide range of tasks such as roadway design, pillar design, subsidence prediction, definition of caving characteristics and longwall face control.[5]

Well-planned and well-executed ground control techniques can, therefore, result in threefold benefits. Such techniques can increase efficiency by maintaining production levels and keeping the roadways clear of rock-fall debris; they can substantially lessen the chance of injuries and fatalities; and, finally, they can minimize the possibility of methane entrapment and the resulting explosion hazard.

Geological Conditions

The Pictou Coal Basin

The geological formations inherent in the Pictou coal basin have been known for many years. The Pictou basin, an extension of the Appalachian field,[6] seems to have been subjected to tectonic pressures and movement, which caused faulting and substantial tilting of strata. These characteristics, especially as they apply to the Foord and associated seams, make ground stabilization while mining a major challenge. Some 60 years

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1 Conversation with Craig Hilton, manager, technical support, Skyline Mines, Helper, Utah.

2 Throughout this chapter, I have relied greatly on the judgment of Dr Miklos Salamon, the Inquiry's expert on ground control, and Roy MacLean, the Inquiry's coal mining adviser. Many of the specifics included in the text are from discussions with them.

3 We will also be using another common expression, "rock mechanics," which is the measurement, study, and understanding of stresses in rock and their effects. Rock mechanics is the tool with which mining engineers plan and effect ground control in underground mines.

4 Syd S. Peng, *Coal Mine Ground Control* (Toronto: John Wiley & Sons, 1978), 1.

5 R.G. Siddall and W. J. Gale, "Strata Control – A New Science for an Old Problem," *The Mining Engineer* 151 (June 1992): 341.

6 Communication with Charles Byrer, U.S. Department of Energy, Unconventional Gas Projects.

ago, one mining authority made the following observation about the Pictou coalfield:

> The most striking features of the coal seams and enclosing strata are the irregular folds and numerous faults in different directions which together with the rapid variation in thickness makes the most difficult mining conditions your investigator has observed in any of the coal fields of North America or in Europe.[7]

It may be that, in the ensuing years, advances in mining technology – including better geological assessments and ground control methods – have rendered these features less formidable. Certainly, ground control techniques have advanced substantially. Nevertheless, hardly a day went by in Westray's brief history when ground problems did not beset the operation. Although continual roof and pillar failures contributed to the ultimate failure of the mine, human failures allowed the ground problems to get out of control.

Experienced underground miners believe that the ground talks to them. They know, by a myriad of signals, whether a roof or a rib is solid or on the verge of failure. They know from long experience what is inherently safe, and what needs support to make it safe. Similarly, an experienced mining engineering team will learn to plan a mine according to the ore body's individual characteristics. A prudent mining engineer uses every available source of information, including history, geological and geotechnical data derived from drilling and from other means of testing, the experience of others, and experience acquired from ongoing mining operations.

Geology – the makeup of the various components of the earth and the interrelationships among them – determines in large part how the ground will behave when disturbed by mining activities. This chapter will examine some of the knowledge that was available to the planners and operators of the Westray mine. It will then show how this knowledge of potential and actual ground conditions was misused, misunderstood, or ignored, and will examine the human failures that may have contributed to the massive ground control problems encountered underground at Westray.

Feasibility Studies

The Foord seam that Westray chose to mine came with a wealth of mining history. Over the course of 120 years, some 60 million tonnes of coal have been mined from 18 seams in Pictou County, 5.3 million of them from the Allan mine, Westray's next-door neighbour on the Foord seam.

Before Westray commissioned Kilborn Limited to plan the mine, a large body of knowledge about the Pictou coalfield had accumulated, with no small amount of wisdom acquired about the real difficulties facing any

7 George S. Rice, "Report on Pictou Coal Field," prepared for the Royal Commission on Acadia Coal Company Limited (1937). Dr Rice was the retired chief mining engineer for the U.S. Bureau of Mines.

mining operator there. A number of feasibility studies had already been carried out. Throughout the 1980s, Suncor Inc., Associated Mining Consultants Ltd, Golder Associates, Dames & Moore, Norwest Resource Consultants Ltd, and Placer Development Ltd contributed to the body of knowledge about the potential coal orebody and its associated ground.[8] As many as 73 exploration holes have been drilled from surface within the Westray mine boundaries, 50 of them since 1981. Geophysical data have supplemented drill core analysis of the more than 40 holes that intersected the Foord seam.

Over the course of the various feasibility studies, analysis of the data suffered from breaks in continuity whenever consulting firms changed. A disclaimer in volume I of the Kilborn report identifies this problem:

> Constrained by shortage of time, neither Kilborn nor Dames & Moore has examined exploratory drill cores, interpreted geological data or separately calculated reserves, but has used information prepared by Suncor Inc., Placer Development Limited and Associated Mining Consultants Limited. Kilborn and Dames & Moore have reviewed the geological and reserve data and are satisfied that the geological analysis and reserve estimation have been completed in accordance with procedures which are well-proven and accepted in the industry.[9]

A further disclaimer appears in section 3.1 of the same report:

> Mine design, planning and scheduling have been completed under time constraints and are largely based upon the work of Suncor Inc., Norwest Resource Consultants Limited, Golder Associates, Associated Mining Consultants Limited and Placer Development Limited. Whilst the current mining proposals represent a reasonable and realistic approach, future work will consider alternative technical practices and approaches in order to further improve mining efficiency and operation.

Thus, it seems that the Kilborn study did not re-examine the physical conditions in the mining area, nor did it attempt to re-examine the feasibility and suitability of the mining plan. As we shall see, the time constraints that prevented such re-examination ultimately led to serious consequences when the mine plan did prove to be neither "reasonable" nor "realistic." The lesson to be learned here is that a lack of continuity between feasibility studies and in mine planning can lead to the perpetuation of faulty reasoning or to the misinterpretation of earlier conclusions.

Geology at the Mine Property

The mining area in the Foord seam is bounded by the outcrop to the south, old workings of the Allan mine to the west, and faulting to the north. It is open-ended to the east, where the depth increases to about 850 m. The

8 See Chapter 2, Development of Westray, and Chapter 11, Department of Natural Resources, for more complete discussions of the various feasibility studies. The studies are listed in Appendix L, Chronology of Westray.

9 Kilborn Limited, "Technical and Cost Review of the Pictou County Coal Project" (1989) (Exhibit 4, s. 2.6).

seam dips from the outcrop in an east-northeast direction at approximately 20 degrees. In the centre of the reserve area, the inclination seems to range from 8 to 12 degrees. On the eastern side of the property, the seam dip increases to over 20 degrees. The seam thickness increases downdip from the outcrop and, in the mining area, appears to range between 2.5 and 8.5 m.

The Kilborn report located and plotted faults in the Allan mine.[10] Apparently, several normal faults striking in a north-south direction were encountered, with vertical displacements ranging up to 25 m. By studying the drill hole logs, Kilborn attempted to anticipate faults in the Westray area. In some holes, the full sequence of strata was not intercepted, suggesting the presence of faults. The full interpretation of the data suggested that faulting to the north and south, with displacements in excess of 100 m, would limit mining. Within the mining area, normal faulting was anticipated; in particular, a north-south–trending fault located on the east side was expected to have a displacement of 50 to 70 m. The Kilborn report did not, however, alert Westray about the limited number of boreholes on which it based its predictions. A comparison of the faulting experienced in the Allan mine with the forecast for the Westray mine would have warned of a possibly overoptimistic prediction. There is no evidence that such a comparison was made.

Kilborn's examination of the cores indicated that the immediate roof of the Foord seam consists of "thin shaley coal, often containing a thin coal band, overlain by carbonaceous shale which grades into an oil shale or shale/mudstone containing silty bands and sandstone which attains a thickness of 15 m in one core hole."[11] This description appears to forewarn of the terrible roof conditions the mine had to endure during its relatively brief operation. The drill-hole data suggest that the immediate floor of the seam is a carbonaceous shale overlying shale/mudstone with interspersed thin sandstone layers. (Because the floor of the seam did not play a significant role in the disaster, its quality will not be the subject of any further discussion.)

Based on laboratory findings, Kilborn predicted "moderately strong" roof and floor strata. With hindsight, this picture is misleading. The author of the Kilborn report's geological section sensed that problems could lie ahead. The report states: "Roof and floor conditions are anticipated to be variable . . . Partial or complete removal of weaker carbonaceous shale, and/or oil shale bands, may be necessary to expose competent roof strata."[12] Such a measure would either seriously degrade coal quality by dilution or, if the waste rock were handled separately, undermine productivity. Neither prospect would appear to be attractive for a mining company.

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10 Exhibit 4, figure 2.4.

11 Exhibit 4, s. 2.4.3.

12 Exhibit 4, s. 2.4.3.

Tests on coal samples yielded uniaxial compressive strengths in the range of 6 to 18 MPa, suggesting a moderately competent seam.[13] In assessing these strength values, the consultants apparently overlooked the fact that laboratory tests carried out on small samples tend to overestimate the strength of coal.

According to the Kilborn report, information from the Allan mine indicated, and the surface boreholes confirmed, that the Foord seam contains ironstone bands in some areas.[14] These bands, with an average thickness of 70 to 120 mm, generally occur in the upper part of the seam and are known to contain pyrites. Such hard material as ironstone may be significant as a potential source of sparks when hit by the hard metal of the continuous miner picks. Clearly its presence was known to mine planners, who nevertheless seem to have insisted that the roof of entries should coincide with the top of the seam. As a result, continuous miners had to cut through the ironstone bands.[15]

Mining Conditions

Kilborn defined the expected mining conditions in section 3.2 of its report. It is important to look at some of them to illustrate the physical conditions in which Westray was expected to operate. These mining conditions appear in table 10.1.

Following the ideas put forward in the Placer study, Kilborn chose the room-and-pillar method, with 6 m-wide entries, as the basis for underground operations. This choice fulfilled a number of Kilborn's 12 listed requirements for mining, many of which are reasonable.[16] Given the physical conditions of the ore body, however, two of the items pose a formidable problem for mine planners:

- coal extraction height of up to 7 m and mining to a depth of 700 m
- minimum roof support requirements.

The room-and-pillar method is ideal for relatively shallow depths, the environment in which it was originally developed (see the section on mining methods later in this chapter). At a depth of 100 m, the pressure arising from the weight of the overburden, or the "coverload," is about 2.5 MPa. This pressure increases to 17.5 MPa at a depth of 700 m. The pillars in room-and-pillar workings are *always* burdened by a load that is higher than the pressure from the coverload. At 700 m, the value of the coverload approaches the upper limit of the coal strength presented in

13 Uniaxial compressive strength is a measurement of how much pressure in one direction it takes to break up the material in question. The megapascal (MPa) is a unit of measurement equal to 145 pounds per square inch (psi). To put the strength of coal in perspective, even shales and sandstones can have compressive strengths greater than 100 MPa. Rock such as granite and limestone can have strengths exceeding 200 MPa.

14 Exhibit 4, s. 2.4.5.

15 My conclusion, as set out in Chapter 6, The Explosion, is that the Westray explosion was initiated by sparking from sandstone or pyrites at the continuous miner in the SW2-1 heading.

16 Exhibit 4, s. 3.4.

Table 10.1 Mining Conditions – Kilborn Report

Seam thickness	2.5 to 8.5 m
Seam inclination	0° to 28° but generally less than 14°
Depth of cover	200 to more than 700 m
Areal extent	Approximately 362 ha
Seam composition	Thinly banded bright and dull coal with occasional ironstone band averaging 70 to 120 mm
Coal strength	6 to 18 MPa in uniaxial compression
ASTM coal rank code	High-volatile A bituminous
Methane emission rate	Less than 6.2 m^3/t
Spontaneous combustion risk	Not clearly defined
Seam roof and floor strata	Moderately strong shales, >20 MPa in uniaxial compression, RQD > 75%

Source: Exhibit 4, s. 3.2.

table 10.1. Because the tabulated values overestimate the true strength, ordinary room-and-pillar mining can be expected to result in difficulties in most of the depth range of the Westray mine. Also, it is a well-known phenomenon that the strength of pillars of fixed horizontal area decreases with increasing height. Hence, the great depth of cover, in combination with a thick seam, should have warned of possible ground control problems.

Most coal mining is carried out today in seams that are nearly horizontal. The Foord seam is fairly steep. The planners should have foreseen that this inclination would hamper mining in a number of ways. Kilborn should have anticipated that underground productivity would suffer and that the strength of coal pillars would be reduced.

Perhaps the most surprising statement in section 3.2 of the Kilborn report is the reference to the quality of the roof. The remark "moderately strong shales," together with a RQD (rock quality designation) value of 75 per cent (of a maximum 100 per cent), suggests a reasonably competent roof. This portrayal does not appear to be corroborated by the geological description (section 2.4) of a roof "composed of thin shaley coal, often containing a thin coal band, overlain by carbonaceous shale which grades into an oil shale/mudstone containing silty bands and sandstone . . ." The subsequent underground problems with roof control proved beyond any doubt the validity of the geological assessment.

Finding

The following combination of mining conditions made Westray a potentially difficult mine to develop and operate:

- **depth of coal in the mining area**

- **thickness of the seam**
- **relatively steep pitch of the seam**
- **virtually unknown faulting in the mining area**
- **poor roof quality**
- **wide entries.**

The cost of operating in such an adverse environment and the inherent uncertainties would suggest that the financial viability of the Westray project should have been in doubt from the very beginning.

Mining Methods

I think many readers may find it helpful, for their understanding of this Report and its recommendations, to have a brief description of the various underground coal mining methods in use. The mining method directly affects ventilation requirements, dust control, the control and dispersal of methane and other hazardous gases, and the particular ground control system to be used. The selection of a particular method will depend on many factors, including capital cost of equipment; geological structure, width, and thickness of the coal seam; estimated coal reserves; and the estimated productive life of the mine. The three principal methods of mining, in descending order of the frequency of use within the industry, are longwall, room and pillar, and shortwall. The last is a hybrid of longwall and room and pillar.

Longwall Mining

Typical longwall layouts are shown in figure 10.1. The drawings are merely illustrative and were chosen for their simplicity. In practice, a mine layout would likely be more complex. For a more detailed, and accordingly more accurate, description of a longwall operation, the reader's attention is directed to several texts listed in the bibliography.[17]

Construction begins with the driving of a set of mains along the total width of the coal seam. The mains provide the means to connect the mine infrastructure, such as ventilation and transport (of materials, miners, and coal), to the proposed longwall panel. Depending on the size of the seam and its relation to the developed sections of the mine, the mains could extend for several kilometres. There are two longwall mining methods: "advancing" (moving away from the mains into the coal face); and "retreating" (the face moving towards the mains). Since modern trends seem to favour the retreat longwall, I will limit my comments to that method. Entries (the headgate and the tailgate) are driven at right angles to the mains through the coal seam to its end or to a point determined by geological or other factors. The panel of coal is isolated by the two "gates," and the distance between them determines the face length.

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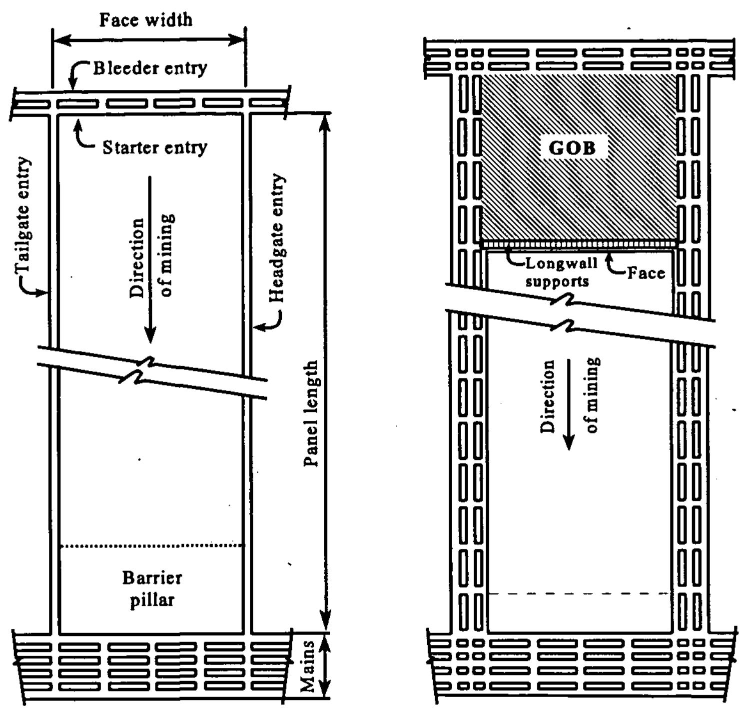
[17] *Longwall-Shortwall Mining, State of the Art,* ed. R.V. Ramani (New York: Society of Mining Engineers, 1981); Society of Mining Engineers (SME), *Underground Mining Methods Handbook,* ed. W.A. Hustrulid (New York: Port City Press, 1982).

Figure 10.1 Typical Longwall Layouts



Typical single-entry longwall panel

Typical triple-entry longwall panel during mining

Source: Society of Mining Engineers, *Underground Mining Methods Handbook*, ed. W.A. Hustrulid (New York: Port City Press, 1982), 291–92.

Although figure 10.1 shows a single-entry system and a triple-entry system, the number of such entries, in practice, is determined by local mining methods and regulations.[18]

The entries required to develop a retreating longwall face are usually driven by a continuous miner, the machine commonly used in room-and-pillar mining.[19] The roof of the resulting passage is then secured by roof bolts (or other means) before passage of workers is permitted. To protect the miners while they are working under an otherwise unsupported roof, the roof may be secured by a temporary roof support (TRS) system until bolting or other permanent support is installed. The TRS is often a hydraulic or screw jack of a type similar to those sometimes used to support beams in home basements.

Longwall mining areas for coal are developed in panels that commonly range from 100 to 365 m wide, and 300 to 4,000 m long. The size of a

18 The multiple-entry system is more typical of the U.S. approach to longwall mining, with a minimum of three entries on each side of the panel, than the European practice of using single entries. The multi-entry mains resemble room-and-pillar workings. The single-entry example more closely resembles the setup in the Devco mines on Cape Breton.

19 The equipment and methods for mining longwall entries and securing the roof are similar to those described in Chapter 6, The Explosion, for the Westray operation.

panel is generally based on geological conditions and projected mine layout. Once the headgate and tailgate entries are developed to the full length of the panel, they are connected by a "starter entry" to establish a circuit for ventilation and to provide the work space necessary for the installation of the longwall equipment.

The equipment consists of a shearer (the coal-cutting device), a chain conveyor, and a system of self-advancing hydraulic roof supports. The shearer heads are large-diameter drums with picks or cutters that rotate into the coal face, cutting the coal. The coal falls onto the face conveyor, which transfers the coal to the entry conveyor belt for transport to the surface. The shearer moves along the coal face, cutting off as much as 1 m of coal on each pass.[20]

The operators and service people are protected by the self-advancing hydraulic roof supports. As the shearer cuts into the face, these massive steel canopies move towards the face, preventing roof falls between the face and the supports, thus protecting the working area. As the shearer advances, the roof usually falls behind the roof supports into the gob (the area from which the coal has been extracted). This controlled roof fall, or "caving," takes place regularly with the movement of the face. Thus, there is no need for roof support in the gob, since the roof collapses behind the operation and out of harm's way. After the shearer passes, hydraulic rams connected to the bases of the supports push the face conveyor forward, and the shearer is ready to cut the next "web."

The mining engineers and others to whom I spoke generally agree that longwall mining is the safest of all current coal mining methods because the miner is protected at all times from the hazards of roof fall – provided that the system is operated properly. It is also the most efficient method.[21] Because of its efficiency and speed, there are times when the longwall operation may have to be curtailed in order to bring methane levels down to acceptable levels. The shearer moves so rapidly across the coal face that methane may be liberated at a rate with which the ventilation system cannot cope. There is also the problem of methane accumulation in the gob.

Room-and-Pillar Mining

In room-and-pillar mining, rectangular blocks of coal left untouched (pillars) constitute the support for the roof in the mined area. A working room-and-pillar panel constitutes a series of parallel passageways with connecting cross-cuts at regular intervals. Part of a room-and-pillar panel is illustrated in figure 10.2.

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[20] In one such operation, the Skyline mine in Helper, Utah, I observed that the shearer could reach a height of 15 feet (4.5 m) along a coal face of about 700 feet (215 m). I was told by my guide that this installation is one of the largest longwall operations in the world. I am informed that shearers are presently available that can cut to a height of 20 feet (6 m).

[21] Inquiry experts place the coal extraction in the order of 65 to 80 per cent for longwall, compared to 50 per cent or less for room-and-pillar mining.

Room-and-pillar mining, the method used at Westray, employs the continuous miner as the extraction mechanism. Some continuous miners have cutting heads that occupy the full width of the entry, but the body of the machine is commonly about 3 m wide. Room widths normally range from about 5 m to 7 m. As the cutting head removes coal from the face, the coal falls onto a chain conveyor built into the continuous miner, and is loaded onto a shuttle car. The shuttle car transports the coal to a belt conveyor system for transport to the surface. As the continuous miner advances and creates the "rooms," it establishes the checkerboard pattern seen in figure 10.2.

For reasons of space, roof control in continuous miner operations is almost exclusively roof bolting (see the following section on ground control methods for a description of roof bolting). The double roof bolters used at Westray, with their built-in automatic temporary roof support system and hydraulically operated operator canopies, are typical of the equipment used in modern room-and-pillar mining. The machine drills the appropriate-sized holes into the roof to the depth set out in the roof control plan and then sets the bolts either mechanically or with resin. A further advance on this machine is the dual bolter built onto, and forming part of, the continuous miner. With such a machine, the length of time that a mine roof remains unsupported is reduced, thus increasing the safety factor considerably.

Room-and-pillar mining does not have the potential to be as efficient or productive as longwall, since it is necessary to leave so much coal in the mine for support. Because of the necessity for immediate roof bolting, it also lacks the speed of the longwall shearer. After advance mining in the room-and-pillar system, it is possible to do some "retreat" mining or depillaring on the way back. Room-and-pillar mining survives for two reasons: (1) it requires a much lower capital investment than longwall; and (2) it has greater flexibility, which is important when operating in geologically disturbed areas.[22]

Shortwall Mining

Robert Stefanko sets out four conditions – economic, technical, geological, and safety – that can make shortwall mining attractive.[23] Since this method uses the continuous miner, the mine operator may change from room-and-pillar mining while fully utilizing existing equipment. The major addition to the equipment required is the hydraulic roof supports similar to those used in longwall mining. The shortwall method may have an advantage over longwall in circumstances where geological conditions provide discontinuous seams of coal. It is also much easier to relocate the shortwall operation than it is the longwall. Since miners are provided the

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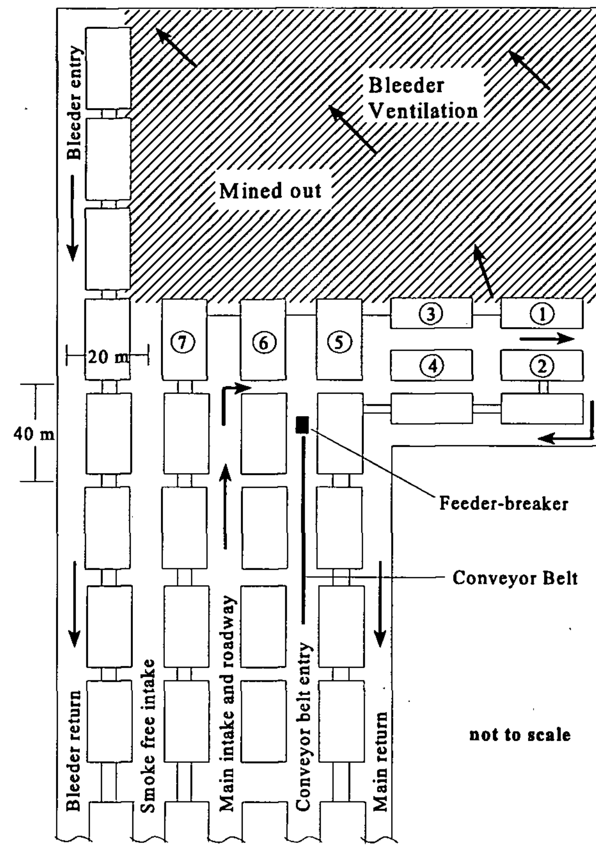
22 For a more complete and technical explanation of room-and-pillar mining, refer to Dr Salamon's report to the Inquiry (Exhibit 58.2, s. 2.2).

23 Robert Stefanko, *Coal Mining Technology: Theory and Practice* (New York: Society of Mining Engineers, 1983), 159.

Figure 10.2 Typical Room-and-Pillar Layout



Section developed with five entries

Source: Prepared from John T. Boyd Company, "Mine Feasibility Study – Westray Mine Foord Seam, Pictou County, Nova Scotia, Canada," Report to Industry Canada (Pittsburgh, June 1994), figure 6.1.

protection of the overhead shield, the operation is safer, and, since the continuous miner operates in an open-ended airway, personnel at the face are able to work in fresh air, not the commonly dust-laden air of room-and-pillar headings.

The shortwall method is much less popular than longwall or room-and-pillar, and most of the mining engineers with whom I have spoken are generally indifferent to it. Because of its attributes, however, the shortwall method should not be overlooked where conditions are favourable.

Roof Support

Roof bolting seems to be the most widely used system of roof support in use today. One source attributes the origin of roof bolting (or rock bolting) in coal mines to the United States: "The origins of roof bolting are

obscure, but its introduction into American mines in the 1940s led to rapid reduction in accidents due to falls of ground."[24]

The traditional roof bolt resembles a length of rebar (the steel rods used for concrete reinforcement) from 1 to 2.5 m long and threaded on one end. A hole is drilled in the roof or rib of the mine, and the bolt is inserted into the hole and secured with resin. (Mechanical anchors are still widely used in hard-rock mining.) Tubes of resin are inserted into the hole and the bolt is then pushed into the hole with an upward spinning motion, which mixes the resin and forces it into the cracks and crevices around the hole. When the resin hardens, a steel face plate (100 to 200 mm square) is placed on the threaded base of the bolt and secured with a large nut. Often, a wire or vinyl mesh is held against the roof by the face plates to catch small material that may come loose from the roof. The bolt, secured by the hardened resin, holds the roof strata together. Where the roof is particularly unstable, it may be necessary to make the bolt holes deeper, with longer bolts or a wire cable replacing the roof bolt. Roof bolts can also be used in several different ways to combat various roof conditions common in underground coal mines. Several applications of roof bolts are illustrated in figure 10.3.

The advantages of bolting in comparison to other and more conventional forms of roof support are set out in a training manual for mine examiners and shotfirers at Devco:

- Bolting allows for the maximum, unhindered movement of men, materials and equipment.
- Bolts can be placed very close to the face and not be in the way of mining machinery.
- Bolts can be spaced very close together, providing a very strong support system.
- Bolting aids in mine ventilation by eliminating timbers and props.
- Bolts can be used in combination with steel beams, wooden bars, or planking to provide extra support.[25]

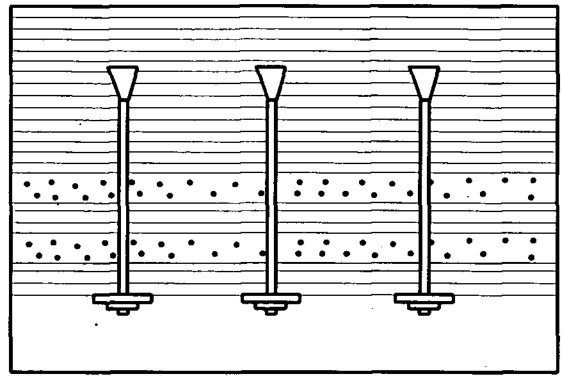
Proper roof bolting is an exacting skill that requires a knowledge of rock mechanics as applied in the geological structures being supported. Finally, it must be emphasized that a bolting system must be designed specifically for the conditions present:

> The choice of the system is based on the capability of each system under the particular geological conditions, the anticipated stresses (both vertical and horizontal), the extent of deformation anticipated and operational constraints.
>
> . . .
>
> At present, the complexity of strata properties and stressfield interactions due to mining operations has prevented the use of formulae or calculator [computer?] designed bolting systems. The actual design of the

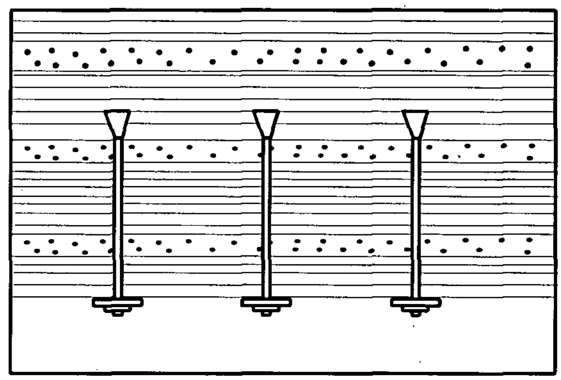
24 Siddall and Gale, "Strata Control," 341.

25 Cape Breton Development Corporation, *Mine Examiner/Shotfirer Training Programme*, Module C/MO 4/5 (Sydney, NS: CBDC, 1987), 27.

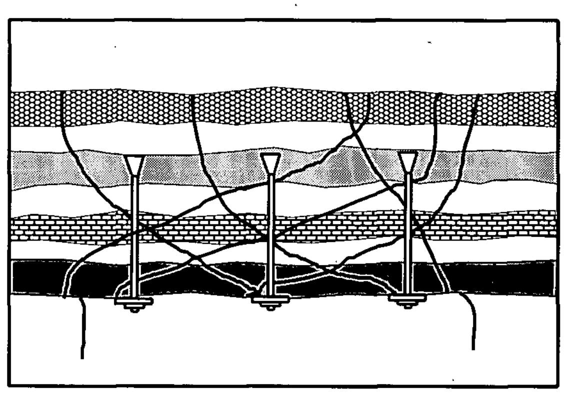
Figure 10.3 Roof Bolting



Suspension method – layers of strata anchored in stronger strata



Beam method – layers of strata laminated to make a beam



Keying method – the roof bolts intersect slip planes of randomly jointed rock, forming them into a stronger unit.

Source: Cape Breton Development Corporation, *Mine Examiner/Shotfirer Training Programme*, Module C/MO 4/5 (Sydney, NS, 1987), 25.

bolting system is determined from an initial appraisal of the site conditions followed by detailed monitoring of the performance of the bolts and then by the actual response of the roadway under the conditions defined.[26]

[26] Siddall and Gale, "Strata Control," 345.

The Westray Mine Plan

The mine design outlined in sections 3.1 through 3.4 of the Kilborn report was apparently the most recent mine plan in Westray's possession before operations in the mine began. The same plan was used in the licence application and must be regarded, at least for the initial stages of the mine's operation, as the blueprint for the eventual mine layout. It is noteworthy that the plan is virtually identical to that suggested in the study by Placer Development Limited, a plan apparently formulated by Associated Mining Consultants Ltd.[27]

Although the Kilborn study includes no substantive discussion of the options available to Westray, it is difficult to dispute the conclusion that led to the choice of room-and-pillar mining. In a faulted and thick coal bed such as the Foord seam, longwall or even shortwall mining would have been technically and economically at a serious disadvantage. It is therefore not the choice of method that I question, but the selection of the operating parameters – for example, upper limit of mining depth, upper limit of mining height, unchanged pillar layout throughout the depth range from 200 to 600 m, and choice of the seam's top as the roof of the entries. In the absence of contrary evidence, the explanation for these unfortunate choices might be based in reasons beyond simple mining consideration. A plausible explanation could be that the need for these extreme limits was motivated by a need to increase extractable coal reserves. The prospects for Westray (or its successor) may have been more realistically assessed by John T. Boyd Company in 1994. According to the Boyd report, "reopening of the Westray Mine is not economically viable in the foreseeable future."[28] Indeed, the report noted that the [1994] market price of coal would have to double to reach viability.

These controversial mining parameters were introduced during the July 1987 study conducted by Placer. This study represented a bold departure from previous investigations, which suggested shortwall mining as the main mining method. In the shortwall system, a continuous miner, along with self-advancing hydraulic supports, is deployed along a relatively short face (40 to 60 m). In all likelihood, the hydraulic supports would be quite capable of containing the weak, layered roof of the Foord seam. However, the team involved in the Placer study did not re-evaluate the tentative recommendations of Golder Associates when it decided to change to the room-and-pillar method.

Lack of Continuity in Planning

Golder Associates produced two early reports for Suncor concerning the geotechnical factors in a possible mining venture. The first report recommended, among other things, that the roof plane of the entries

27 Exhibit 10.2, pp. 1–3.

28 Exhibit 26, pp. 2-6–2-8. John T. Boyd Company, "Mine Feasibility Study – Westray Mine Foord Seam" (June 1994). This report was commissioned by Industry Canada.

should coincide with the coal-rock contact.[29] This recommendation was accepted by subsequent consultants and persisted – to the mine's and its workers' peril – into Westray's operational phase, despite Golder's obvious assumption that mining would be based on either a longwall or a shortwall system and that, in either case, longwall-type supports would be used to secure the roof of the producing faces. The second Golder report, while retaining the original recommendation concerning the roof plane, made important additional comments, including the assessment that the thickness of the shale would be a controlling factor in roof conditions.[30] Furthermore, the report presented preliminary coal strength data, indicating a range from 6 to 18 MPa, with a mean strength of 14 MPa.

The two Golder reports were prepared before any of the mining feasibility studies were carried out. Nevertheless, the recommendation for roof control made in the first of the Golder reports in 1984 was adopted by the Norwest team in 1986 and retained by the subsequent investigators. Because Norwest was considering mining methods that involved hydraulic support systems, this choice may have been justified.[31] However, in the next feasibility study, the Placer group decided to place the room-and-pillar method at the core of its plans. This method involves the exposure of a considerable roof area and employs large moving machines (shuttle cars and continuous miners), so the use of longwall-type supports would have been impractical. In these circumstances, it would have been prudent to avoid using the inferior coal-rock interface as the entry roof.

It appears that no fresh geotechnical investigation preceded the decision to change the mining method, and the original Golder recommendation was carried forward. The Kilborn team, the next group performing a study, did not revisit the technical issues and seems to have ignored the warnings in the Golder reports. Thus, the Placer change in mine plans was adopted by Kilborn, and consequently the roof of the entries in the Westray mine coincided with the weak roof of the Foord seam. This sequence of steps, as events have shown, put Westray in a vulnerable position. Three separate teams conducted three feasibility studies. Gerald Phillips, subsequently Westray's general manager, was apparently the only person who participated in all three studies. The lack of continuity in experienced and knowledgeable personnel during the planning and feasibility stages may have contributed to the exceptionally bad roof conditions in the Westray mine.

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29 Exhibit 13.1, p. 28. Golder Associates, "Geotechnical Aspects Related to the Acadia Coal Project – Pictou County, Nova Scotia" (Vancouver, October 1984).

30 Exhibit 13.2, p. 15. Golder Associates, "Rock Mechanics Advice for the Acadia Coal Project – Pictou County, Nova Scotia" (Halifax, April 1986).

31 Exhibit 9.3, s. 2.1.1.

Finding

In spite of several warnings of potentially serious ground control problems, the management of Westray proceeded with mine development without having completed verification of many of the tentative estimates contained in several feasibility studies.

Ground Conditions at Westray

The Mine

Access to the Westray mine was through two inclined tunnels, or slopes. Excavation of the slopes started in May 1990, and (after an interruption of several months) in February 1991 the slopes reached the Foord seam (near No. 5 Cross-cut), at this point too thin and dirty to be considered minable. Here the slopes were continued in the Foord seam in a north-northeast direction until, at about No. 9 Cross-cut, the seam thickness and dirt content had improved to a more or less minable quality. There, the development of the B and C1 Roads commenced in a northwest direction. The aim of these drives was to open up the Southwest section. Maps 1 and 2 in Reference illustrate the mine's roadways and the chronology of its development.

In the meantime, the two main slopes, No. 1 and No. 2 Mains, continued in the original direction for about 110 m, at which point the mains were turned, because of faulting, into an east-northeast direction for about another 110 m. Here the development split. Three drives, 1, 2, and 3 North Mains, were driven in a north-northeast direction, and two entries continued in the original direction for a short distance. These two were stopped and abandoned, obviously for some geological reasons. After about 120 m, two drives were turned off from 3 North Main towards the east (2 East and 1 East), which, after 60 to 70 m, turned right and joined, to become 1 Southeast. This single entry was driven until it was in line with the earlier-abandoned No. 2 Main heading, at which point it was turned to the southwest, with the apparent intention of holing into the abandoned drive. At the time of the explosion, work was in progress in the Southeast heading. See map 9 in Reference for a geotechnical view of the North mains and Southeast sections.

The North mains continued for some distance, but eventually 3 North Main was discontinued. Some 260 m from the start of the North mains, the development split: three headings turned northwest, 2 North Main proceeded in its original direction, and North 6 Cross-cut turned to the east. Apart from the cross-cut, mining was in progress in all these drives at the time of the explosion.

Let us now look at the development of Southwest 1. (Map 8 in Reference is a geotechnical view of the Southwest section.) This panel was planned to come into being on the northeast side of SW1-B and SW1-C1 Roads. It was intended to be a room-and-pillar section. As the plan of the area reveals, the attempts to establish this panel were unsuccessful. Six

cross-cuts were initiated, but proved insufficient to form a healthy coal-producing section. According to the geological plan, (see map 4 in Reference), the east side of Southwest 1 was badly disturbed by a series of parallel faults. Eventually, the idea of having an effective production section in this area was abandoned, and SW1-4 Cross-cut was developed on the southwest side of SW1-B Road. From this and a parallel cross-cut, a number of parallel entries were driven unusually close to each other in the northwest direction. Phillips, in a memorandum dated 13 April 1992 that was addressed to all Westray employees, stated that these pillars were designed to have a width of 12 m "but were cut to as little as 6 metres. . . ." The relatively undisturbed pattern of the area reveals that it was an effective section. The plan divulges also that, unfortunately, the panel was abandoned in haste.[32] (This is apparent from the unfinished appearance of the layout.) There were no activities in this area at the time of the explosion.

The last development in the short-lived Westray mine was in Southwest 2, developed via SW2-A and SW2-B Roads. These entries, which were started at points close to SW1-2 Cross-cut in SW1-B Road, were driven almost due west. The development to open up this panel followed the departure from Southwest 1. Little was accomplished in the area before the disaster. This was the third section of the mine being actively mined at the time of the explosion.

This brief survey of the mine plan found no convincing indication of management's plans.

Production Shortages

The seriousness of Westray's mining problems was aggravated by the company's contractual obligations to supply coal to Nova Scotia Power Corporation (NS Power). This becomes obvious from an examination of Westray's production records, as presented by Salamon in his report to the Inquiry:[33]

- The contract with NS Power called for total sales of 445,000 tonnes in 1991. The actual delivery was less than 6,000 tonnes.
- The underground (run-of-mine) coal production jumped significantly in January 1992, to 63,804 tonnes from 23,625 tonnes in December 1991. This increase coincided with the full development of the section with the narrow pillars.
- During 1992, the contract required delivery at a rate of 58,333 tonnes per month (700,000 tonnes per year). The highest sales, which occurred in March 1992, represented only 84.5 per cent of the contract. One reason

32 The retreat from Southwest 1 is covered in its various aspects later in this chapter (in the section on ground conditions at Westray, Southwest 1) and in Chapters 7 and 8, Ventilation and Methane.

33 Exhibit 58.2, s. 3.2. The contractual and financial implications of the deal with the power company are covered in Chapter 2, Development of Westray. They are touched upon here simply to add context to the geological problems being encountered.

for the shortfall is that at no time had the saleable tonnage of clean coal reached 54 per cent of the run-of-mine production.

- Underground production dropped significantly in April 1992, to 40,495 tonnes from 69,780 tonnes in March, a 42 per cent reduction. It is noteworthy that Southwest 1 was abandoned at the end of March.
- To the shortfall in sales during the period of production, October 1991 to 7 May 1992, the delay of some 13 months in the start of production should be added.[34]

From this perspective, Westray management laboured under considerable pressure to produce coal.

Ground Control Problems

It is clear that Westray's production problems stemmed from unexpectedly severe geological conditions and ground control problems. Evidence of the adverse ground conditions is manifold.

Westray miners were preoccupied with the state of the deteriorating roof conditions. Miners felt that it was only a matter of time before someone would suffer serious injury or death from a rock fall. Ted Deane testified that he and his partner often spoke with their foreman, John Bates, about the ground conditions. Bates was certain that someone would eventually be injured by a roof fall; he was, at that time, less concerned about an explosion.[35] According to Randy Facette, the drive to unionize the workforce was motivated, in large part, by the roof conditions: "I guess our main concern [was] that someone was going to get killed there soon by a rock fall . . . because we had so many of them."[36] Buddy Robinson was an experienced miner whose fears could not be taken lightly. He testified that the men at Westray were under significant stress, due in great part to the instability of the roof:

> Q. What was putting you under stress?
> A. The whole concept of the mine and the way – working with all these inexperienced people and the way the mine was being handled and – it was – like I said before, it was only a matter of time I thought before a rock fall would kill a bunch of these rock bolters. And it was just phenomenal that it didn't in the end.
> Q. It was just a matter of luck, you're saying?
> A. Like I said, it was more good luck than good management.[37]

Indeed, the close calls attested to by miners during this Inquiry support Robinson's characterization of the situation as "phenomenal." Shaun Comish related an incident in which he was breaking through at the intersection of No. 1 Main and 2 North Main with the continuous miner.

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34 See Chapter 2, Development of Westray, for details about the delay in development.

35 Hearing transcript, vol. 26, pp. 5380–81.

36 Hearing transcript, vol. 33, p. 7228. The United Mine Workers of America failed in its attempt to unionize the workforce in late 1991. The United Steelworkers of America later succeeded in 1992.

37 Hearing transcript, vol. 30, p. 6432.

A co-worker advised Comish to "pull back under the arches, get back quick."[38] Just seconds after Comish pulled the machine back and stepped out, the whole roof caved in. He went on to describe another time when the back end of the continuous miner he had been operating was buried by a roof fall.[39]

Lenny Bonner testified to such an episode occurring in SW1-A3 Road, where he was operating one of two shuttle cars. Bonner had expressed some concern to his foreman about going under an overhang on the left-hand rib to load the coal from the continuous miner. While he was dumping a load, a big piece of the rib caved in, blocking the continuous miner. Bonner said that, had he been in his shuttle car loading coal, he would have been dead.[40]

In November 1991, Ron MacDonnell and Jack Matthews were in the bucket of the Scooptram setting steel arches at the intersection of No. 1 Main and No. 11 Cross-cut. MacDonnell testified that "part of the roof came in," snapping off the chock blocks they had been tying in. MacDonnell was knocked down into the bucket by a large chunk of roof "a couple of feet thick and a few feet wide." Admitted to the hospital with a sore neck and back, he took the next three working days off.[41]

Tom MacKay told of an episode when he and other crew members were roof bolting a caved area in SW1-7 Cross-cut. One worker was standing on the full extended temporary roof support (about 5 m off the ground), while MacKay was standing on top of the driller's canopy.[42] They were hanging screen with mechanical bolts. MacKay told the Inquiry:

> There was a great big rock behind Buddy's back. And I told him, I said, "You'd better get over here." . . . I said, "That rock there looks like it . . . " because it was starting to work, dribble a little bit. I said, "It looks like it's going to let go." And he just never done too much, never moved. So I let a little holler at him and I said, "You'd better get over here." So then he turned around and I hollered again, and he jumped. And just as he jumped, it came down and landed where he was standing there.[43]

These men had been standing precariously under the unsupported roof on the very devices designed to protect them from falling rock. The Inquiry heard many similar tales of horrific roof conditions and close calls.

The geotechnical maps, maps 8 and 9 in Reference, indicate that roof overbreaks occurred frequently. Overbreaks varied in thickness, from 0.2 m to 1.5 m, and involved a significant proportion – roughly one-third

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38 Hearing transcript, vol. 28, p. 5799.

39 Hearing transcript, vol. 28, pp. 5799–5800.

40 Hearing transcript, vol. 24, pp. 4729–30.

41 Hearing transcript, vol. 29, pp. 6069–72.

42 Both practices are extremely dangerous. The temporary roof support is on the bolter to keep the roof from falling while the miners are bolting. The driller's canopy is a protective covering under which the miner can work in relative safety. It stretches credulity that these hazardous practices could be carried out without the knowledge and consent of the shift foreman and the underground manager.

43 Hearing transcript, vol. 32, pp. 7048–49.

to one-half – of the exposed roof. The overbreaks had a significant impact on a number of aspects of the mine's operation. Perhaps the most obvious of these was the impairment of coal quality resulting from the addition of waste rock. The dilution caused by overbreak is estimated to be in the range of 20 to 40 per cent.[44] A second adverse effect of overbreak is on roof support. An irregular roof is always harder to secure than a reasonably uniform roof surface.

The geotechnical maps show a number of other conditions that represent adverse roof and rib conditions in many places in the mine. These conditions include "cutter roof," "pillar slabbing," and "cleat separation."[45] Most of these phenomena suggest movement or loosening in the roof strata.

Perhaps the clearest evidence of excessive roof movement is provided by the extensometer measurements obtained in the rock mechanics monitoring holes drilled into the roof. These vertical holes are located mostly at the intersections of roadways. A program for drilling the holes is given in a memorandum, dated 13 November 1991, from engineering superintendent David Waugh to underground manager Roger Parry.[46] The results from the monitoring holes indicate that the roof mass frequently sagged quite appreciably, often at heights of more than 3 or 4 m above the roof surface.[47] Analysis of the graphs of observed sag in 39 roof holes reveals that some 62, 46, 28, and 15 per cent of the holes show a maximum sag in excess of 50, 100, 150, and 200 mm, respectively. Salamon suggests, as a rough guide, that sag in excess of 50 mm constitutes a warning of undue loosening in the roof.[48] This being so, more than half the holes showed unduly large roof movement. Therefore, considerable danger of major roof falls existed in the mine.

A set of reports collated by Westray staff contains the descriptions of 16 roof falls. These events occurred during the period of approximately seven months between 28 September 1991 and 24 April 1992.[49] Most of the falls took place at three- or four-way intersections. The falls were estimated to range from 3 m to 15 m in height and from 5 m to 20 m in length. They were major roof falls, constituting grave danger to the men working in the mine.

In all but two cases, the roof fall reports refer to the thinly bedded nature of the shales that form the roof of the roadways. The report on "ground fall no. 1" describes the roof conditions: "The original roof was flat, cut to the shale. The overlying shale was the normal sequence of thinly bedded, laminated, polished shales." This description fits exactly

44 Exhibit 58.2, table 2.

45 Cutter roof is a localized break in the roof that first shows up as a longitudinal crack. Pillar slabbing involves pieces of rib falling onto the roadway. Cleat separation occurs in natural planes of weakness in bedded coal.

46 Exhibit 15.0030.

47 Exhibit 15.0033.

48 Exhibit 58.2, p.12.

49 Exhibit 15.0076–0120.

the conditions observed by Salamon at a roof fall inspected during an underground visit on 8 August 1992. This feature of the roof appears to be the most obvious reason for the exceptionally poor roof behaviour experienced at Westray. This thinly bedded shale had been noted in the exploratory surface hole logs. Golder's 1986 report also emphasized the need to make a "roof conditions plan."[50] These warnings appear to have been overlooked by those who planned and later operated the mine.

One symptom of adverse ground conditions is the sheer variety of support systems that Westray experimented with during the short span of the mine's life. These experiments included various roof and side bolting schemes, trusses, rigid and yielding arches, and square sets. A number of documents reveal the scale of experimentation:

- Westray Bolting History, draft, 28 November 1991 (Exhibit 15.0121–22)
- Westray Coal: Ground Support Standards, draft, 17 March 1992 (Exhibit 15.0123)
- Bolting Procedure, draft, 5 March 1992 (Exhibit 15.0124)
- geotechnical maps (Exhibit 45.15)
- ground support maps (Exhibit 45.07)
- Report on Ground Falls and Recommendations for the Support of Intersections (Exhibit 15.0191-97)

In late February 1992, Jack Parker of Jack Parker and Associates, Inc., was invited to visit Westray. Parker is a rock mechanics consultant with wide experience in a great variety of mining conditions. In a letter dated 29 February 1992 to Waugh, Parker reported on his first impressions of the mine:

> During the first day underground I was thinking that roof conditions were horrendous – that most folks would have walked away from them, that except on "government projects" few operators would want to rehabilitate the very high roof failures, for example. But after a good night's sleep and second look I came to feel more comfortable, seeing that management and miners had learned to handle those difficult situations, carefully, and without complaints.[51]

Regardless of Parker's second thoughts, his statement, coming from an experienced and solid professional, reveals exceptionally bad conditions. There are many reasons to suggest that the miners endured these dangerous conditions "without complaints," but the evidence belies any suggestion that they did so without fear. There is much evidence to show that the miners were extremely apprehensive about the roof situation at Westray.

Perhaps the most revealing description of the ground control situation at Westray was given by Waugh to the RCMP on 9 May 1994, two years after the disaster: "The Westray Project was driven by ground problems.

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[50] Exhibit 13.2, ss. 6.2–6.3.

[51] Exhibit 15.0207.

The ground problems affected production and development. I felt someone would get hurt but strictly from ground fall."[52] Waugh was the only person in Westray Coal who had professional experience in ground control, although most of that experience related to potash mining.

Finding

Mining at Westray consistently encountered unexpected and adverse geological conditions. It is obvious that Westray managers were ill prepared to deal with these conditions, and, as a result, when they encountered an unexpected condition, they did not know how to deal with it.

Southwest 1

The Southwest 1 section was the panel in which long, narrow, and ultimately high "finger" pillars were employed. This layout evolved from attempts to improve ground conditions. Resulting side benefits included high productivity and fairly regular output. The mine achieved its highest rate of production during the brief time this panel was in operation.

It is unclear how the idea of this particular plan was planted in the minds of management. It could have come from Waugh or from any of several consultants with whom the mine management was in contact during the last months of 1991. According to many reports, poor roof conditions occur when the *horizontal* pre-mining stresses are high; however, this situation can be alleviated by driving follow-on entries in the "shadow" of a leading drive. The idea is to divert the stress trajectories away from the to-be-protected rooms. Placing several rooms in the shadows of one another may result in an extended protection scheme.

High *vertical* stress can also cause poor roof and rib conditions. Such a state can be observed frequently in entries along a longwall panel. These roadways are usually protected by so-called "chain pillars." A number of operators have reported that the deterioration of such entries can be alleviated through the use of "yield" pillars. The idea is that the yield pillar will shed some of its load to nearby abutments and, as a result, relieve bad roof and rib conditions.

While the shadow and the yield-pillar mechanisms are entirely different, the implementation of the two ideas leads to virtually identical mining layouts – that is, to rooms separated by narrow pillars. When the overall width of a panel created in this manner is small, improvements are often achieved, and it is immaterial whether the improvement results from the stress shadow effect or the load shedding by yielding pillars.

It would appear, however, that there is a definite limit to the applicability of these two methods. To gain overlapping stress shadows, the rooms must be close to one another; therefore, the intervening pillars must be narrow. Similarly, experience shows that pillar yielding is

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52 RCMP transcript, p. 6.

achieved only if the pillars are narrow. Hence, in many instances, the pillars designed to fulfil the requirements of either of these concepts will become yield pillars. Common sense suggests that there is an upper limit on the span up to which yield pillars can be effective. This limit, or critical span, is defined by the distance to which the yield pillars can shed their load. If this span is exceeded, the rapid deterioration of the panel, and often even its sudden collapse, becomes inevitable. It seems that the sudden and drastic deterioration of Southwest 1 at Westray is a textbook example of such failure.

Westray management became convinced towards the end of 1991 that high horizontal stresses were responsible for their ground control problems. Presumably, to combat this phenomenon through the stress shadow concept, Southwest 1 was developed with narrow pillars. Both production records and observations seem to indicate that conditions did improve, at least for a while. It is unclear whether mine management was aware of the need to keep the panel width within a critical span. Whatever the case, the events that started to unfold on 23 March 1992 proved that the 100 m-wide panel was too wide.

A bare outline of the sequence of events, but not the environmental conditions, can be deduced from the underground operating shift foreman's reports over the period of withdrawal from Southwest 1.[53] It takes little imagination to see the horror story unfolding during those days.

Day shift, 23 March: Owen McNeil (This appears to be the last date on which mining (depillaring) occurred in SW1-A Road.) The continuous miner (No. 2000) was moved into SW1-A2 and then into SW1-A3. The Stamler feeder-breaker was also removed from SW1-A to SW1-A3.

Night shift, 23 March: Bryce Capstick (Indications of roof stresses are evident from this report.) Chocks were built in SW1-A, SW1-A1 and SW1-A2 Roads. A second continuous miner (No. 2002) was in SW-A2.

Day shift, 24 March: McNeil Mining took place in both SW1-8 Cross-cut and SW1-A3 Road. (The mining was reported as being slow.) Roof trusses had to be adjusted and additional blocks added for support in SW1-A2. The shift ended with mining in SW1-A2.

Night shift, 24 March: Capstick A plastic stopping was erected in SW1-8 Cross-cut between SW1-A2 and SW1-A3 Roads. The pillar in this area was reported to be giving indications of failure. The continuous miner, shuttle car, and roof bolter were moved out of the "top roads" (presumably meaning the SW1-A3 heading and the inbye end of SW1-8 Cross-cut). A continuous miner, roof bolter, and shuttle car were removed from the section. All equipment was reported to have been "backed" outbye of SW1-8 Cross-cut.

53 Exhibit 42f.0153–207.

Day shift, 25 March: McNeil Cables, a fan, and ducting were removed from SW1-9 Cross-cut. A roof bolter and Stamler feeder-breaker were removed.

Night shift, 25 March: Capstick It was necessary to reinforce roof supports during this shift. Arrangements were made to install additional supports under carrier beams in SW1-B Road at the junctions of both SW1-8 and SW1-6 Cross-cuts. A further chock was erected in SW1-8 Cross-cut outbye SW1-A Road. More items of equipment, including an auxiliary fan and ducting, were removed from the SW1-A heading.

Day shift, 26 March: Ferris Dewan Nine hundred and twelve tonnes of coal were mined by depillaring in SW1-A3, despite a third day of indications of pillar failure. (This would seem to have been a last dash for coal production in SW1-A3.) The continuous miner had been moved back along SW1-A3 beyond SW1-8 Cross-cut, indicating further deterioration of conditions. Four double-width and two normal chocks were set in locations not clearly identified. The roof trusses were tightened in SW1-A1 and SW1-A3.

Night shift, 26 March: Arnie Smith (This was the final shift in which coal was produced from Southwest 1.) A further 432 tonnes were extracted from depillaring, although the site is not given. The continuous miner was in SW1-A3.[54] At some point, the rib collapsed behind the continuous miner. An unsuccessful attempt was made to pull it out with a shuttle car.

Day shift, 27 March: Dewan The conveyor in SW1-4 Cross-cut was dismantled. The box end, together with a continuous miner and two shuttle cars from SW1-A3, was moved to the SW1-B Road and SW1-4 Cross-cut intersection. The conveyor drive head was moved to SW1-C1 Road.

Day shift and night shift, 27 March: Smith More pieces of equipment, including a fan, electrical panels, and conveyor structure, were removed from SW1-A3. Two stoppings were rebuilt in an unspecified location.

Day shift, 28 March: Dewan On this Saturday, a fan, ducting, and other items were retrieved from SW1-B and SW1-C1 Roads. A chock and a belt stopping were installed in SW1-4 Cross-cut. Four arches were set in SW1-B Road, and a transformer was recovered from SW1-A Road.

Night shift, 28 March: Smith Most of this shift was spent continuing the recovery of smaller items from Southwest 1, including loads of chocks, pipes, conveyor structure, and electrical equipment. There were entries on roof bolting in No. 3 and repairing of belt flaps.[55]

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54 The foreman's report does not identify the location of this continuous miner, but Eagles recalled that it was in SW1-A3 Road (Hearing transcript, vol. 76, pp. 16473, 16475).

55 Presumably referring to the poor roof conditions in SW1-3 Cross-cut and the "belt strip" stopping that was hung in that same location in an attempt to divert air into the Southwest 1 section.

Night shift, 29 March: Smith A steel "intersection" was begun in SW1-3 Cross-cut. (The ground control problems around the SW1-C1 Road and SW1-3 Cross-cut intersection led to the installation of the Southwest 2 conveyor in SW2-B Road (intake), which required vehicular traffic to be diverted through SW1-2 Cross-cut into SW2-A Road (return). (See Chapter 7, Ventilation, for details.) The chock in SW1-B Road was completed.

Day shift, 30 March: Capstick An additional chock was built at each of the two stopping sites in SW1-B and SW1-C1 Roads inbye SW1-3 Cross-cut. That same cross-cut received further supports, including chocks and cross-beams.[56]

Other descriptions add further details about the scene. In a memo dated 7 April 1992, engineering superintendent David Waugh and geotechnologist Stan Chesal described the events vividly:

> On Monday, March 23, 1992, at 6:00 pm a loud noise was reported high above A-2 roadway. Later that night a floor heave occurred 1 metre high along the updip rib in the A-1 road outbye #9 crosscut. By the morning of March 24, 1992, the pillars inbye #8 crosscut were reported under load, cracking and slabbing with the back dribbling and bagging into the wire screen. Dywidag trusses had slackened up to 6 inches within 12 hours.
>
> . . .
>
> The area was abandoned on March 27, 1992, with all men and equipment safely removed. The area was barricaded against entry at the time.[57]

In his statement to the RCMP, Waugh characterized the scene during the retreat, stating that "the ground conditions were extremely bad."[58]

Wyman Gosbee described the retreat from the Southwest 1 section:

> It was scary. It was like a nightmare. We were rushing. We were trying to get it out, and we knew that the ground conditions were real bad at the back. And you could hear it, and you could, you know, even along – I believe along one of these roads it was dribbling a little rock. And we were all trying to work as fast as we could to get that out of there.[59]

Jay Dooley testified to the conditions in the Southwest 1 section prior to the retreat: "It was working all over, it wasn't just one roadway. The whole thing was in motion."[60] Dooley alerted Roger Parry to the condition, and they decided to retrieve the equipment from the area. At that point, there was agreement that it was not a temporary withdrawal: "I was under the understanding that we're out of here," Dooley told the Inquiry. "And if we get everything out of here, we're going to be very lucky."

56 Eagles made the point that "it was critical that we kept the [SW1-3] cross-cut open," as it was a primary ventilation route for the new Southwest 2 section (Hearing transcript, vol. 76, p. 16479).

57 Exhibit 15.0216.

58 RCMP transcript, p. 4.

59 Hearing transcript, vol. 25, p. 4983.

60 Hearing transcript, vol. 38, p. 8525.

Wayne Cheverie was also present during Westray's retreat from the section. He testified that his crew was depillaring in SW1-A3 Road, the only minable roadway left in the Southwest 1 section, when a piece of coal about 10 feet square popped out of the rib and wedged the continuous miner down in the cut. The continuous miner was stuck, and attempts at using the shuttle car to pull it out failed. Parry gave the crew approval to take a Scooptram into the section to break the coal blocking the machine. Cheverie had the following to say about the condition of the roof at this time:

> [T]he roof started to bid over our heads . . . small flakes of coal started coming off the roof, therefore indicating that there was pressure coming on the roof, and usually in that situation you get out and make sure that, you know, it's going to be all right before you go back in there. But because we had the machine stuck in there, we stayed in there and tried to facilitate getting the machine out.[61]

At this point, Cheverie left to service the Scooptram. On its way to the section, the Scooptram quit as a result of high methane. (The methanometer on the machine was registering 6.9 per cent methane.) Cheverie testified that workers were not asked to evacuate the mine at that time, but to move down into the fresh air. By then, Cheverie was nearing the end of his shift.[62]

Gosbee had been driving the Scooptram when it quit. At this point, Parry took a methane reading and informed the workers of the high methane. Gosbee and a few others then began to fix an old stopping on SW1-A Road in an attempt to direct the airflow into the high-methane area. They continued to work in the section despite the methane, working on the stopping until the end of their shift and then leaving the mine.[63] When Gosbee came in for his next shift, a transformer and fan in SW1-A3 Road were the only pieces of equipment left to be retrieved. Arnie Smith, Gosbee's foreman, asked if there was a Scooptram driver. Gosbee asked how the Scooptram would function in such high methane. According to Gosbee, Smith responded that " 'the Scooptram is not going to shut down.' " Gosbee then realized that the methane sensor on the machine had been unhooked during the retrieval of the equipment.[64] He refused to drive the Scooptram into Southwest 1.

Bonner drove the Scooptram into the Southwest 1 section that night. He said that the engine was "knocking and banging and the visibility was very poor. . . . It was unventilated." Bonner and two others went up the SW1-A3 Road. Bonner raised the bucket as the men attempted to get the fan. He described what followed:

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61 Hearing transcript, vol. 20, pp. 3962–64.

62 Hearing transcript, vol. 20, pp. 3965–66. **Comment** It is appalling that this took place with the underground manager present. He must have known that the explosive concentration of methane is 5 to 15 per cent and that regulation required withdrawal from the area at 2.5 per cent methane.

63 Hearing transcript, vol. 25, pp. 4987–89.

64 Hearing transcript, vol. 25, pp. 4990–91.

> Yes, we were going in to get a fan, and at some point during that we got a light flashing in at us kind of frantically to get out. So I started lowering the bucket and moving it away from the wall . . . and before the bucket actually got down, the men were jumping out and running ahead of me. . . .
>
> So I had to drive relatively slow because the visibility was bad and I didn't want to run over anybody in front of me. And as soon as we got out past that intersection . . . just outbye that intersection of A-3 Road . . . it caved in.[65]

On 13 April 1992, Gerald Phillips informed all Westray employees by memo of the abandonment of Southwest 1.[66] He tried to analyse the reasons for the failure: "As you can tell from reading this, we are not sure which was the critical factor." He went on to write: "There is a right panel size (length/width) and depillaring method for our deposit. We just need to adjust what we know and have learned to date, and we will find it."

Finding

Miners were chased out of the Southwest 1 section in March 1992 as a result of horrific ground conditions. This is a clear indication that Westray management had not yet learned to operate the mine safely and productively. Without adequate planning, management was confronting each problem on an ad hoc basis and was still searching for solutions up to the time of the explosion.

Experience and Expertise in Ground Control

Rock mechanics is a highly complex area of study requiring expertise, usually acquired through a post-graduate engineering program. Over the years, its obvious benefits to safety and production have gained wide recognition. As stated in a South African text:

> During the last few decades a great deal of effort has been devoted to the development of rock mechanics as applied to engineering. The basic principles of the subject have been established and a variety of methods and tools specifically relevant to this field of application have been developed. In mining, rock mechanics has become an important tool in planning the layout of underground mines, in the evaluation of support requirements, in the alleviation of mining hazards and in making various technical decisions. Most of these activities today are part of the work of the rock mechanics specialist.[67]

The importance of rock mechanics as applied to mining has been recognized in Canada. An Ontario provincial inquiry report contained the following comment:

> Mine design is critical to the success of any mining operation. Good, well thought out planning can ensure maximum safety, with minimum disruption

65 Hearing transcript, vol. 24, pp. 4756–58.

66 Exhibit 64.18.

67 S. Budavari, *Rock Mechanics in Mining Practice*, Monograph Series No. 5 (Johannesburg: South African Institute of Mining and Metallurgy, 1993).

> to production. On the other hand, poor design can lead to serious local and regional stability problems.
>
> Historically, mining techniques in Ontario mines and in other mines around the world have evolved in response to pragmatic concerns. Much of the mine design and planning was based on site-specific experience, with little rock mechanics input. In some instances this resulted in major stability problems. However, growing economic and safety concerns are directing companies to choose mining methods and to plan mines with due consideration for ground conditions.[68]

It is important that coal mine managers have adequate training in ground control. Miners should also receive sufficient training to allow them to recognize problems as they arise and take whatever emergency remedial action appears necessary.

Experience and Expertise at Westray

One of the main problems of Westray was a lack of in-house experience in underground coal mining. As has been noted, nature had endowed the Westray mine with unusually difficult mining conditions. In the circumstances, it is regrettable that the management team, except for Phillips, had no previous underground coal mine management experience.[69] Phillips, the general manager, had trained and worked in British coal mines, but the conditions and working practices there are significantly different from those encountered at Westray. Generally, British collieries use longwall mining methods and extract relatively thin flat seams.

The combination of the inherently difficult physical conditions and the inexperienced management (and crew) led to serious problems in the new mine. It appears that management regarded ground control as the most serious and persistent problem at Westray. At about the end of October or in early November 1991, Marvin Pelley, Curragh Resources' president of development and projects, named Graham Clow, a Curragh vice-president, to coordinate a task force on rock mechanics at Westray.[70] At about the same time, Westray decided to engage a consultant on ground control; David Waugh accepted the appointment for three months. Neither Clow nor Waugh had coal mining experience. Clow was an experienced mining engineer, with rock mechanics experience in potash, gypsum, and hard-rock mining. He had also dealt with consultants in the field and was

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68 Ontario, Provincial Inquiry into Ground Control and Emergency Preparedness in Ontario Mines, *Improving Ground Stability and Mine Rescue* (Ontario: Queen's Printer, 1986) (Chair Trevor Stevenson), 4.

69 Phillips was the most senior manager in the Curragh organization with any underground coal mining experience. Roger Parry and Glyn Jones had previous mining experience, but no management experience. Marvin Pelley and Clifford Frame had only been involved in surface coal mines.

70 Clow (Hearing transcript, vol. 74, pp. 16181–85).

familiar with rock mechanics procedures.[71] Waugh had considerable exposure to rock mechanics in potash mines but, as he put it, "[t]his was my first experience in . . . or near a coal mine."[72]

Largely as a result of Waugh's appointment, serious attempts were made at Westray to learn about and to understand the significance of the roof displacements and other ground control phenomena. At about thesame time, the task force under Clow's leadership started a major campaign to gain some insight into ground control problems associated with mining coal at depth. These were the correct steps, but they came late. They should have been initiated before mining commenced, and they should have been an integral part of the mine-planning process.

External Expertise

Major consulting firms had been involved with the Westray project since its inception. Of these consultants in the pre-mining days, probably only Golder Associates and Dames & Moore would be recognized as having expertise in rock mechanics. According to Waugh, "Golder had been the main consultant and were still there. Dr Richard Brummer was the main consultant with Golder. Golder had been involved with the project from inception and I believe had also been involved with Placer."[73] It is unclear whether Golder's involvement was continuous; it is more likely that the firm was invited from time to time to carry out investigations of specific problems.

Between about November 1991 and the day of the explosion, six different consultants had advised Westray management.[74] Unfortunately, this turn from famine to feast was not entirely beneficial. Each consultant had a particular background that influenced its approach. Westray management, the recipient of the advice, was ill-equipped to evaluate the recommendations. In the following crucial instance, it accepted inappropriate advice that resulted in a wrong decision. Management was persuaded that high horizontal ground stresses were largely responsible for poor roof conditions, so it implemented the suggestion of forming panels supported by narrow "finger" pillars, as has been described above. This decision led to the loss of Southwest 1. Fortunately no one was injured as a result of the hasty abandonment. It should be noted, however, that the failure could have been disastrous, causing the death of the people working in the area.

Three of the consultants raised red flags about using narrow pillars to create stress shadows that would relieve the alleged horizontal stresses. Two of the warnings were quite specific; the third was implied. Salamon

71 Hearing transcript, vol. 74, pp. 16180–83.

72 RCMP transcript, p. 1.

73 RCMP transcript, p. 1.

74 Golder, Dames & Moore, Denis Mraz, Jack Parker, John T. Boyd, and Chris Mark.

discussed these warnings at length during his testimony at the Inquiry.[75] As far as he could determine they had been ignored by Westray.

Finding

Westray management, from the chief executive officer down, seemed unable to implement the advice of competent professionals. This incapacity discloses a serious defect in the Westray management mentality that is probably related to a combination of incompetence and inexperience.

Several basic points may be drawn from the Westray experience:

- **Comprehensive planning should be done as far in advance as possible so that problems may be anticipated and surprises kept to a minimum. This was not evident in the manner Westray attempted to deal with its ground control problems.**
- **It seems almost axiomatic that an underground coal mine should retain the services of competent management and engineering personnel with proven experience and technical competence. Westray was significantly lacking in this regard.**

RECOMMENDATION

42 **Consultants, when required, should be selected carefully to ensure that their background and expertise are consistent with the specific requirements of the problem to be analysed. Any conflicts in the advice from these consultants ought be resolved through discussion and, if necessary, through further advice. Conflicts in technical advice must be resolved, not ignored, as seemed to be the practice of Westray management.**

Impact of Ground Control on the Explosion

Although the evidence does not lead to the conclusion that ground control problems played a direct role in the ignition of the explosion at the Westray mine, the possibility of indirect contributions cannot be excluded. Four consequences of poor ground conditions may be significant in this respect.

[75] Hearing transcript, vol. 7, pp. 1298–1316. Richard Brummer of Golder Associates faxed to Kevin Atherton his calculations on the narrow pillars (4 November 1991). He predicted they would fail (Exhibit 15.0128–31). Derek Steele of Dames & Moore faxed a letter to Phillips on 13 November 1991. Among other things, he warned that not enough was known at that point about underground conditions to be able to plan panel development (Exhibit 15.0147–51). Jack Parker faxed a letter to Graham Clow on 28 December 1991. He questioned the wisdom of 100 m pillars, stating that they were too wide, and he questioned the horizontal stress model on which Westray was basing its planning (Exhibit 15.0198–201).

Roof Cavities

Roof falls and, probably more importantly in the present context, roof overbreaks resulted in many small and large roof cavities. These cavities obviously provided opportunity for the accumulation of pockets of methane, particularly in the presence of methane layering, a condition that existed at Westray as a result of inadequate ventilation.

Since roof cavities must be supported for roof control purposes, their existence is often obscured. Consequently, a methane accumulation or pocket may go undetected. Pockets of gas add to the accumulation of methane in the mine roadways, especially in the absence of adequate ventilation, thus increasing the danger of methane ignitions.

Release of Gas from Crushed Coal

Where ground stress conditions are adverse, coal permeability may be increased considerably – to some significant depth into the solid coal seam – by fissures, cracks, opening cleats, and such. This enhanced permeability would promote further methane release. In parts of the Westray mine, high stress conditions probably caused a greater than normal rate of gas emission. For example, the conditions in Southwest 1 are likely to have contributed to an increase of methane liberation. It is impossible, in the absence of data, to quantify the increase.

Possible Sudden Release of Gas from Southwest 1

The weight of the evidence presented to the Inquiry reveals convincingly that Southwest 1 was inadequately designed. The section was abandoned and barricaded against entry on 27 March 1992.[76] Following abandonment, this panel was standing in a considerably weakened condition – just prior to the explosion on 9 May. It is widely known that a room-and-pillar panel, standing on narrow yielding pillars, can collapse suddenly and violently. Experience has shown that a large volume of methane will accumulate in such a panel, which contains openings and is surrounded by crushed coal, if not properly ventilated,. A sudden failure of the pillars will cause the rapid lowering of the roof, which in turn will lead to the abrupt ejection of the accumulated gas into the main body of the mine's air.[77]

This is a likely scenario for the sudden movement of large volumes of methane into the Westray ventilation system at any time during April or early May 1992. Hence, an unsatisfactory design of a mining panel not only leads to risks arising from a major roof fall, but can also create a potential explosion hazard.

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76 The barricades are the infamous "stoppings" located inbye SW1-3 Cross-cut on SW1-C1 and SW1-B Roads. As discussed at length in Chapter 7, Ventilation, they did nothing to decrease the flow of methane out of the abandoned Southwest 1 section.

77 Malcolm McPherson (Hearing transcript, vol. 10, p. 1802).

Diversion of Attention

Perhaps the most serious effect of the ground control problems that burdened the Westray mine was not physical but mental. The adverse roof and rib conditions posed a continuous hazard and hampered production. Major falls week after week, daily overbreaks, and the ultimate loss of Southwest 1 must have constituted a serious threat to the mining crew and placed Westray management under considerable stress. It was probably obvious to everyone concerned that the very existence of the mine was in question. Senior managers were preoccupied with finding the solution to the ground control problems. As a result, attention was diverted from other major issues and hazards. Although it is impossible to quantify the contribution of such a major diversion to the disaster, it was likely significant.

Finding

The entire ground control situation at the Westray mine is singularly significant in that it typifies the lack of planning, of competence, and of responsibility of senior Westray management. The response of Westray management to these continuing problems seemed to exacerbate them and divert attention from other serious safety concerns. In the result, the entire safety mentality at Westray deteriorated while management was consumed with its apparent inability to deal with ground control.

Legislation and Regulations

The *Coal Mines Regulation Act* is quite inadequate in dealing with the subject of ground control, as well as other aspects of safety-oriented mining techniques. The subject is dealt with under section 75, Support of Roof and Sides. Subsection (1) includes the general statement: "The roof and sides of every roadway and working place shall be made secure . . ." Subsection (2) sets out the requirements for the dimensions of the roadway, which "shall be of sufficient dimensions to allow the horse or other animal to pass without rubbing itself or its harness against the roof or sides." Subsections (3) and (4) are equally outdated in their requirements.

These provisions of the act invite comparison with comparable legislation in other jurisdictions. In the United States, the requirements for ground control are set out in 30 CFR 75, Subpart C – Roof Support. Section 75.200, Scope, reads in part: "This subpart C sets forth requirements for controlling roof, face and ribs, including coal or rock bursts, in underground coal mines." Subpart C then details the requirements for the following:

- Protection from falls of roof, face and ribs
- Mining methods
- Roof bolting

- Installation of roof support using mining machines with integrated roof bolters
- Conventional roof support
- Pillar recovery
- Warning devices
- Automated Temporary Roof Support (ATRS) systems
- Manual installation of temporary support
- Roof testing and scaling
- Rehabilitation of areas with unsupported roof
- Roof support removal
- Supplemental support materials, equipment and tools
- Longwall mining systems
- Roof control plan
- Control plan information
- Roof control plan-approval criteria
- Evaluation and revision of roof control plan.

I have reviewed legislative regimes from several jurisdictions, including the United Kingdom, South Africa, British Columbia, Ontario, Alberta, and those under the *Canada Labour Code*. None has schemes as detailed as that of the United States or as outdated and skeletal as those of Nova Scotia.

I have a preference for the approach illustrated by the U.S. regime. It sets out, in great particularity, the requirements for ground control, as well as other areas, so that operators know the regulatory environment in which they will operate. This may be troublesome at the outset, but on balance it may be preferable to wide discretionary powers exercisable by the regulatory official or body. Section 159 of the *Coal Mines (CBDC) Occupational Health and Safety Regulations* requires the mine operator to "prepare a plan of strata control for any proposed underground workings of a coal mine that is designed to prevent the collapse of the roof and sides of those workings," after which the plan "shall be posted . . . in such a manner that it is readily available for examination by employees."[78]

RECOMMENDATIONS

Planning, Equipment, and Materials

43 **A legislative regime should be put in place to ensure regulatory involvement in all areas of ground control in which safety is a consideration. The regime should encompass planning approval, materials and equipment certification, and any other aspect of ground control having safety implications.**

[78] SOR 90-97.

44 The regulations should specify the following at a minimum:

(a) Ground control plans and any revisions to those plans should be prepared by the mine operator and submitted to the regulator for approval prior to the implementation of any such plans.
(b) The ground control plan should show the existing geological conditions and the mining system to be used. The plan should also indicate any unusual hazards and outline the manner in which these will be handled.
(c) Approved plans should be available to miners and other underground workers and should be posted in the mine at the area affected by the plan.

(d) What the plan is required to specify should be set forth by the regulator from time to time, and should include:

(i) a columnar section of mine strata;
(ii) planned width of openings and size of pillar (if required);
(iii) thickness of seam;
(iv) method of support to be used;
(v) type, sequence, and spacing of support materials;
(vi) requirements for temporary roof support systems; and
(vii) type and thickness of strata in the roof and in the floor for a depth of 3 m below the coal bed.

(e) The regulator may require further and better information on the plan and may require that the plan be reviewed by a qualified specialist in rock mechanics.
(f) The regulator may require revisions to the plan at any time if satisfied that conditions or accident experience indicate that such revisions are necessary or conducive to safety.
(g) The ground control plan should be reviewed at least once every six months by the regulator.
(h) The mine operator should record on the plan and report to the regulator any unplanned fall of roof or rib or any significant rock burst (more than 0.3 m in thickness) that occurs above the bolt anchorage area, impairs ventilation, impedes the passage of persons, causes injury to miners, or causes miners' withdrawal from the area, or that disrupts activities for more than one hour.
(i) All roof control materials should conform with standards as established by various testing agencies such as the Canadian Standards Association (CSA) or the American Society for Testing and Materials Specifications (ASTMS). In the absence of standards, such materials could be approved by the regulator.
(j) The regulator should from time to time issue directions, such as found in 30 CFR 75.204, respecting the use of roof bolts, torquing requirements for roof bolts, and testing requirements for roof bolts and for other types of roof support systems.
(k) All entries and drives where roof bolting is the main means of roof support should have imbedded warning devices that monitor any downward movement in the roof strata. Such warning devices should be of a type approved by the regulator and should be placed at intervals specified on the plan. Installation of such devices should not relieve the operator from making regular inspections as prescribed.

(The type of device referred to here is that generic category in which the "tell-tale" extensometer – the simple mechanical gauge produced at the CANMET Coal Research Laboratory in Cape Breton – would be included.)

Internal Expertise

45 The legislation governing coal mines should be revised to ensure that every underground coal mine operator be required to engage, when required, the services of a qualified mining engineer with specialized post-graduate training in rock mechanics relating to coal mines.

46 The legislation and regulations governing coal mines should be reviewed to ensure that all personnel working underground receive training in ground control as appropriate to their activities and responsibilities. In particular,

(a) Coal miners should receive a course on ground control as part of their basic mine training, plus annual refresher courses on ground control.
(b) Mining supervisory staff, including mine managers, underground managers, and overmen, should receive extensive training in ground control.
(c) Non-mining personnel employed underground should receive sufficient training in ground control to enable them to recognize potential hazards.
(d) Training programs for these three categories of employee should be developed by mine management in cooperation with the joint occupational health and safety committee and the regulator. The regulator should review these training programs to ensure that they reflect changing technology and mining practices.

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