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/m^3] . . . 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

[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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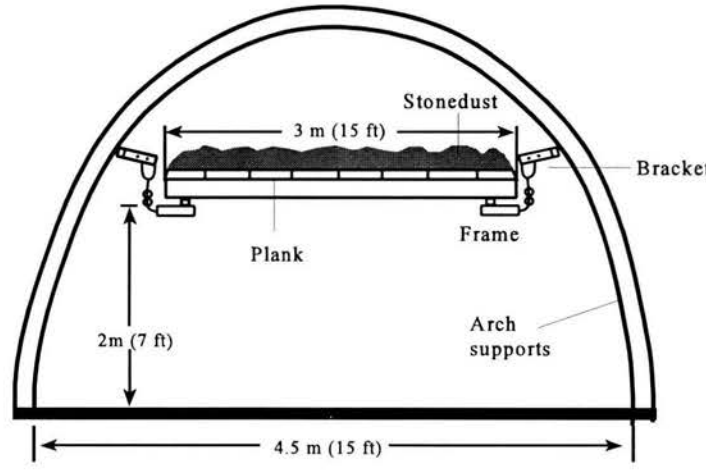
12 Brian Mountford and Associates Ltd, "Passive and Triggered Barrier Systems for Canadian Underground Coal Mining Conditions – Final Report" (Vancouver, BC: Brian Mountford and Associates Ltd, 1983) [Mountford Report], 1-4.

13 Mountford Report, 1-9.

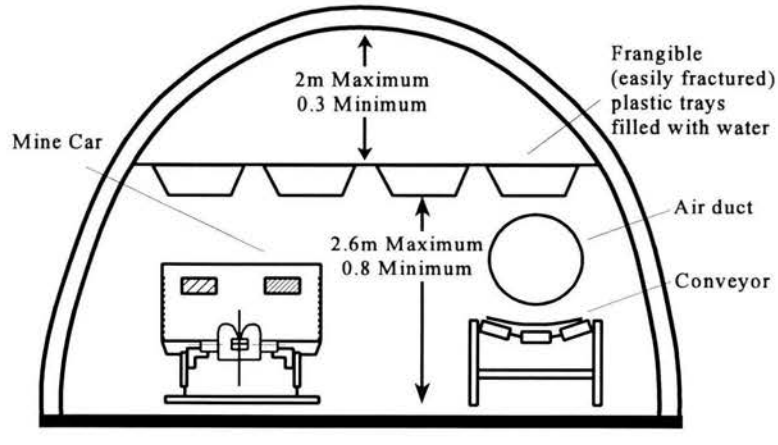
14 See the section on mine visits in Chapter 16, The Inquiry, for an account of my visit to the Skyline and other mines.

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

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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

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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,

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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

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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

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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

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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

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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

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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

[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.

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[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.