

DAY 13

NOVEMBER 28, 1995

WESTRAY MINE

PUBLIC INQUIRY

HEARD BEFORE: The Honourable Justice K. Peter Richard,
Commissioner

PLACE: Stellarton, Nova Scotia

COUNSEL:

Solicitor for the Commission: Mr. J. Merrick, Q.C., and
Ms. Ena MacDonald, document coordinator

Solicitor for the Department of Justice Canada: Ms. Lynn
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Solicitors for the Department of Justice Nova Scotia:
Messrs. R. Endres, Q.C., J. Traves, and Wm. Wilson, Q.C.

**Solicitor for the United Steelworkers of America and the
Nova Scotia Federation of Labour:** Mr. David Roberts

Solicitor for the Westray Families Group: Mr. B. Hebert
Representing the Town of Stellarton: Mr. John Murphy,
Town Councillor

Representing the Canadian Union of Public Employees: Mr.
Robert Wells

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1 November 28, 1995 - 9:33 a.m.

2 COMMISSIONER Good Morning.

3 ALL Good Morning.

4 COMMISSIONER Mr. Merrick?

5 MR. MERRICK Thank you, Mr. Commissioner. This morning
6 the witness will be Dr. Paul Amyotte.

7 **DR. PAUL ROBERT AMYOTTE**, sworn, testified as follows:

8 CLERK Please state your name and spell your last name
9 for the record.

10 A. Paul Robert Amyotte, A-M-Y-O-T-T-E.

11 EXAMINATION BY MR. MERRICK

12 MR. MERRICK Doctor, you hold a Doctorate in Chemical
13 Engineering?

14 A. Yes, sir.

15 Q. You're employed where?

16 A. At the Technical University of Nova Scotia.

17 Q. And you reside where?

18 A. In Dartmouth.

19 Q. Now you are not a mining engineer?

20 A. That's correct.

21 Q. You have had no practical experience in mines?

22 A. Correct.

23 Q. But you do have a specialty and an interest in dust
24 explosions.

25 A. Correct, sir.

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 Q. When did you first begin to examine and experiment
2 with dust explosions?

3 A. In about 1984 as part of my Ph.D. research, I
4 undertook a study of dust explosions in a particular type
5 of explosion vessel, specifically looking at the effects
6 of turbulence on dust explosions.

7 Q. What was the title of your thesis?

8 A. I believe it was something like "An Investigation of
9 Dust Explosions Using the Hartman Bomb."

10 Q. All right. Your resume, which is included in your
11 report which is Exhibit 54, lists a large number of
12 publications and papers and other activities that you've
13 been involved in. I notice that you have had specific
14 research funding provided for projects. Each of those
15 have dealt with dust explosions?

16 A. Yes, sir, that's correct.

17 Q. Just let me flip over and find this. This is on
18 page nine of your resume.

19 A. Yes.

20 Q. Tell me about those research contracts?

21 A. The three research contracts on page nine of my C.V.
22 are contracts which were awarded through the Coal
23 Research Agreement, the Committee on Atlantic Coal.
24 That's a funding program that's administered by the
25 Province. The partners in that are the Cape Breton

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1 Development Corporation, Nova Scotia Power, and the
2 Department of Natural Resources which administers the
3 funding. The former Energy Mines and Resources, now the
4 Federal Department of Natural Resources, is also involved
5 in that program. The first contract, the title as stated
6 is "An Examination of the Inerting Requirements of Coal
7 Dust/Air and Methane/Coal Dust/Air Mixtures," which was
8 done in conjunction with Cape Breton Development
9 Corporation.

10 We then did a second contract with Devco looking at
11 the Ignitability Characteristics of Coal Dust/Air and
12 Methane/Coal Dust/Air Mixtures. As a small part of that
13 work, we did some inerting tests looking at the effect of
14 rock dust particle size on the amount that you need to
15 inert a coal dust explosion.

16 And that led to the third contract which was
17 specifically on the examination of particle size, the
18 effects of the rock dust on coal dust explosion
19 suppression.

20 Q. These were all laboratory experiments?

21 A. That's correct, sir.

22 Q. Or testing, I take it. In addition, I notice in
23 your consulting work that two of your consulting tasks,
24 apart from for the Inquiry itself, have related to
25 hazards or characteristics of coal dust and methane

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 ignitions and explosions.

2 A. Yes, sir.

3 Q. I notice from your publications that a significant
4 number of them also relate to aspects of dust explosions,
5 in particular, coal dust explosions, that sort of thing.

6 A. Yes.

7 Q. I take it then that over the years since 1984 when
8 you became involved in this field that you have done a
9 considerable amount of experimentation and testing
10 relating to the explosibility of coal dust and the
11 inerting requirements for coal dust.

12 A. Yes, sir.

13 Q. I notice many of your papers have titles that relate
14 to that topic.

15 A. Yes.

16 Q. You are also a professional engineer registered in
17 the Province of Nova Scotia?

18 A. Yes, I am.

19 Q. Okay. You were retained by the Westray Public
20 Inquiry to first determine the concentration of dust that
21 would be necessary for a coal dust ignition or to sustain
22 a coal dust explosion.

23 Secondly, to determine the amount of incombustibles
24 required to inert coal dust and that would include
25 determining the impact of the presence of methane.

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1 And then, finally, to render an opinion to the
2 Inquiry as to, in your view, the appropriateness of the
3 present statutory regulations as far as the required
4 amount of incombustibles.

5 Is that a fair summation of your retention?

6 A. Yes, it is.

7 Q. Okay. Dealing with that, tell me what you did? You
8 began a series of tests.

9 A. The first thing we did was to -- We received a
10 sample of coal from the mine and prepared it into two
11 size fractions, both a fine fraction and a coarse
12 fraction. The particle size distributions are given in
13 the report. We considered it important to look at two
14 boundaries of particle size: very fine and very coarse.

15 We broke the work into two phases, and in the first
16 phase we looked at coal dust and methane. This was the
17 part of the study not dealing with rock dust suppression.
18 So we conducted a series of tests for both size fractions
19 of coal, explosion tests in our 20-liter chamber, looking
20 at initially, without methane, trying to determine the
21 maximum explosion pressure and rate of pressure rise as a
22 function of dust concentration, and then turning our
23 attention to the lean flammability limit or the minimum
24 amount of coal dust which would support an explosion. We
25 then repeated those tests with methane.

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 Q. All right, let me just stop you there for a moment.
2 The coal dust that you were working with was from the
3 Westray Mine itself?

4 A. Yes, sir.

5 Q. And you then divided it into two sizes or size
6 ranges for your testing. What were those sizes?

7 A. They're given in the report. They're actually
8 particle size distributions, dust. It's very unusual to
9 have a dust in which all the particles are one particular
10 size. So it's actually a particle size distribution
11 which are given in the report. The mean particle
12 diameter for the fine coal was 29 micron and for the
13 coarse coal, 250 micron.

14 Q. Now you said that you chose a coarse and a fine dust
15 to establish sort of perimeters, not necessarily the
16 range but the perimeters of your testing.

17 A. Yes.

18 Q. Why did you choose those particular sizes?

19 A. We didn't set out --

20 Q. Or size ranges?

21 A. To specifically produce 29 micron mean diameter and
22 250 micron mean diameter distributions. Based on our
23 experience with how long we had to crush and grind the
24 coal to produce a fine fraction and a coarse fraction, we
25 did that work. Our reason for choosing a fine and a

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1 coarse is because it's pretty much a standard in dust
2 explosibility testing to look at fine particle sizes and
3 coarse particle sizes simply because the particle size of
4 the dust has a significant effect on the explosibility of
5 the dust. And this is common practice and what's done at
6 the U.S. Bureau of Mines, and it's certainly been common
7 practice in our laboratory to look at different particle
8 sizes.

9 Q. And the particle size differences that you were
10 looking at here, would that be compatible with or
11 comparable with the sizes used by the United States
12 Department of Mines in their testing?

13 A. Yes, in the literature, there are data on the
14 particle size distributions used in both lab scale and
15 full scale mine testing at the U.S. Bureau of Mines. The
16 size distributions that we used in our work here are
17 comparable to the size distributions used by the U.S.B.M.

18 Q. And I assume that they would have been comparable as
19 well to the size distribution ranges that you would have
20 used in your Devco contracts.

21 A. Yes, the finer size fraction would be a little bit
22 finer than what we note to be or have seen as
23 representative size distributions from Devco, and the
24 coarse coal would again be representative of the contract
25 work we had done for Devco.

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 Q. All right. So that having divided the Westray coal
2 into these two size distribution groupings, you then
3 tested each of them to determine two specific
4 characteristics, I understand.

5 A. Yes.

6 Q. First, the maximum pressure that would be -- Let me
7 start with the first. First would be the rate at which
8 pressure would increase as that dust ignited or exploded.
9 Would that be a fair layman's summation of it?

10 A. Yes, very good.

11 Q. Some dusts have a fast rate of pressure increase,
12 some have a slower rate of pressure increase.

13 A. Correct.

14 Q. You also tested to see what that maximum pressure
15 would be once an explosion or ignition occurred.

16 A. Yes.

17 Q. Is that fair? Why would you test first to determine
18 those characteristics?

19 A. We could have done the lean flammability work first.
20 It's whether you do that first or you do the explosion
21 over pressure, rate of pressure, first is pretty much
22 just a matter of choice. I think what's more important
23 is why we felt we had to do the testing to determine the
24 maximum explosion rate and rate of pressure rise and that
25 was to put the dust we were dealing with in the context

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 of an international classification of dust explosibility,
2 first of all.

3 And, secondly, so we could determine the dust
4 concentration at which we saw the maximum explosion
5 pressure and maximum rate of pressure rise so that we
6 could use that dust concentration in the second phase of
7 the work dealing with the rock dust suppression.

8 Q. All right. With those objectives, tell me about
9 this international classification of dust? This would be
10 a classification system that applies to all kinds of
11 dust, including coal dust?

12 A. Yes, sir.

13 Q. Just describe it to me, what the rankings are and
14 how Westray coal ranked?

15 A. There is a parameter known as the K_{st} parameter.
16 Upper case "K" subscript "St," "St" being the first two
17 words [sic] of the German word for dust which is "staub."
18 That K_{st} parameter is obtained by multiplying the maximum
19 rate of pressure rise for dust by the cubed root of the
20 vessel volume in which the dust is being exploded.

21 Q. Okay, now you're going to lose me there. Tell me
22 basically --

23 COMMISSIONER I'm gone already.

24 MR. MERRICK Basically tell me what the categories are
25 as a result of that.

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 A. Okay.

2 Q. What are the ranking levels?

3 A. I just felt that it was difficult to tell you the
4 categories without telling you what the categories meant.

5 Q. Oh, I'm all for a shortcut this morning.

6 A. Okay. The categories are, you have an St1 dust and
7 St2 dust or an St3 dust, depending on the value of this
8 K_{st} parameter which depends on the maximum rate of
9 pressure rise.

10 Q. Do you also have an St zero?

11 A. You can have an St zero dust, which means that the
12 dust does not explode.

13 Q. Okay, and I take it, which is on the high end, if
14 you will, for rate of pressure rise and maximum pressure,
15 the St1 or the St3?

16 A. The St3.

17 Q. Okay, so that an St3 dust would have the highest or
18 the fastest rate of pressure rise.

19 A. In a given volume, yes.

20 Q. In a given volume.

21 COMMISSIONER Mr. Merrick, in striving to sort of
22 understand this in a way, can I equate the rising
23 pressure with a term that was used earlier on as a shock
24 wave?

25 A. Not directly, sir, I believe. The shock or pressure

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 wave that's advancing ahead of the flame front, the
2 strength of that will be dependent, I guess, in some way
3 on the maximum rate of pressure rise. It's probably a
4 better analogy is to draw -- to relate the maximum rate
5 of pressure rise to the speed with which the flame is
6 travelling.

7 Q. Okay.

8 A. So a higher rate of pressure rise would give you a
9 faster flame speed.

10 COMMISSIONER Okay, thank you.

11 MR. MERRICK All right, and how did you classify the
12 Westray coal based on the experimentation that you did?

13 A. Westray coal is an St1 dust. Both the fine and
14 coarse fractions without methane, and also as it turns
15 out, with methane.

16 Q. Now that surprises me a little because I would have
17 thought that coal dust was one of the ones that would be
18 considered more likely to explode. Now that must mean
19 that there's a distinction here on this St classification
20 that we have to have explained. The St classification
21 doesn't necessarily relate to how dangerous a dust is.
22 Is that a fair layman's statement?

23 A. It does in the sense that a higher St classification
24 means that the maximum rate of pressure rise is higher.
25 You're going to attain the maximum explosion pressure

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1 much faster in an industrial situation. Explosion relief
2 vents that you may design have to take that into account.
3 But what the St classification doesn't do is tell you
4 anything about the maximum explosion pressure that you
5 will eventually reach.

6 So it's a bit unfortunate that qualitative
7 descriptors added on to the St classification are
8 sometimes that an St dust is a weakly explosible dust and
9 St2 is moderately explosible and an St3 is strongly
10 explosible. The fact remains that there are many, many
11 dusts. There are far more St1 than St2 than St3 dusts.
12 The St1 dust are hazardous, a significant hazard on their
13 own.

14 Q. And I take it that the St rating does not
15 necessarily indicate that it isn't easily ignited.

16 A. No.

17 Q. All right. All that rating does is talk about the
18 rate of pressure rise.

19 A. That's correct, sir.

20 Q. Nor does the St ranking indicate that coal dust
21 cannot, once ignited and once the pressure does rise,
22 still have high pressures.

23 A. No, not at all. Certainly the explosion pressures
24 that we measured, although the Westray coal dust is an
25 St1 dust, the explosion pressures were of the order of

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 seven to eight bar.

2 Q. So that would be, and we're talking there in general
3 terms about the violence of an explosion that could be
4 created by that dust.

5 A. Yes, sir.

6 Q. And coal dust, even though ranked as St1, can be as
7 violent as many other dusts.

8 A. Yes, sir.

9 Q. Okay. So that having tested to determine those two
10 characteristics, first to classify the dust, and we'll
11 come second in a few minutes as to how you use that
12 information in the latter test. Did you then repeat that
13 test using the presence of methane?

14 A. Yes, we did.

15 Q. What presence of methane?

16 A. We chose a methane concentration of 2.5 percent
17 methane by volume in air.

18 Q. Why did you choose that?

19 A. It's my understanding the provincial mine
20 regulations require that at that concentration of
21 methane, men be evacuated from the mine. So there's
22 something very significant about that concentration of
23 methane in terms of the regulations. In the past, we
24 have done tests with one percent methane, two percent
25 methane. I suppose we could have just as easily have

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1 chosen those. But two and a half percent methane, I
2 believe, gives us a reference point to the mining
3 regulations and also is a significant enough methane
4 concentration that we can clearly see the difference
5 between what happens with methane and without.

6 Q. All right. And just dealing solely with the tests
7 that indicated the rate of pressure rise and the maximum
8 pressure achieved, what happens to the same particle size
9 of dust when you add methane?

10 A. When you add methane, if we look first at the
11 maximum explosion pressure that's achieved, the effect of
12 methane in a laboratory scale test is to attain virtually
13 the same or nearly the same maximum explosion pressure as
14 you had without methane present, but you reach that
15 maximum explosion pressure at a lower dust concentration.

16 Q. So it takes less coal dust, and I'm going to put
17 this in layman's terms again, it will take less coal dust
18 to achieve the same violence of explosion, if you have
19 methane present.

20 A. That's correct, sir.

21 Q. All right. Incidentally, just before I go on, when
22 you did this testing between the fine dust and the coarse
23 dust without methane, was there a distinction between the
24 two as far as rate of pressure rise and maximum pressure?

25 A. Yes. If I can just refer in my report -- Do you

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1 want the page number that I'm referring to?

2 Q. Yes, please, that would be of assistance to us
3 later.

4 A. On page 32.

5 Q. This is under Tab 3 of your report, I believe.

6 A. Yes, Tab 3, page 32.

7 Q. Yes.

8 A. Figure 4.5 which shows the effect of coal particle
9 size on PM, the maximum explosion pressure, and the
10 $(dP/dt)_m$ the maximum rate of pressure rise with no
11 methane present. And you can see in the upper plot for
12 the coarse coal, you have a somewhat lower maximum
13 explosion pressure being achieved, but I wouldn't call
14 that a significant difference between -- or too
15 significant a difference between the coarse and fine
16 coal.

17 In the lower plot, you can see that we have
18 approximately in the peak region of the curve there about
19 a 100 bar per second difference between the rates of
20 pressure rise that you can generate without methane and
21 with methane. So there is a significant effect there.

22 Q. Are both those charts showing us a dust without
23 methane?

24 A. Yes, they are, sir.

25 Q. Okay. And I take it then that as a general

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 statement, fine coal dust will have a somewhat faster
2 rate of pressure rise and a somewhat higher maximum
3 pressure.

4 A. Yes.

5 Q. Again, putting it in layman's terms, it would tend
6 to be somewhat more violent an explosion.

7 A. Yes, sir.

8 Q. All right. And when you then added methane in the
9 concentrations that you've told us, you said that you
10 would now get your maximum pressure with a lesser amount
11 of coal dust. Was there the same distinction between
12 coarse dust and fine dust with methane?

13 A. That's why I'm looking for that plot, sir. I know
14 it's in here somewhere. Back on -- Actually we've shown
15 them separately on pages 29 and 30, Figures 4.3 and 4.4.
16 4.3 shows only the fine coal and that simply is
17 illustrating the effect of methane addition.

18 COMMISSIONER Doctor, would you refer to paragraph
19 numbers because the pages in my copy don't seem to have
20 reproduced, if I have the right --

21 A. Okay, sir, I'm referring --

22 COMMISSIONER I'm at Exhibit 54. Is that where I should
23 be?

24 A. Yes.

25 COMMISSIONER Okay.

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 DR. AMYOTTE I believe probably the figure that will
2 better address your question, Mr. Merrick, is Figure 4.6
3 on page 33.

4 MR. MERRICK It would be following the last piece of
5 text on paragraph 4.1.2. It's about four or five pages
6 past that.

7 COMMISSIONER I have Figure 4.6, yes.

8 MR. MERRICK Okay.

9 A. Yes. I'm sorry, if you can repeat the question?

10 Q. Yes. Did the presence of methane -- Was the
11 distinction between coarse and fine coal dust, the fine
12 coal dust achieving a slightly somewhat higher rate of
13 pressure rise and a somewhat high maximum pressure, was
14 that same distinction observed when you added methane?

15 A. Yes, you can see that. It's not really, I don't
16 think, as significant without the methane present, but
17 you can see that in Figure 4.6 in the peak region of the
18 bottom curve for the maximum rate of pressure rise.

19 The top one shows that at higher concentrations,
20 once you've reached the peak explosion pressure, and then
21 you go to higher concentrations, there's a bit of a
22 reversal there where the coarser dust is showing a little
23 bit more or a slightly higher explosion pressure than the
24 finer dust.

25 Q. I take it that from your other testing and in your

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1 other testing you've done somewhat similar tests or
2 experiments using different levels of methane, have you?

3 A. Yes, sir.

4 Q. And is it a fair conclusion then to draw that this
5 kind of phenomenon is probably applicable at even lesser
6 amounts of methane?

7 A. I would say yes, although because of the inherent
8 variability when you're doing a lab scale dust explosion
9 test, it's difficult sometimes, I'd say a one percent
10 methane level, to decide whether what you're seeing is
11 really a true effect of the physics and chemistry of
12 what's happening or if it just isn't an artifact of the
13 repeatability of the experiment. Certainly at two
14 percent, two and a half percent, you can demonstrate
15 quite clearly that the effect of methane is significant
16 in terms of the explosibility of coal dust.

17 Q. But as a general statement, are you satisfied that
18 the presence of methane in the general body of air that
19 is involved in a coal dust ignition will tend to cause
20 the coal dust to explode at lower concentrations of dust?

21 A. Yes, sir.

22 Q. And that as a general statement, finer dust is,
23 using a layman's term, somewhat more dangerous than
24 coarse dust.

25 A. Definitely, sir.

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 Q. All right. So that's the results from this first
2 series of tests that you did dealing solely with the rate
3 of pressure rise and the maximum pressure.

4 A. Yes, sir.

5 Q. With and without methane. Now the next series of
6 tests, as I understood you, you were going to try to
7 establish how much coal dust you actually needed, both
8 fine and coarse, for there to be a dust explosion.

9 A. Yes, sir.

10 Q. Tell me about those tests.

11 A. What we did in that case was we started at a
12 concentration, we knew, I believe, the lowest 200 grams
13 per cubic meter was the lowest dust concentration that we
14 tested in the explosion over pressure and rate of
15 pressure rise tests. We then dropped back in
16 concentration to the vicinity of 100 grams per cubic
17 meter and tested and established whether an explosion
18 would happen or not. We then decreased the coal dust
19 concentration in increments until we reached a point
20 where an explosion did not occur, and then we did replica
21 testing around that area to determine what the lean
22 flammability limit or minimum explosible concentration
23 was.

24 Q. All right, and tell me what you determined as far as
25 the amount of dust that would be required in order to

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 permit a coal dust explosion to occur. Now you did this
2 first without methane?

3 A. Yes, sir.

4 Q. So what were your results without methane?

5 A. For the fine coal dust without methane, we found a
6 lean flammability limit of 80 grams per cubic meter.

7 Q. Okay, and what about for the coarse dust?

8 A. For the coarse coal dust, the lean flammability
9 limit was 100 grams per cubic meter.

10 Q. So that, again, fine dust seemed to be able to
11 sustain a dust explosion with less dust.

12 A. Yes, although the actual amounts of dust involved at
13 those low concentrations is very small.

14 Q. Now that's what I want to try to get in my head is
15 just how much dust are we talking about? If you were to
16 take that dust and let it settle out into a layer on the
17 surface of whatever volume you're dealing with, how thick
18 a layer would that be?

19 A. It would probably be, if I can refer to -- I'll just
20 check here.

21 Q. You're now referring to Exhibit 36-B.

22 A. Yes, 36-B, Tab 3. Using the equation given very
23 near the end of the document, the final report, in fact,
24 on page five.

25 Q. Now that volume has not got exhibit page numbers,

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 but the last yellow tag or last yellow divider.

2 A. Right.

3 Q. Is the report that you're referring to.

4 A. Yes, sir.

5 Q. And then that report has its own page numbers. So
6 it's page five of that report.

7 A. Yes, sir.

8 Q. Yes?

9 A. On that page, you see an equation for calculating
10 the height or the thickness, rather, of a dust layer
11 corresponding to a given assumed height of the enclosure,
12 dust concentration, and bulk density of the dust. At the
13 lean flammability limit of, say, 80 grams per cubic
14 meter, you would have to assume a bulk density, and I've
15 assumed several bulk densities here. I think a
16 reasonable bulk density would be 800 kilograms per cubic
17 meter, bulk density of the coal dust and for a height of
18 three meters, a three-meter enclosure, the thickness of
19 the layer is .3 millimeters.

20 Q. So it's less than half of a millimeter

21 A. Less than half a millimeter, yes, sir.

22 Q. And if you were to change the size of the area that
23 that dust would be dispersed in once it was dispersed, it
24 would still remain, I assume, somewhere within those
25 general perimeters of less than a meter?

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1 A. Yes, sir. If you doubled the height, you would
2 double the thickness layer to .6 millimeters. If you
3 tripled the height, you would triple the thickness to .9
4 millimeters, still less than one millimeter.

5 Q. Yeah. So that whatever area we're talking about,
6 the amount of fine coal dust needed to initiate a coal
7 dust explosion is an extremely thin layer of coal dust?

8 A. Yes, sir.

9 COMMISSIONER Would that be recognizable in suspension
10 in the air?

11 A. There's a rule of thumb that I recall reading in a
12 test by one of the key workers in this area. It goes
13 something, sir, like a distance of one meter through a
14 dust cloud of about 60 grams per cubic meter, at a
15 distance of one meter if you had, I believe it's a 40-
16 watt light bulb, you would barely be able to see the
17 bulb.

18 COMMISSIONER I see. Okay, thank you.

19 MR. MERRICK That sounds consistent with other
20 descriptions like that we've had from previous witnesses.
21 Now so that is the amount of coal dust that would be
22 needed to sustain a coal dust explosion. Now that -- and
23 you've compared it to us for the layer. That layer or
24 that amount of dust would be the minimum amount needed --

25 A. Yes, sir.

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 Q. -- is that right? Is there a maximum amount of dust
2 that can be involved in a coal dust explosion?

3 A. One of the fundamental differences between dust and
4 gases is in the upper flammability limit or the rich
5 limit. For a gas, for example, for methane, the upper
6 limit is 15 percent by volume methane, as you know. For
7 dust you have -- you can go to extremely high
8 concentrations and still get an explosion, several
9 thousand grams per cubic meter and still have an
10 explosion. It's somewhat an area of debate in the dust
11 explosion research world as to whether the upper limit
12 exists. Eventually, of course, you would reach a point
13 where you can't disperse all of the dust and therefore
14 you wouldn't have an explosion. But pneumatic conveying
15 systems, for example, it's assumed there that the dust
16 loading is so high that you're above that upper limit.
17 You don't know what the upper limit is. It's just that
18 there's so much dust in there you must be above it. So
19 you can go to very high coal dust concentrations --
20 concentrations of airborne coal dust and still sustain an
21 explosion.

22 Q. Taking the numbers that you've give me though,
23 assuming for the moment that that may be the maximum, how
24 thick a layer would that be?

25 A. Well, I would have to work through the calculations,

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1 I guess. If you took a concentration of, say, not 800 --
2 or, sorry, not 80 grams per cubic meter but 8,
3 multiplying that by 100, that's 8,000 grams per cubic
4 meter. That's getting up there. That would be of the
5 order of 30 millimeters thickness. I -- there's another
6 thing that comes into play though, that although you may
7 have all of this dust, you can still get a dust
8 explosion; not all of that dust is going to burn.
9 There's only so much oxygen available in the environment
10 or in the atmosphere. The only dust that can burn is the
11 dust that will consume that oxygen. Once the oxygen is
12 consumed, the remaining dust will not burn.

13 Q. So that it's somewhere below that, as far as the
14 maximum dust that would be involved in a post-explosion?

15 A. Yeah, that would be -- that would actually be
16 involved in the combustion, yes, sir.

17 Q. And I'm trying to just get a layman's perspective on
18 this, but if the maximum amount of dust that could be
19 involved in a dust explosion would form a layer, give me
20 a rough estimation? A quarter of an inch?

21 A. I would say you're probably talking about dust
22 concentrations of somewhere in the range of 400 grams per
23 cubic meter which would be about five times the lean
24 limit. So five times .3 millimeters, about 1.5
25 millimeters.

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1 Q. And which is -- I have to keep going back to the
2 old --

3 A. Let me see. 1.5, there's --

4 Q. Well, in any event --

5 A. That's .15 centimeters and there's 2.5 centimeters
6 in an inch, so it's substantially less than an inch. I
7 mean, you're talking very thin layers again.

8 Q. So that -- and let me put this in layman's terms, so
9 that if you've got any more dust on a roadway than about
10 a half an inch, you've got way more dust than you can
11 even explode?

12 A. Yes, sir.

13 Q. So if we've got anecdotal evidence that there was
14 six inches of dust or dust up around your ankles, you've
15 got way more dust than is certainly needed to initiate a
16 dust explosion and way more dust than can even be
17 involved in a dust explosion?

18 A. You've got way more dust than would be needed to be
19 raised up into suspension and support a self-sustaining
20 coal dust explosion, yes, sir.

21 Q. And I guess the key thing that's coming out of this
22 evidence then is that it's making it, for me at least,
23 very graphic as to the relatively small amounts of dust
24 that you really need to have the hazard of a coal dust
25 explosion?

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1 A. Yes, sir.

2 Q. You don't need six inches of coal dust in that
3 roadway. All you need is that very thin layer?

4 A. Yes, sir. In fact, to get six inches of coal dust
5 up into suspension and have it all combust and burn, the
6 only way I can see that happening is if you had lots of
7 continual oxygen coming in. It's a very thin layer that
8 corresponds to the amount of airborne coal dust. If that
9 layer gets raised up in suspension and becomes airborne,
10 that is a very thin layer to take you up to the
11 concentration of coal dust in suspension which would
12 consume all of the available oxygen.

13 COMMISSIONER Excuse me. Mr. Merrick, I just wanted to
14 not correct but clarify a point that might come out a
15 little bit different in the evidence than as, you know,
16 on the written word. And that is Mr. Merrick presented
17 or posed a question that only so much dust on the floor
18 of the mine would be flammable, indicating that if there
19 was -- you know, you could indicate from that that if
20 there was more than that it would sort of become
21 automatically inflammable. But the point is that if you
22 have six inches, only the first millimeter will go up, in
23 any event? Is this --

24 A. I'm not sure that it would only be the first
25 millimeter --

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1 COMMISSIONER Well --

2 A. -- that would go up, sir. Or, you know, what the
3 portion of the dust that would be raised I think would
4 be --

5 COMMISSIONER That's sustainable --

6 A. -- depending on the --

7 COMMISSIONER -- by the oxygen? That's --

8 A. Yes.

9 COMMISSIONER Yeah.

10 A. Yes.

11 COMMISSIONER Sustainable by -- so the ratio is not the
12 thickness of the coal dust on the floor of the mine, but
13 that little measure of coal dust which would be -- which
14 would feed on what oxygen was available in the mine?

15 A. Yes, sir.

16 COMMISSIONER Yeah, okay. I don't know if that
17 clarified or confused things.

18 MR. MERRICK Yes. Well, the point that is driven home
19 to me is that when we are assessing the degree to which
20 there was a coal dust hazard in that mine, we don't have
21 to be looking for an awful lot of coal dust for there to
22 be that hazard?

23 A. No, sir. The hazard would exist at a measure of
24 dust -- a lean limit of 80 grams per cubic meter. The
25 hazard would exist, assuming that the height is three

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1 meters and the bulk density is about 800 grams per cubic
2 meter, the hazard exists with a layer that is less than
3 one millimeter thick.

4 Q. Now I know that you took your height of three meters
5 from information that was given to you by the RCMP.

6 A. Yes, sir.

7 Q. If indeed the roadways in this case were higher than
8 that, perhaps as high as 18 feet in places, would that
9 significantly change the quantities that you're talking
10 about?

11 A. If you had around 18 feet, say. It's not six meters
12 but it's close enough, you're doubling the height, you're
13 doubling the layer of thickness to .6 millimeters, still
14 well under one millimeter.

15 Q. Okay. Now so that was the results of your tests on
16 the two particle sizes of coal dust to determine how much
17 it would take to sustain an explosion. You then went
18 back and did the same series of tests with methane
19 present?

20 A. For the fine coal dust, sir, yes.

21 Q. Yes. And this was the same level of methane?

22 A. 2.5 percent by volume.

23 Q. And what were your findings as to the amount of dust
24 required once you had methane present in that
25 concentration?

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1 A. The -- for the fine coal dust, the lean flammability
2 limit was decreased from 80 grams per cubic meter to 30
3 grams per cubic meter when the atmosphere contained 2.5
4 percent methane.

5 Q. So that with that concentration of methane, you
6 needed less than half the original amount of coal dust to
7 sustain a coal dust explosion?

8 A. Yes, sir.

9 Q. Now you say that you did that test only with the
10 fine coal dust.

11 A. Yes, sir.

12 Q. Why did you only do the fine coal dust?

13 A. We wanted to see what the effect -- well, it's a
14 well-documented occurrence that methane addition will
15 lower the lean flammability limit, and we wanted to
16 demonstrate for the fine coal dust what that would be.
17 We can also predict by a predicted equation, by weighting
18 the lean limits of the coal dust and the methane, what we
19 would get, and we didn't see the need to do it for the
20 coal dust. We know it's going to be about a half of 100
21 grams per cubic meter, approximately 50 or so. It's
22 going to be less.

23 Q. For the coarse dust as well?

24 A. Sorry, for the coarse dust in the presence of
25 methane.

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1 Q. Yes. In fact, your report I think refers to the
2 formula that allows you to do the analysis for the coal
3 dust by the formula rather than by actual testing?

4 A. Yes, sir.

5 Q. Okay. But that's a significant impact of the
6 presence of methane, that amount of methane?

7 A. I agree.

8 Q. Explain to me, if you would, why methane would have
9 this effect?

10 A. The generally accepted method by which coal dust
11 explodes is the heating of the coal particles and the
12 release of the volatiles. And it's actually the
13 volatiles that are burning, so you have gas phase
14 combustion.

15 When you add methane, what you're doing is directly
16 adding a volatile. You're adding a gas which then mixes
17 with the volatiles being released from the coal and
18 allows you attain a concentration of volatile matter at a
19 lower coal dust concentration, a concentration of
20 volatile matter that will in fact combust.

21 Q. So it's -- and, again, this is very simplistic, but
22 it's the equivalent of adding a lot more coal dust? Very
23 simplistic.

24 A. That would be one way to look at it although the --
25 yeah, I guess so. It's just the direct addition. Adding

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1 more coal dust or adding solid matter, you still have to
2 go through the volatiles being released. The direct
3 addition of methane is a more effective way to get to a
4 more explosable mixture. But I guess, on balance,
5 simplistically, yes, that's what you said.

6 Q. But your answer -- I don't want to bring the world
7 down to too simple terms --

8 A. No.

9 Q. -- your answer though has led me to an observation
10 that I would ask you to comment on. Would we be correct
11 in -- let me back up. We've talked over the last three
12 weeks and some about a methane ignition then propagating
13 into a coal dust explosion. And in our minds we've seen
14 that there's been first a gas explosion and then a dust
15 explosion.

16 But from your answer you've told us that really
17 what's happening in a coal dust explosion is that the
18 volatile elements of the coal dust, the entrapped
19 methane, propane, any other volatile components are
20 really expelled and they burn. To what extent does the
21 dust itself burn?

22 A. That's a matter of a bit of debate, I guess. In
23 laboratory scale tests it's generally accepted that the
24 residence time or the time in which the explosion is
25 occurring is so short that there is virtually no time for

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1 heterogeneous combustion, for the solid coal particles to
2 burn much.

3 I've seen evidence, full-scale mine testing done at
4 the U.S. Bureau of Mines, where they've tried to examine
5 the post-explosion residue and see, well, was there much
6 of this heterogeneous combustion of the coal dust solid
7 particles themselves burning once the volatiles had been
8 released. It's somewhat inconclusive. I think on the
9 lab scale you can say that the solid particle -- there's
10 not much solid particle burning.

11 In a full-scale scenario though, I think you can say
12 that there is certainly more potential for a longer
13 residence time and some burning of the solid particles
14 remaining behind the flame front once the flame is past.

15 Q. So that while it's hard to determine how much of the
16 solid portion of the coal dust actually will be consumed
17 in the explosion, in reality when we talk about a coal
18 dust explosion, a significant portion of it really is
19 still the burning of the gas --

20 A. Yes, sir.

21 Q. -- given off by the dust?

22 A. Yes, sir.

23 Q. So it's still, in one sense of the term, a large
24 portion of it is still a gas explosion?

25 A. I've never heard it put in that sort of way. I

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1 think you still have to recognize that the source of fuel
2 is the coal dust involved, is the solid matter.

3 Q. Yeah.

4 A. You can then get into, well, what happens, how does
5 the dust actually explode. And different dusts will
6 explode in different ways. You can look at metal which
7 perhaps melt first and then vaporize and then begin to
8 burn and explode. So, again, you're looking at more --
9 sort of a gas-type phenomenon. The fact remains that
10 it's the coal dust itself which is the source of the
11 combustible material.

12 Q. All right.

13 COMMISSIONER Just a sec. Just if I pursue that just a
14 moment, Doctor. You said earlier that the explosion
15 occurs so rapidly that it's not possible to burn off the
16 solids. Is this -- would the residue be what has been
17 referred to by others as "coking?"

18 A. Yeah, I've heard that term as well. And I think
19 that's probably a good description of it.

20 COMMISSIONER Okay.

21 A. When I'm talking about there not being enough time,
22 I'm saying in our laboratory scale tests where, you know,
23 our vessel volume is like that, it's 20 liters, the
24 explosion is over in 1/10th of a second.

25 COMMISSIONER Yeah.

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1 A. So there isn't significant time. If you look at the
2 residue that's left, which you clearly see after an
3 explosion, are very rounded fused type particles with
4 evidence of what are known as blowholes where the
5 volatiles have been emitted.

6 COMMISSIONER Yeah. And that's coke?

7 A. Yes, sir.

8 COMMISSIONER Basically? Yeah.

9 A. Yes.

10 COMMISSIONER Okay, thanks.

11 A. My understanding.

12 MR. MERRICK But the amount to which the solids will be
13 burned or not will depend on the particular circumstances
14 in a particular explosion?

15 A. Yes.

16 Q. Some will be burned more, some will be burned less?

17 A. I think that's an accurate representation.

18 Q. All right. So that's -- that explains to us why
19 methane has this effect on coal dust and the likelihood
20 of the dust or the limits at which the dust will ignite
21 and explode. Now that completed, I take it, the testing
22 for phase one of your study for the Inquiry?

23 A. Yes, sir.

24 Q. The second phase was to examine and determine the
25 amount of stone dust that would be required to add to the

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1 coal dust in order to prevent an explosion occurring?

2 A. Yes.

3 Q. And, again, how did you carry out that test?

4 A. In these tests we fixed -- based on the results that
5 -- from the first phase of testing, we fixed the coal
6 dust concentration at 500 grams per cubic meter because
7 for all of the conditions with methane or without methane
8 in Phase One, at that concentration we had seen the
9 maximum explosion pressure and rate of pressurize. So
10 500 grams per cubic meter represented -- was a measure of
11 a very hazardous dust concentration. That corresponds in
12 our laboratory chamber to 10 grams of coal dust being
13 used in each test.

14 We then prepared coal dust, dolomite, rock dust
15 mixtures, starting at 50/50 mixtures. So we had 50
16 percent of the mixture was coal dust, 10 grams. 50
17 percent was rock dust, 10 grams of rock dust. We would
18 mix them together, disperse them into the chamber and
19 ignite. We would then increase the dolomite percentage
20 in increments of 10 percent going from 50 to 60 to 70 and
21 so on until we did not get an explosion. And we would
22 then narrow down that range. So if we had an explosion
23 at 70 percent dolomite and we didn't at 80, we then did a
24 test at 75 percent dolomite to determine a five percent
25 band in which we could pin down the inerting level. We

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1 did those tests for the fine coal with and without
2 methane and for the coarse coal with and without methane.

3 Q. And as a result of those tests, you came up with
4 percentages needed under each of those scenarios. And
5 just before we take you to that I notice that your
6 results are broken down to show the amount of stone
7 dusting needed as opposed to the total amount of
8 incombustibles. Explain to me that distinction.

9 Q. The distinction is that the dolomite percentage is
10 just that, it's the percentage of rock dust in the rock
11 dust/coal dust mixture. The total incombustible content
12 is now taking the dolomite, the ash in the coal, and the
13 moisture in the coal as being inert material and
14 expressing those three components as a percentage of the
15 total solids mixture.

16 Q. So that the -- and we've already heard evidence on
17 this, that coal has a certain amount of incombustible
18 content in it --

19 A. Yes, sir.

20 Q. -- which acts as -- an incombustible acts as a
21 dampening effect on an explosion?

22 A. Yes.

23 Q. So that to know the amount of stone dust -- sorry,
24 to know the amount of total incombustibles to inert coal
25 dust, you have to know how much incombustibles you're

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1 starting with in the dust itself?

2 A. I would agree with that.

3 Q. And I assume that to do that you would have to sam -
4 - to be as accurate as possible, you would have to sample
5 the particular coal from the particular coal seam?

6 A. Yes, sir.

7 Q. And you did that with Westray coal?

8 A. Yes, we tested a sample, as received. I believe it
9 had come from the vicinity of No. 10 Crosscut.

10 Q. That was provided to you by Mr. Smales on behalf of
11 the Inquiry?

12 A. Yes, sir.

13 Q. And how did you analyze what the incombustible
14 content of Westray coal was?

15 A. We produced the fine and coarse fractions of the
16 coal dust and then had the Minerals Engineering Centre at
17 TUNS do a proximate analysis on each of the samples. And
18 that proximate analysis gives you the percentages of
19 moisture, ash, volatile matter, and fixed carbon.

20 Q. And do you have that broken down for us?

21 A. Yes, sir. Exhibit 54 under Tab 3, page 7 which is
22 the page after Section 2.2.

23 COMMISSIONER Proximate analysis of coals?

24 A. Yes, sir. Table 2.3.

25 COMMISSIONER Uh huh.

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1 A. And they did duplicate testing on the samples that
2 we have provided them and the ash and moisture
3 percentages are given as 21.6 percent ash for the fine
4 coal and 26.4 percent ash for the coarse coal.

5 MR. MERRICK So what they did, I assume, is take an
6 average of the two samples in each category?

7 A. Yes, sir.

8 Q. All right. And so that the second two -- last two
9 columns that show "25.4" and "51.8," one of them is
10 identified as "volatiles," the other one is "carbon."
11 Both of those are combustible components?

12 A. Yes, sir.

13 Q. All right. This is an important figure because I
14 believe that your report as to the amount of
15 incombustibles in Westray coal was also used by a couple
16 of the other consultants that have already testified
17 here. All right. So using that as the proximate -- now
18 what do you mean by "proximate" analysis?

19 A. I'm not sure exactly. It doesn't mean approximate.
20 It's a different -- you do a proximate analysis or an
21 ultimate analysis. And ultimate analysis gives you a
22 breakdown of all the elements, carbon, hydrogen,
23 nitrogen, oxygen and so on. It's very specific.

24 This type of analysis is somewhat more general. It
25 doesn't tell you what those volatiles are or really what

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1 that fixed carbon is.

2 Q. Okay.

3 A. It just allows you to -- primarily, what it's, to
4 me, is of use of or for is in determining what the ash
5 content is.

6 Q. All right.

7 COMMISSIONER But not total? Sorry.

8 A. I would say it's accurate within itself, sir. But
9 it --

10 COMMISSIONER Yeah.

11 A. -- it can't tell you, for example, what percentage
12 of hydrogen is in the coal.

13 COMMISSIONER Okay.

14 A. To do that you would need an ultimate analysis.

15 MR. MERRICK Yes, all right. So that using that as a
16 starting point, you then describe to us how you would
17 attempt to initiate explosions adding more and more stone
18 dust.

19 A. Yes, sir.

20 Q. And narrowed it down to within that band of five
21 percent. What were your results without methane?

22 A. Without methane -- do you want the rock dust
23 percentage or the incombustible?

24 Q. Well, are you reading off a table?

25 A. Yes, sir.

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1 Q. Where is that?

2 A. It's Table 4.3. Again, Exhibit 54, Tab 3, page 43.

3 COMMISSIONER Table 4.3?

4 A. Yes, sir.

5 COMMISSIONER Okay, that was lucky. Dolomite inerting
6 requirements?

7 A. Yes. The -- for the fine coal, in the absence of
8 methane, the percentage rock dust is 79 percent or 84
9 percent total incombustible.

10 MR. MERRICK Yes.

11 A. For the coarse coal dust, in the absence of methane,
12 the percentage of dolomite is 69 percent or 77 percent
13 total incombustible.

14 Q. And if I am understanding you then, again using my
15 layman's perspective, what we're saying is that for fine
16 coal dust, to prevent it from exploding, you would need
17 total incombustibles of 84 percent.

18 A. Under the conditions that we were testing, yes, sir.

19 Q. Yes. And of that 84 percent, some is already
20 supplied by the inherent amount of ash or incombustible
21 in the coal, but you've got to add 79 percent stone dust
22 to get to the total?

23 A. Yes, sir.

24 Q. And the same with the coarse?

25 A. Yes.

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1 Q. Okay.

2 COMMISSIONER Is there any relevance to the final
3 column, the inerting ratio, Mr. Merrick, or is that
4 premature?

5 MR. MERRICK I'm not sure. I didn't ask that question
6 in my preparation. I'll ask it now.

7 A. It's an alternate way, sir, of expressing the amount
8 of rock dust that you need to suppress. And the inerting
9 ratio is the ratio simply the mass of dolomite or rock
10 dust that you've added, divided by the mass of coal dust.
11 So what it tells you is that for the fine coal dust, you
12 need about four times as much rock dust as you do coal --
13 as you have coal dust. Or 3.8 times, actually.

14 COMMISSIONER I see, okay.

15 A. So if I had 10 grams of coal dust being dispersed,
16 to inert it I would need about 40 grams of added rock
17 dust. So it's a useful number in that sense.

18 COMMISSIONER Okay, yeah. I see that, yeah.

19 MR. MERRICK Now you then did the same series of tests
20 but this time using methane?

21 A. Yes.

22 Q. Okay. And what were the results with methane? I
23 assume they're here on the table, are they?

24 A. Yes, Table 4.3. For the fine dust at 2.5 percent
25 methane, we found 84 percent rock dust to inert or 88

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1 percent incombustible. For the coarse coal dust with 2.5
2 percent methane by volume, we found 76 percent added rock
3 dust or 82 percent in total incombustible.

4 Q. So, again, with methane in the air you're going to
5 need more incombustible material?

6 A. Yes.

7 Q. And I assume that one can draw a rough conclusion
8 from that that even at lower levels of methane than 2.5
9 percent, the same general phenomenon would probably exist
10 which would require greater attention to stone dusting?

11 A. I would say that's correct based both on what I
12 understand the mining regulations to say and also based
13 on the laboratory scale tests that we have done at lower
14 percentages of methane with other coal dust.

15 Q. Let me ask you this, how significant is the particle
16 size -- all right, let me back up and try -- start it
17 this way. You said in your introductory comments to me,
18 particularly when you were describing the Devco contracts
19 that you had, that you had done some experimentation as
20 to whether the particle size of stone dust made a
21 difference in the dampening effect of stone dust. Tell
22 me about that?

23 A. The third contract that we had done for Devco
24 involved examining the effect of rock dust particle size
25 on the amounts it needed to inert. We approached it from

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1 a fundamental perspective by preparing very narrow-sized
2 fractions of rock dust. Size fractions that you couldn't
3 produce commercially and use but, nevertheless, allowed
4 us fundamentally to look at the problem.

5 We also used broad-sized distributions of rock dust
6 such as are used in coal mines. We took the regular
7 grind of rock dust that Devco uses, sieved it a bit to
8 get an overall narrower size distribution, but
9 nevertheless a very broad-sized distribution. When we
10 tested with the -- in all cases, the finer-sized rock
11 dust, we found quite a significant effect on the amount
12 of rock dust that you need. If you go to a finer
13 particle size of rock dust, you need less mass of rock
14 dust to inert the same amount of coal dust.

15 Q. This is significant because this may be the basis
16 for recommendations as to the kind of rock dust that
17 should be used in mines. Because if there are different
18 degrees of safety, depending on the coarseness of your
19 rock dust, then that's something that's significant. Are
20 you aware of ongoing interest in this topic in other
21 mining circles, in particular in the States?

22 A. I'm aware that the people at the US Bureau of Mines
23 are certainly interested in this, and it's my hope that
24 they or someone may eventually do some full-scale mine
25 testing with finer-sized rock dust. We've shown this

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1 effect at the laboratory scale. It's my belief that what
2 is now needed is to do larger scale testing involving
3 fine rock dust or finer.

4 Q. Now help me with this: What you're saying is that
5 if you have a very fine grade of stone dust, you will
6 need less of it to inert coal dust.

7 A. Yes.

8 Q. Than you will of a coarser grade of rock dust.

9 A. Yes, sir.

10 Q. So you could actually still achieve your inerting
11 levels with less stone dusting if you're using a very
12 fine grade of stone dusting.

13 A. Yes, that would be one way to look at it. I think
14 another way to look at it would be to leave the inerting
15 level, the required inerting level where it is, go to a
16 finer size rock dust and, therefore, you may have an
17 increased margin of safety.

18 Q. All right. Now you gave me a very graphic example
19 last evening as to why finer grades of this rock dust
20 will have a greater dampening or inerting effect. Tell
21 me about that.

22 A. I hope I can remember what I told you.

23 Q. I'll give you the buzz word "Rubik's cube."

24 A. Yes, I think it was something like when you decrease
25 the particle size of a dust, what you're doing, although

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1 you're decreasing the particle size, the overall, the
2 diameters of the particles, you're greatly increasing the
3 surface area. So something like an eight-fold reduction
4 in particle size leads to an 800 percent increase in
5 available surface area. And that's important because of
6 the mechanism by which rock dust suppresses. I think the
7 example I used last night was if you picture a cube and
8 now picture next to it the same sized cube, but it's a
9 Rubik's cube, one of those things I could never master,
10 and you pull off the little, the same cubes but now the
11 Rubik's cube, and you pull off the little tiny cubes that
12 make up the Rubik's cube, and you set them all about and
13 you examine the surface area of those tiny cubes which
14 you've effectively reduced the particle size, and you
15 find you have a much greater surface area than the
16 original cube can provide.

17 Q. Why is surface area important in a dampening effect?

18 A. Rock dust is a thermal inhibitor. It suppresses
19 explosions by draining away or absorbing the heat that
20 would otherwise go to heat up other dust particles and
21 cause combustion. There's a lot of radiant heat
22 absorption that occurs. Radiant heat absorption occurs
23 at the surface of the rock dust. So if you simply
24 increase the surface area of the rock dust, then you're
25 creating more of a surface area to absorb the radiant

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1 heat that you want to absorb with the rock dust and
2 prevent from going to heating up the coal dust.

3 Q. How significant difference does it make based on
4 your initial examinations? I mean, are we talking
5 something that's a very noticeable difference?

6 A. To me it's a very noticeable. Unfortunately, I
7 didn't bring the third contract report or the paper that
8 we've recently published from that. It's difficult for
9 me without that in front of me to give you numbers, but
10 we're talking -- Another piece of work that we've just
11 finished involved some bag house material, limestone,
12 which is very fine, and comparing that to, say, the
13 regular grind of rock dust that's used, I believe it's
14 something like a change from perhaps 75 percent added
15 rock dust to 60 to 65 percent added rock dust.

16 Q. So it's a significant variance.

17 A. It's significant and if you also look at it on the
18 inerting ratio basis in terms of the actual mass of rock
19 dust that you need, not just that percentage, but the
20 actual mass, there can be a significant reduction in the
21 amount needed.

22 Q. Okay.

23 COMMISSIONER Mr. Merrick, just a point on that and
24 trying to tie Dr. Amyotte's evidence into Dr.
25 McPherson's, when he referred to the process of trickle

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1 dusting in mines, I take the leap and think to myself
2 that trickle dusting would be more effective the finer
3 the dust used. Was this --

4 A. I'm not familiar with that, sir.

5 Q. Well, trickle dusting, the dust is blown into the
6 mine through the vent system and it sort of hangs in
7 suspension with the coal dust, but the finer the dust,
8 the more it would hold in suspension, wouldn't it?

9 A. That would seem to make sense to me. The finer dust
10 would not be so quick to settle out.

11 COMMISSIONER Does that tie in at all with Dr.
12 McPherson?

13 MR. MERRICK The trickle, I would guess and I guess,
14 Doctor, you're not able to comment on this because you're
15 not a mining person, but I would guess that the finer
16 your rock dusting, the more compatible or it would be
17 certainly equally compatible with the trickle dusting
18 type of system.

19 A. Yeah.

20 COMMISSIONER And the more area of dust you would have
21 to inert the coal, yeah.

22 DR. AMYOTTE The testing that we did solely involved
23 pre-mixed coal dust/rock dust mixtures.

24 MR. MERRICK Yes, all right. Now so that those were
25 the tests that you did for the Public Inquiry. In a

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 second I'm going to ask you what conclusions you,
2 therefore, have as to the adequacy of the present
3 regulations. But just before I do, these were all
4 results that you obtained in your laboratory. Did you
5 make checks to validate how or to check how valid this
6 would be in actual conditions?

7 A. Yes, sir.

8 Q. What did you do?

9 A. We looked at what's done at the U.S. Bureau of
10 Mines, which is a ready resource for us. They're close.
11 We can easily obtain their technical reports. We know
12 some of the people there so we're able to read their
13 reports and if something is not clear, pick up the phone
14 and call them.

15 The U.S. Bureau of Mines has two full scale
16 facilities. Well, the Bruceton Experimental Mine, it's
17 my understanding, has been shut down and the Lake Lynn
18 Experimental Mine, I know they've had budget cutbacks,
19 but I believe it's still operating. The point is they
20 have a facility and have had facilities to do full scale
21 explosion testing. They also do a lot of work in the
22 laboratory scale and in a 20-liter chamber. They try to
23 optimize their full scale tests by doing screening tests
24 in the 20-liter chamber, and what they've found in
25 comparing between their lab scale results and full scale

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1 results is that the lab scale results tend to
2 underestimate somewhat the full scale tests in terms of
3 the amount of rock dust needed to suppress. Towards the
4 end of the report, very near the back of Exhibit 54, page
5 55, Figure 4.13, which is two pages after Section 4.4.5.
6 Figure 4.13.

7 What you see here is a plot taken from the U.S.B.M.
8 data of the amount of rock dust as a function of the
9 volatility of the coal. The solid line on the top is the
10 L.L.E.M. or the Lake Lynn Experimental Mine, and the 20-
11 liter chamber is the dashed line. And you can see that
12 there is some underestimation. The dashed line resides
13 somewhat below the solid line. But, nevertheless, it's
14 my opinion that they're not totally out of whack with one
15 another. There's a reasonable estimation of full scale
16 results by laboratory scale results. We've put on this
17 plot, not to suggest that -- Well, we put on it the
18 inerting levels for the fine and the coarse Westray coal
19 and you can see, at least in my opinion, that they are in
20 the same vicinity.

21 Q. So there is some validation that your results are
22 correlated to an actual situation.

23 A. I certainly believe so.

24 Q. All right, taking all that into account, you're
25 aware of the present requirements in the Regulations for

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 the percentage of incombustibles that must be added.

2 What are your comments or observations as to the adequacy
3 of the existing Regulations?

4 A. Well, I think that in terms of the 65 percent
5 incombustible level that that's something that definitely
6 needs to be looked at and, in my opinion, is probably not
7 adequate for coal dust explosion suppression. The
8 numbers that we've got in this report at the lab scale
9 for inerting of the Westray coal are clearly above that
10 level. You have to remember that we're dealing with, in
11 the fine coal, a very wide size distribution but small
12 particles.

13 The full scale experimental work done at the U.S.
14 Bureau of Mines, my interpretation of their reports is
15 that they're finding that at 65 percent, they can't
16 suppress, in a full scale explosion test, pulverized coal
17 or fine size coal dust. The 80 percent level, they have
18 a differentiated approach, as I understand it, in the
19 United States: 65 percent incombustible in areas of the
20 mine where the coal dust is likely to be fine and 80
21 percent incombustible where the coal dust -- I'm sorry,
22 the other way around. 65 percent incombustible where the
23 coal dust is likely to not to be very fine and 80 percent
24 where the coal dust, in return entries, where it may be
25 quite fine.

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1 Q. Now do they basically make that distinction as to
2 where dust will be coarse, generally coarse, and
3 generally fine, by identifying intake and return?

4 A. Yes, what I have here is 65 percent total
5 incombustible for intake entries in commercial operating
6 mines and 80 percent total incombustible for return
7 entries or returns.

8 Q. All right, okay.

9 A. Their full scale experiments that they've shown
10 would indicate that the level of 65 percent for U.S.
11 coals, and they test Pittsburg seam and Pocahontas seam
12 bituminous coals, the 65 percent level is not adequate.
13 Those coals are similar to, in terms of explosibility, to
14 Westray coal and CBDC coal, certainly.

15 The 80 percent inerting level, I believe they found
16 to be marginally effective for very fine coal dust. So
17 if in their tests they were to disperse only fine coal
18 dust, there was no coarse coal dust at all, I believe
19 their term is "marginal protection" at the 80 percent
20 incombustible level.

21 Q. Based on what you've read of their testing and based
22 on your own laboratory tests, are you in a position that
23 you can make any recommendations as to what you think
24 should be the levels in the regulations?

25 A. Right. I thought I was until just a minute ago

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1 because this is, I believe, not the revised report that I
2 have, Exhibit 54. I may be wrong. Maybe I just can't
3 find it. The opinion piece that we gave subsequent to
4 this report, I have, but it doesn't appear to be in here.

5 Q. That's fine. Just give us your evidence.

6 A. I'll just take a sec. I think the only thing that's
7 substantially changed between what's here and the revised
8 report, in fact, is this opinion on the regulations.

9 So, again, if I could just quickly set the framework
10 for the opinion, it's based on our lab scale tests which
11 we haven't tested the same coals in a full scale mine.
12 But based on those numbers that we've determined at the
13 lab scale, and the fact that the coal dusts are
14 comparable to what the U.S. Bureau of Mines has tested at
15 lab and full scale, my opinion is that a requirement
16 where coal dust is likely to be coarse, if one went with
17 the differentiated approach in the United States, about
18 75 percent total incombustible to me would seem adequate.

19 And given that in the full scale tests in the
20 States, 80 percent has not been adequate or has been
21 marginal for fine coal dust, then it seems to make sense
22 to me to go to a level of 85 percent where the dust would
23 be finer. So 75 percent for coarse and 85 percent for
24 fine.

25 Recognizing that there are, no doubt, some very

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1 practical difficulties associated with deciding when coal
2 dust is fine and when it's coarse, if a single number
3 would be more appropriate, then I would say that an 80
4 percent total incombustible level in the absence of
5 methane would be adequate.

6 There are also, in terms of the percent added
7 methane, based on our tests and what we've seen coming
8 from full scale tests in other places, the Regulations
9 concerning the additional stone dust needed when methane
10 is present seem quite adequate. The idea of one percent
11 additional rock dust for each .1 percent methane, which
12 is essentially saying one percent methane, you need 10
13 percent more rock dust or inert material, to me is
14 adequate.

15 On the matter of particle size, the current
16 regulations require at least 50 percent of the stone dust
17 to pass through a 200-mesh sieve, which is, I believe,
18 about 75 micron in diameter. I think that number is
19 worth looking at as well. Not just in light of what we
20 have recently done on the effect of rock dust particle
21 size, but in light of that there seems to be a feeling
22 that if we go to finer size rock dust, we may achieve
23 more effective suppression.

24 Again, I realize that there are probably practical
25 difficulties associated with all of this, but based on my

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1 expertise in laboratory scale testing and having examined
2 what is being done in full scale testing at the U.S.
3 Bureau of Mines, that would be my opinion.

4 Q. I'm taking from your comments that if there were to
5 be recommendations that there be minimum particle size --
6 sorry, maximum particle size restrictions on stone dust
7 to be used in a mine in order to insure you were getting
8 a finer grade of stone dust, that's something that we
9 shouldn't just set an arbitrary number on at this point.

10 A. No.

11 Q. But it's something that should be looked at with
12 practical input from owners, I suppose, stone dust
13 suppliers.

14 A. Absolutely, yes.

15 Q. Maybe some more testing.

16 A. Yes, well, I agree.

17 Q. And does that essentially complete the retainer that
18 you were asked to perform for the Westray Public Inquiry?

19 A. I believe that's everything. That covers everything
20 in my report, or our report.

21 Q. There are two other topics that I do want to address
22 with you in your evidence this morning.

23 COMMISSIONER Mr. Merrick, before we get into that, I'm
24 confused on this and I want to go back to Table 4.3 and
25 you might assist me in this, Doctor.

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1 Column 3, dolomite concentration, and you have, say,
2 a round figure of 80 percent by weight for fine. And
3 that's 80 percent of what?

4 A. That's 80 percent of the solids mixture. In terms
5 of a ratio, that would be the mass of the rock dust
6 divided by the mass of coal dust plus rock dust. So it's
7 simply a percentage of the rock dust in the total solid.

8 COMMISSIONER Okay, so if you have 100 percent, 80
9 percent of that must be dolomite, or a noncombustible.

10 A. Yes, sir.

11 COMMISSIONER Okay, how do I relate that to the inerting
12 ratio which is like, you say, four times rock to coal
13 dust?

14 A. Okay.

15 COMMISSIONER That would seem to me, the way I'm
16 interpreting that, is that I need four times as much rock
17 dust in that 100 percent sure thing. Am I --

18 A. No, you're absolutely right. If you had 100 grams
19 of dust that was both coal and rock dust, if 80 percent
20 of that 100 grams was rock dust, that means you have 80
21 grams of rock dust and 20 grams of coal dust.

22 COMMISSIONER Okay.

23 A. So 80 grams of rock dust, 20 grams of coal dust,
24 place 80 grams over 20 and you get four, which is the
25 inerting ratio.

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1 COMMISSIONER Okay, I'm glad I cleared that because I
2 was looking at it as you take 100 grams and you inert
3 with 80 grams and that's not right.

4 A. You mean 100 grams of coal dust?

5 COMMISSIONER Coal dust, yes.

6 A. I see, no, it would be 100 grams of coal and rock
7 dust together.

8 COMMISSIONER Okay, I'm glad I cleared that up. Thank
9 you very much. Sorry, Mr. Merrick.

10 MR. MERRICK No problem. Just on that table to make
11 sure I've got it here, the dolomite concen -- the stone
12 dust concentration which for the fine coal dust, no
13 methane, we're rounding off at 80 percent. That has got
14 to be 80 percent of the total.

15 A. Yes.

16 Q. Even though -- Yes, that's right. The inerting
17 ratio, though, is just the amount of the stone dust
18 required to the total, not the ratio of total
19 incombustible to the total. That's just more confusing.

20 A. The inerting, yeah, what you said about inerting
21 ratio. I think you know what it means.

22 COMMISSIONER All inclusive.

23 MR. MERRICK All right, no, I've got it nice and clear
24 in my mind. I'm not going to ask another question and
25 ruin it. Let me come back to a separate topic, less

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1 confusing, but perhaps significant.

2 Prior to the explosion in 1992, you had been
3 communicating with Westray with a proposal to do testing
4 for them on the coal dust that they had and coal dust and
5 rock dusting samples?

6 A. Not rock dusting samples, but inerting tests with
7 rock dust.

8 Q. Inerting tests. Tell me about your dealings with
9 Westray, what your proposals were, what their reaction
10 was and what happened? Are you looking for notes of an
11 interview?

12 A. No. No, that's okay. I was just looking for the
13 proposal that we had given them, which I've got here.

14 Q. All right.

15 A. I would probably need the notes of the interview
16 with the RCMP if I was to go into any great detail as to
17 specific times and so on. Do you want me to speak
18 generally?

19 Q. I'll get you to speak generally, but I will give you
20 the notes of the interview, just in case you need it to
21 refresh your memory on specific dates or counsel may want
22 to ask specific dates. But all I need for my purposes is
23 a general description of your proposal to Westray and
24 your dealings with them.

25 A. Okay.

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1 Q. If you can tell us where you're looking at in your
2 exhibit book.

3 A. Okay.

4 COMMISSIONER 36-B or --

5 MR. MERRICK 36-B.

6 A. 36-B, Tab 3. After the second orange or yellow
7 divider.

8 COMMISSIONER Statement of Paul Amyotte, with a big
9 number "1" at the top.

10 A. Oh, okay, yeah.

11 COMMISSIONER Is that it?

12 A. Yeah, that is the statement I gave to the RCMP.

13 MR. MERRICK All right.

14 A. Essentially what happened was I just happened to
15 meet Mr. Phillips, I think it was an energy strategy
16 round table in Halifax in 1990 and sort of introduced and
17 talked about the possibility of doing some testing, and
18 then it was a matter of bouncing back and forth between
19 the company and myself and sorting out what the
20 parameters of the testing would be, what type of work was
21 going to be done. That eventually led to the proposal
22 which is after the next divider and several, about eight
23 pages after that next divider after my statement to the
24 RCMP.

25 Q. It's a letter --

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1 A. A letter to Kevin Atherton, April 5th, 1991.

2 Q. Yes.

3 A. In which I was sending him the proposal to look at -
4 - I guess what really amounts to similar type work to
5 what we ended up doing for the Inquiry. Looking at
6 explosion pressure and rate of pressure rise. We're
7 suggesting coarse and fine fractions, different methane
8 concentrations. The lean limit, ignitability limits and
9 also rock dust inerting requirements. That proposal we
10 than bounced around back and forth through, I guess, over
11 about the next year in trying to define better the scope
12 of the work and exactly what would be done and when we
13 would start. Yeah, you have the purchase order in here.

14 Finally I then began to deal after Kevin with David
15 Waugh. I think it was three days before the explosion or
16 thereabouts that I received a fax of the purchase order
17 to go ahead and do the project. Obviously, we did not do
18 that work.

19 Q. I take it that if we want to have sort of a
20 narrative description of your contacts and communications
21 with them, it's under that, after the first yellow tab,
22 yellow divider in tab 3, that statement to the RCMP.
23 That gives the details and the dates.

24 A. Yes, sir.

25 Q. But the bottom line is is that you basically were

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1 offering to do for them the same testing that you did for
2 us. Had you done so, you would have been reporting to
3 them the fact that in order to inert Westray coal dust,
4 you needed more than 65 percent incombustibles, and you
5 never had a chance to do that testing because three days
6 after getting the contract, the explosion occurred.

7 A. I can't, not having done the work, I can't state
8 categorically what I would have been reporting to
9 Westray. I think you can draw some conclusions from what
10 we ultimately did find for the samples of Westray coal
11 that we tested. Had we tested coal of similar ash
12 content, produced similar particle distributions to what
13 we did in the Inquiry work, the conclusions would have
14 been essentially the same as what we've reported here.

15 Q. You never did actually carry out any testing for
16 Westray?

17 A. No.

18 Q. All right. That's all I want to explore with you on
19 that particular topic. This may be an appropriate point
20 to break for the morning then, Mr. Commissioner.

21 COMMISSIONER Thank you.

22 INQUIRY RECESSES (TIME: 10:57 a.m.)

23 INQUIRY RESUMED (TIME: 11:13 a.m.)

24 COMMISSIONER Mr. Merrick.

25 MR. MERRICK Thank you. Dr. Amyotte, over the break I

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1 took a few moments just to clarify the business about
2 your addendum or your revision to the report.

3 A. Yes, sir.

4 Q. And, for the record, I will indicate that following
5 the filing of the initial report that we have in Exhibit
6 54, the Inquiry did go back and ask you a specific
7 question as to what your opinion was as to what the
8 inerting levels for incombustibles should be in the
9 regulations. You filed with the Inquiry approximately an
10 additional page of text to your report and one additional
11 paragraph to your conclusions in which you address that.
12 That is the evidence that you have given today. It
13 appears though that that additional page and paragraph
14 was not circulated to parties; it didn't make it in the
15 exhibit book, so we're going to do that over the next few
16 days. But there's no other changes that I'm aware of to
17 your report or your conclusions?

18 A. No, not --

19 Q. Is that consistent with your understanding?

20 A. Yes, it is, sir.

21 Q. All right.

22 A. I think we would have added a paragraph in the
23 executive summary dealing with that opinion as well
24 but --

25 Q. Yes, and you did do that. It basically was just a

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1 written text of the evidence that you gave us this
2 morning?

3 A. Yes, sir.

4 Q. All right. Now let me come to the last topic I want
5 to address with you. In addition to being retained by
6 the Public Inquiry, you were then subsequently also
7 retained by the RCMP, I understand?

8 A. Yes, sir.

9 Q. That was for the purpose of the investigation that
10 they were doing relating to the criminal charges?

11 A. Yes, sir.

12 Q. We have had filed with the Inquiry the reports that
13 you did the for the RCMP and that is Exhibit No. 36-B
14 that we've been referring to this morning. Is that
15 correct?

16 A. Yes.

17 Q. And I note from that exhibit that essentially you
18 filed two reports or conclusions with them. This is Tab
19 3 of that exhibit that I'm referring to. You first gave
20 them a report called "General Comments on Coal Dust
21 Explosions." And then you gave them a second one that's
22 entitled, "Specific Comments on the Westray Coal Mine
23 Explosion?"

24 A. Yes, sir.

25 Q. In those responses or those documents, particularly

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1 the one entitled "Specific Comments on the Westray
2 Explosion," you set out your views as to how the
3 explosion may have initiated and propagated through the
4 mine?

5 A. Yes, sir.

6 Q. Okay. You yourself do not purport to hold yourself
7 out as a mining expert or consultant?

8 A. Absolutely not.

9 Q. You haven't previously been asked to examine or
10 express views on a mine explosion?

11 A. No, sir.

12 Q. And you have no particular -- you have no mining
13 training or mining experience?

14 A. No, sir.

15 Q. In fairness to you, I take it that when the RCMP
16 asked for your views, it may have been pushing a little
17 bit your limits of experience and training?

18 A. I've thought about that and I think I disagree with
19 you.

20 Q. All right.

21 A. I would certainly not purport to give an opinion
22 based on a detailed knowledge of mine design or
23 ventilation or anything of the sort. What I did in
24 examining and giving my opinion on the causes of the
25 explosion was to really attempt to stay within my

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1 envelope of expertise. And I think I accomplished that.

2 I used three key elements to start my analysis. The
3 first was the International Loss Causation Institute's
4 model -- I'm sorry, the International Loss Control
5 Institute model for loss causation which deals with five
6 separate levels of accident causes, a model which I have
7 personally used in the past in my own department to look
8 at incidents and which I have used in teaching a course
9 on workplace health and safety. I went through three
10 blocks of that model and stopped where my expertise
11 stopped.

12 I know dust explosions. I have seen or done
13 hundreds of dust explosions, possibly 1,000, albeit at
14 the laboratory scale. I went to great lengths in both
15 reports to clearly establish in the second chapter
16 immediately after the introduction what my expertise was
17 to indicate that it was in laboratory-scale testing and
18 that any relevance that my work may have to full-scale
19 testing or full-scale industrial situations would come
20 from the choice of appropriate conditions at which you do
21 laboratory-scale tests and my own attempts to stay
22 abreast of the technical literature and maintain my
23 contacts with people who do full-scale testing. And that
24 was the second point.

25 The third point in the starting of my analysis was

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1 the use of a model which is documented in the U.S. Bureau
2 of Mine Reports to be a typical sequence of events in a
3 coal explosion in which it's believed that coal dust has
4 been involved.

5 So with those three elements giving me a starting
6 point, I then proceeded, attempting to stay clearly
7 within what my expertise allowed me to do.

8 Q. All right. And accepting all of those
9 qualifications, I do note that a hypothesis that you
10 developed in those reports appears to be fairly
11 consistent with the theories that have been put forth by
12 other witnesses who have testified and who will be
13 testifying and who have filed reports and who have
14 perhaps had more experience in mine explosions.
15 Accepting all of that, I'm not going to ask you much in
16 detail about the theory or the hypothesis that you put
17 out for the RCMP. Other counsel may want to explore that
18 with you, but there were a couple of points that you made
19 there that I thought were of interest and I wanted to
20 just ask you about.

21 A. Uh huh.

22 Q. In particular, you made a comment about a plot of
23 samples that was produced by, I think, Mr. Richmond for
24 the RCMP that reflected the analysis of samples taken
25 coming down the Southwest -- I've got to keep my

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1 designations correct here, the -- just let me get my
2 right roadway, coming down the Southwest 2-1 Road and
3 then out, I think it was, the Southwest 2-A Road in which
4 you noted that on those samples, as you came away from
5 that face where the continuous miner was, that there was
6 a drop or decrease in the combustible content of the
7 coal. Do you recall that portion of your comments to the
8 RCMP?

9 A. Yes, sir.

10 Q. Just describe to me what you did comment on and what
11 your observations were?

12 A. Okay. The plot that I'm referring to which I
13 provided you a copy of, as you said, was prepared by Mr.
14 Ken Richmond, formerly of the U.S. Bureau of Mines,
15 showing that in the vicinity of the mine face and where
16 the samples were taken down along Southwest 2-1 Road, the
17 combustible content of the samples is up approximately
18 around 70 percent.

19 Q. Now just so that everybody should have on their
20 table in front of them a two-page plot --

21 A. Okay, I'm sorry.

22 Q. -- which is what we're looking at, and for
23 identification purposes that's now being marked Exhibit
24 73/13.

25 MS. MACDONALD I think it's on your far right there,

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1 just --

2 MR. MERRICK No, more to the right. At the far end of
3 that table. No, around to the far -- yeah.

4 COMMISSIONER Oh, here -- All right.

5 MR. MERRICK Now what we should be looking at first, I
6 take it, is the page that's entitled, "Summary Analysis
7 of Dust Samples."

8 COMMISSIONER The number of this again?

9 MR. MERRICK 73/13. It will be Exhibit 73, Tab 13?

10 MS. MACDONALD Uh huh.

11 MR. MERRICK Tab 13.

12 COMMISSIONER Okay. Uh huh.

13 MR. MERRICK And the page -- on mine it's the second
14 page. It's entitled, "Summary Analysis of Dust Samples."

15 A. Yes, sir.

16 Q. Okay. With that in front of us, continue your
17 description.

18 A. So starting at -- let me see, just take a minute --
19 all right.

20 Q. These are samples taken by somebody else?

21 A. Yes, these are -- my understanding is that these are
22 the samples taken after the explosion by the RCMP.

23 Q. And, in fact, this plot was done by somebody else;
24 you merely commented on it?

25 A. Yes, that's correct.

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1 Q. All right.

2 A. To me, what this plot is showing is that as you move
3 further away from the mine face and at a distance of 100
4 meters or a bit further along the Southwest 2-B Road,
5 that there is a drop in the combustible content of the
6 samples that were analyzed from approximately 70 percent
7 near the face, Southwest face, to about 58 percent at
8 that distance of approximately 100 meters.

9 Q. So as we look at that graph on the left-hand side
10 where the shaded area starts, purportedly that represents
11 the face at the Southwest 2-1 Road where the continuous
12 miner was?

13 A. Yes, sir.

14 Q. And then this doesn't purport to represent the
15 roadway. but it is a graph indicating the amount of
16 combustible percentages as you moved away that road and
17 then ultimately down the Southwest 2-B Road?

18 A. Yes, sir.

19 Q. So that at about the point, according to the graph,
20 about 100 meters from the face, it's dropped down?

21 A. Yes.

22 Q. What comment do you make based on that kind of
23 information, assuming it to be correct?

24 A. My comment, as I stated in the report, if that one
25 equates a decrease in combustible content with the

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1 initiation of a coal dust explosion, then that is
2 evidence of the possibility of the coal dust explosion
3 starting to occur along the Southwest 2-B, Southwest 2-A
4 --well, referring to this, the Southwest 2-B Road.

5 Q. So that, in effect, this is on the postulation that
6 the drop in combustibles is accounted for by their being
7 consumed, possibly, by being at that point involved in
8 the -- a coal dust explosion?

9 A. Yes, sir.

10 Q. Now this is just a postulation.

11 A. Yes, sir.

12 Q. We cannot say that with any exactitude, but it is a
13 factor that may corroborate that theory?

14 A. It's my understanding, sir, that -- yes, and in fact
15 what I attempted to do was use this as one component in
16 the analysis that I gave.

17 Q. Yes. Now if this were correct and if it was, in
18 fact, evidence that combustibles were at that point being
19 involved in the explosion, as I am reading this graph and
20 looking at the measurements, then that would have been
21 very close to the intersection of Southwest 2-1 Road and
22 Southwest 2-B Road?

23 A. Yes, sir.

24 Q. All right. Whether or not that is so --

25 COMMISSIONER Which "2" road? Southwest --

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 MR. MERRICK Southwest 2-1 Road and Southwest 2-B Road.

2 In fact, if I can use this little laser pen, what we're
3 looking at then is a point at about that junction,
4 generally where the boom truck was? Is that right?

5 A. Yes, sir.

6 Q. Okay. But this is only put forward as a hypothesis
7 which may account for this kind of data?

8 A. I'm not sure I understand.

9 Q. This is --

10 A. The idea of the decrease in combustible content
11 indicating -- I think that -- yes, I think that is one
12 way, to me, in which the combustible content could
13 decrease, that if that sample had previously been
14 involved in a coal dust explosion, you would expect the
15 combustible components to be less. Can there be other
16 ways in which that occur, I don't know. But that's
17 certainly to me, based on my expertise in dust
18 explosions, is possible that the decrease in combustible
19 content can be equated with the initiation of coal dust
20 burning.

21 Q. The only reason I'm being careful with my comments
22 is that I'm assuming that you would agree that this is
23 not to be taken as a persuasive or conclusive piece of
24 evidence, but it is an indicator?

25 A. I'm not sure what, legally, what a persuasive or

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 conclusive piece of evidence is, sir.

2 Q. Well, I just --

3 A. I'm not trying to be difficult. I just don't know.
4 It's a piece of evidence that I felt was important to my
5 analysis and which lent credence to that analysis as, I
6 guess, a corrob -- I can't say the word. It was a
7 valuable piece of evidence, as far as I was concerned.

8 Q. Fair enough. Okay.

9 COMMISSIONER Can I follow up on that just a second.
10 Did you actually do an analysis or a test on the dust
11 that you got from Richmond at that time?

12 A. No, sir, nor did Ken Richmond. Those samples were
13 collected and were analyzed at -- for combustible,
14 incombustible matter, it's my understanding, at CANMET in
15 Ottawa.

16 COMMISSIONER Okay, I'm going to take a long leap here,
17 was there any -- do you know from any of the material
18 that you have read whether or not there was any evidence
19 of coking of that material?

20 A. In my report I've referred to some scanning
21 electromicroscopy work that was done.

22 COMMISSIONER Well, I'm familiar with it, yeah.

23 A. Okay. But you're looking under a scanning
24 electromicroscope --

25 COMMISSIONER Yeah.

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 A. -- at the residue to see if there is some evidence
2 of coking.

3 COMMISSIONER Yeah.

4 A. And although -- and I would not argue that that is
5 conclusive in itself. It's just another piece in the
6 evidence, the fact that there was some evidence in -- now
7 these samples were out along, I believe it was 2-B Road,
8 I will have to refresh my memory, but at any rate it was
9 a bit further away from the location we're looking at
10 here, and there was some evidence of coking based on SEM
11 photographs.

12 COMMISSIONER Just another little piece in the puzzle
13 then, isn't it?

14 A. Yes, sir. To me that's what it was.

15 COMMISSIONER Yeah, okay. Thank you.

16 MR. MERRICK And that's all I wanted to make sure that
17 -- I wanted to make sure we had in the correct context.

18 A. Yes, sir.

19 Q. Okay. Now the only other comment that I wanted to
20 ask you about that was in your RCMP report is that you
21 have postulated that if, in fact, the explosion did occur
22 in the mechanism that generally has been thought of, and
23 that's coming down out of the Southwest, out to the C-1
24 and B Road and then out into the mains, that it would
25 tend to probably go up the return main because that would

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 be where there would be a more likelihood of a methane
2 concentration in the return air. And the thing I wanted
3 to just clarify --

4 A. Oh.

5 Q. -- is that if the methane concentration in the
6 return air was less than five percent in the general body
7 of air --

8 A. Uh huh.

9 Q. -- that methane would be a factor only if there was
10 also coal dust involved at that point. Is that fair?

11 A. Yes, sir. And it, in fact, is what I meant. And it
12 has -- I think it ties in quite closely with the
13 laboratory-scale work we had done for the Inquiry where -
14 - and it's a well-known, well-established fact that small
15 percentages of methane well below the lean limit of
16 methane at five percent can greatly increase the hazard
17 posed by coal dust.

18 Q. Yes.

19 A. So I agree with your statement.

20 Q. Yeah. So it's on the premise that there also is
21 coal dust at that point?

22 A. Yes, sir.

23 Q. All right. Those are the only questions that I have
24 for you.

25 COMMISSIONER Thank you, Mr. Merrick. Mr. Roberts?

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1 EXAMINATION BY MR. ROBERTS

2 Q. Mr. Amyotte, just to begin with the last point that
3 Mr. Merrick was asking you about, we've tended to talk
4 here about a methane fire and a methane explosion and
5 then a coal dust explosion as being almost discrete
6 events, one triggering the other. But I seem to hear
7 from you that in fact in a situation where you would have
8 methane in the air body that you would -- that that
9 methane would increase the intensity of the coal dust
10 explosion itself, and they're not really -- it's not
11 correct to look at them as discrete events?

12 A. I think it's more or less correct to look at the gas
13 and dust explosion as discrete events in terms of the
14 sequence of the -- you know, the only way that that dust
15 is going to explode is if it gets raised into suspension.
16 So in the sense of a discrete gas explosion, precursor
17 shock wave raising dust and then that igniting, I think
18 that's correct. But I think you're also correct in
19 saying that any time that there is even small percentages
20 of methane in an atmosphere, one, two, three percent,
21 although that methane by itself would not support
22 combustion, it does add to the hazard explosibility of
23 the coal dust by itself. And I don't really -- I don't
24 want to leave the impression with anyone here that I'm
25 saying it wasn't coal dust that exploded, it was a gas

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1 explosion. The mechanism of coal dust explosion is that
2 it is predominantly the release of volatiles and the
3 burning of those volatiles with some char burn-up if the
4 residence time is long enough. It is still a dust
5 explosion. It's called a dust explosion. It's not
6 called a gas explosion.

7 Q. And I guess what I was putting to you was that I
8 seemed to hear you say that in circumstances where you
9 would have some methane present in the air, that the
10 intensity of the coal dust explosion which would follow
11 would be enhanced by that methane?

12 A. Yes, that's correct.

13 Q. Okay. Now the work you did for the RCMP, my
14 understanding is that you didn't, from an answer you gave
15 to the Commissioner, that you didn't actually do any
16 analysis, sample analysis yourself? Is it --

17 A. In doing -- analyzing for a combustible, the
18 combustibles, no, that -- what I did was I received the
19 reports, the analyses that were done on those samples and
20 I analyzed the analysis --

21 Q. Right.

22 A. -- the analyses.

23 Q. And these were all, as I understand it, dust samples
24 taken after the explosion?

25 A. Yes, sir.

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1 Q. And is it true that you expressed the opinion that a
2 sample taken after the explosion is still a good
3 indicator of the proportions of inert and combustible
4 material before the explosion?

5 A. Yes, in my opinion it -- post-explosion sampling can
6 -- is representative of conditions that would exist pre
7 with some obvious differences. Dust that existed in one
8 location prior to the explosion would not expect to be
9 found there. There will be -- and I think there's
10 evidence of some coking or some partial pyrolysis of the
11 coal, the coal dust being involved. So there are going
12 to be some differences.

13 Q. But this is a basic principle that's accepted in the
14 industry or in the science that this -- the post-
15 explosion state is an indicator of a pre-explosion
16 relationship?

17 A. I'm not sure that it's accepted by everyone. I
18 think that there is perhaps some debate. The people that
19 I've talked to though generally feel that it is
20 acceptable. Reading an old report, I think the Tidewell
21 Report from several years ago which indicates that it is
22 a reasonable way to try and gain a picture of the
23 conditions that existed prior to the explosion.

24 Q. And in this particular instance of the samples you
25 reviewed, I think it was 65 of them, was that?

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1 A. Yes, I believe that's correct.

2 Q. And almost all samples exceeded the legal limit in
3 Nova Scotia for incombustibles or for combustibles,
4 sorry?

5 A. Just refer to -- yes. I looked at 65 analyses for
6 combustibles. I believe the number was 61. I'm looking
7 for --

8 Q. I think 57, if I could --

9 A. Yes, I'm sorry. Fifty- -- yeah, sorry. Yeah, 57 of
10 the analyses indicated combustible material greater than
11 30. So looking at it from the other perspective now, if
12 you need 65 incombustible, you're only allowed 35
13 combustible, so 57 indicted greater than 35 weight
14 percent combustible material.

15 Q. And in the graph that you reviewed with Mr. Merrick,
16 all of the samples from the Southwest section exceeded
17 the legal limit by a substantial margin?

18 A. On this graph from Mr. Richmond, yes, all of the
19 samples on there from the Southwest section are above, as
20 you can see, the legal limit of combustible being 35
21 percent.

22 Q. All right. And, in fact, as I look at the bottom, I
23 see a line for average limestone in sample percent. And
24 that it seems to be around one percent as you start from
25 the face and never gets above four percent?

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1 A. Right. Now --

2 Q. Is that your understanding of --

3 A. My understanding is that that would be determined
4 from the CO₂ that's evolved during the testing for the
5 incombustible matter. Limestone is calcium carbonate
6 and, as I'm sure you know, you heat it and it will
7 decompose and CO₂ will be driven off and then you can
8 determine the limestone in the sample.

9 Q. Is that an indication of the presence of rock dust?

10 A. I really don't have the expertise. It can be. I
11 mean, obviously, that limestone is rock dust. So if
12 there's limestone in the sample, it can come from having
13 been added. But I can't comment on whether that
14 limestone would be, I guess, what you might call a sort
15 of natural background material that would be there.

16 Q. All right. One other point about your RCMP work,
17 you made reference I think to the fact that you found a
18 high percentage in the samples of fine dust among the
19 Westray coal samples?

20 A. Of the 65 or so samples that were there, I selected
21 samples from the South -- limited sampling from the
22 Southwest section and then further out I think along -- I
23 just want to make sure that I've got the right location
24 here. Yeah, from the fall of ground on B Road to the
25 intersection of B-2 Road in those samples. And looking

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1 at that table as well, you can see the higher combustible
2 content from the Southwest samples as compared to further
3 out where, in my opinion, the coal dust explosion is now
4 occurring.

5 Q. Did I read your report though to indicate that -- in
6 terms of the proportion of fine versus coarse dust in the
7 Westray dust, there tended to be more fine dust?

8 A. I think what -- my conclusion in the report was that
9 in terms of particle size considerations alone, because
10 there is a -- you know, you can go so high in particle
11 size, you can have chunks that won't sustain a dust
12 explosion, but in terms of particle size considerations
13 alone, the samples that had been collected afterwards and
14 that I chose in those specific locations, the Southwest
15 section and then out on B Road, those samples are -- were
16 explosable based solely on particle size considerations.
17 I'm not sure that I commented in here on degree of
18 fineness, just that on particle size alone, they were
19 explosable.

20 Q. Okay. Now on the -- I want to ask you a couple of
21 questions about your dealings with Westray before the
22 explosion.

23 A. Yes, sir.

24 Q. You've indicated that you were essentially proposing
25 to do for them what you ended up doing for the Inquiry.

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1 A. Although, if I could interject, obviously at that
2 time I did not know that.

3 Q. Of course. Of course. But nonetheless, you were
4 trying to develop for Westray an effective formula for
5 what they would have to do to make their -- the coal dust
6 inert that they were producing. It was something
7 tailored to the particular coal that they were producing
8 here.

9 A. I was interested in doing research of an applied
10 nature. I'm not saying that I look at all of this as a
11 research project at all, but the fact of life is that for
12 a university professor at my university, we teach, we
13 provide service, we administrate, and we do research. My
14 research is in dust explosions and, specifically, coal
15 dust explosions. I want that research to be relevant, to
16 be of some value to industry. Otherwise, I shouldn't
17 bother doing it.

18 So my intent in speaking to the people at Westray
19 was to offer my services, because it may be of benefit to
20 them and it was up to them to judge if they felt I would
21 be of benefit. Why I wanted to do the work, I wanted to
22 look another coal material. I wanted to examine the
23 effect of coal dust concentration on the amount of rock
24 dust required to inert and so on. So there were many
25 reasons that I had approached Westray to do the work,

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1 many of the same reasons that I initially approached
2 Devco to do the work with them.

3 Q. If I could simplify though, you would have been able
4 to tell Westray with some reasonable certainty how much
5 inert material they would have to apply in their mine in
6 order to make the mine safe from a coal dust explosion.

7 A. Had I done -- I can't generalize it like that again,
8 because had I done or had we, remember we're a team, had
9 we done the work that we had proposed for Westray, which
10 was similar to the work we did for the Inquiry, and
11 again, I go back to my response to Mr. Merrick on this
12 point, had the particle size distributions been about the
13 same, the conditions and so on, we would have been able
14 to present them with the same data that we presented to
15 the Inquiry. I don't know if that answers your question.

16 Q. My sense from reading the material that you provided
17 was that they didn't seem to put a particular priority to
18 the proposal you were making.

19 A. I'm not really in a position to judge what priority
20 Westray was putting on me at all. I can be, I guess to
21 people who know me, I can be a real pain sometimes and
22 fairly tenacious when I want to do a piece of work and I
23 will go after them. My understanding is that they were
24 involved in trying to get the mine up and running and
25 production and so on and things about which I really have

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1 no expertise. All I know is that I was committed to keep
2 going after them to do the work, and it was progressing
3 along, in my opinion, slowly. But I don't know what the
4 Westray impression of me was. All I know is that
5 eventually three days prior to the explosion, we had
6 reached an agreement that this was the work that we were
7 going to do.

8 Q. And that was a little over a year after you made
9 your proposal about what the work would be.

10 A. Yes, I think the letter to Mr. Atherton was dated
11 approximately April of '91 and then early May '92.

12 Q. Now a particular question about your exchange with
13 Westray and I'm referring you to the can say document
14 from the RCMP which you've already referred to in 36-B
15 just behind Tab 3.

16 A. Okay.

17 Q. Now I just want to read to you from the middle of
18 that page:

19 "On 91-05-07, I called for K. Atherton and he called
20 back on 91-05-08. I have noted raw coal estimate. He
21 wanted to know how much raw coal we would need to do any
22 work. I wrote to K. Atherton on 91-05-13. I answered
23 his question of 95-08. I called Mr. Atherton on 95-05-
24 31. He wasn't in. I called again and he still wasn't
25 in. I called again three times. I got Mr. Atherton on

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1 91-06-05. He indicated he was still interested but it
2 would be a month or so before they got into coal
3 samples."

4 So that's 91-06-05. Now reading the correspondence,
5 you told Mr. Atherton that you would need between 10 and
6 20 kilograms of coal in order to do the testing. Do you
7 recall that? I can refer you ahead.

8 A. If you say it's there.

9 Q. May 13, '91.

10 A. I probably did because that's one of the things you
11 obviously have to know, and the question is usually asked
12 early in the proposal stage.

13 Q. Just to be precise.

14 A. 10 to 20 kilograms sounds --

15 Q. Five pages ahead, I believe, there's a letter dated
16 May 13, '91 where you say: "To produce the dust, we need
17 10 to 20 kilograms of raw coal."

18 A. Right. Oh, sorry, about five kilograms of coal
19 dust, yeah, right.

20 Q. So you told him you needed to 10 to 20 kilograms of
21 raw coal.

22 A. Right.

23 Q. So he then wrote or called you as of July 2nd, 1991,
24 he said they would be a month away from coal. That was
25 his response to you?

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1 A. I must have had a note on that somewhere in here.
2 This is a pretty detailed file. I brought the original
3 file with me here. It looks like virtually every phone
4 call and whatnot is in here.

5 Q. It's summarized in your can say and you'll agree --

6 A. Oh, I agree that the can say is what I said to the
7 RCMP and what I believe to be correct, yes.

8 Q. Okay, that's fine. Just one other point. In your
9 discussion with Mr. Merrick about whether or not it would
10 be appropriate to reduce the particle size of rock dust
11 in order to enhance its inerting qualities, we've
12 discussed with another witness the implications to
13 employees underground who may be breathing rock dust and
14 that rock dust in its current composition is not
15 necessarily a health hazard. You didn't look at whether
16 or not finer particles of dust would, in fact, be a
17 health hazard to people who might breathe them in.

18 A. No. No, we certainly didn't. I mean that is well
19 outside the scope of my expertise. But, again, going
20 back to my comments to Mr. Merrick, I believe, at least I
21 hope what the testimony will say that my comments were on
22 the particle size, and I recall Mr. Merrick saying, you
23 know, let's not fix a number now. There are lots of
24 things that need to be investigated. This is one of
25 them. Can commercial producers of limestone produce the

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1 size? Are there other sources of material that one might
2 have some environmental benefits by using it? There are
3 lots of things that need to be considered, and health and
4 safety from an industrial hygiene perspective is
5 certainly one of them.

6 MR. ROBERTS Thank you very much.

7 COMMISSIONER Mr. Hebert?

8 MR. HEBERT Thank you.

9 EXAMINATION BY MR. HEBERT

10 MR. HEBERT Doctor, to perhaps pick up where Mr.
11 Roberts had left off in terms of your involvement with
12 Westray itself, as I look at your statement to the RCMP,
13 it refers to, in one instance, that you had provided
14 information, journal, I guess, photocopies of journal
15 articles to Westray at one point and, as well, I believe
16 the words you used was that you were pretty sure or you
17 were sure that you had sent other information.

18 Let's look at the first one. It appears to be, you
19 attached a copy of the Journal of Loss Prevention
20 Process, 1991, Vol. 4, January. Can you indicate what
21 that article was about? Is that reproduced?

22 A. Yeah, actually it would be a paper from the Journal
23 of Loss Prevention in Process Industries, and I believe
24 if I just turn down further, it should be, of course, the
25 journal number as photocopied has missed -- No, here it

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1 is, okay. That is, and I don't know how to direct you to
2 this. Well, I'm looking at the can say, and then I have
3 a divider sheet, and I go to the next divider sheet, and
4 I turn the page and I see "General Comments on Coal Dust
5 Explosions."

6 Q. That was your first report to the RCMP?

7 A. Right.

8 Q. Okay.

9 A. Now if you grab about a half an inch of text,
10 Appendix "A", which is actually after page 26, after my
11 actual writing in that report, and now we start to get
12 into the papers that I'm showing. Appendix "A" which is
13 that article, is "Laboratory Investigation of the Dust
14 Explosibility Characteristics of Three Nova Scotia
15 Coals." That would represent about half of the first
16 contract report that we did for Devco.

17 What we typically do to fulfil the requirement of
18 the contract is produce a technical report for the
19 company and then with their permission we attempt to
20 publish the material in the open literature.

21 Q. Okay.

22 A. So that would be 1991, Volume 4, and you can verify
23 that if you turn over a few pages into the article,
24 you'll see at the bottom, Journal of Loss Prevention in
25 Process Industries, 1991, Volume 4, January.

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1 Q. Oh, yes, okay. And does this article, to your
2 knowledge, deal with the percentages of nonflammable or
3 incombustible matter required to suppress --

4 A. I have intimate knowledge of the article because I
5 wrote it. It doesn't deal with the rock dusting aspects
6 of that first Devco contract. It deals with the hazard
7 evaluation phase, which is like Phase 1 for the work we
8 did for the Inquiry for these coals. The three coals
9 we're talking about here are Prince, Phalen, and Lingan
10 coals from CBDC. Explosion pressures, over pressures,
11 lean flammability limits and so on, which is what that
12 paper deals with.

13 I don't want to anticipate your question but I can
14 tell you where the inerting material is, if you want it.

15 Q. Okay, but this article would address the hazardous
16 nature, I guess, of fine coal dust and add mixtures of
17 methane and coal dust?

18 A. Yes.

19 Q. All right. Now that was the first article that you
20 sent, and you're also quite sure that you sent a second
21 article?

22 A. Yeah, I guess relying on my can say because,
23 obviously, at this point in time, I have no recollection
24 of -- I mean if that statement wasn't there, I wouldn't
25 even be able to say "I think." But relying on the can

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1 say that I'm quite sure that I sent along at this time a
2 journal. Actually it would be the Journal of Hazardous
3 Materials and the paper is "Effects of methane, add
4 mixture, particle size, and volatile contents on the
5 dolomite inerting requirements of coal dust."

6 In many ways, this work that we did here was the
7 knowledge formation stage which allowed us to do the
8 Inquiry work. That's Appendix "B." No, sorry.

9 Q. D?

10 A. No, I'm going to have to -- It's in here, I'm sure.

11 Q. I see it as Appendix "D."

12 A. I'm sorry, D, yes, I thought you said "B." It is
13 Appendix "D," right, from the Journal of Hazardous
14 Materials, 1991.

15 Q. And, again, this article deals specifically with the
16 inerting aspects or characteristics of rock dust?

17 A. Yes, this deals with the second phase of the first
18 contract that we held with CBDC, which was the inerting
19 work.

20 Q. All right. And in terms of were percentages of rock
21 dust to coal dust referred to in this article and were
22 recommendations made or conclusions drawn?

23 A. I'm sorry, I've got a page in here that shouldn't
24 be. Anyway, okay, the article continues. Yes, the
25 summary table well down in the report or in the paper,

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1 rather, in Appendix "D."

2 Q. Is there a page number in the article?

3 A. The journal article itself, it's page number 196 and
4 it's Table 3. And you can see for Prince 1 and Prince 2,
5 the 1 and 2 for each sample refers to just particle size.
6 The designations we put on it: Zero, one and two percent
7 methane, the dolomite concentrations and the total
8 incombustible content.

9 Q. Okay, and it appears that the percentages are
10 similar or consistent with the results that you
11 subsequently attained with the Westray coal.

12 A. Yes, sir.

13 Q. And just for the record, they appear to -- The total
14 incombustible content of dolomite to inert the coal gas
15 appears in the various samples to range from 77 percent
16 to as high as 91 percent when two percent methane is
17 present?

18 A. Right. These coal dusts were very fine. These were
19 fine materials. So we weren't testing coarse coal dust
20 here as we did in the Inquiry.

21 Q. I see.

22 A. But that's correct, 91 percent, I guess, is the
23 upper found in a couple of places and a low of 77 percent
24 for the Phalen 1 coal. The Phalen sample that we were
25 testing there seemed to have an abnormally high ash

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1 content.

2 Q. Okay. And I take it those are the only two articles
3 that you can either recall or have referenced in your
4 statement to the RCMP that you provided to Westray?

5 A. Yes, the only two articles. I did leave a technical
6 report which --on my visit to Westray with Kevin
7 Atherton. I'm sure it's in here as to when I went. I
8 think it was October or thereabouts. I'd have to read it
9 to check the exact date. But when I was at Westray
10 talking to Mr. Atherton, I left a copy of the technical
11 report that we had provided to Devco on the first
12 contract, in fact, which in a technical report format,
13 summarizes those two papers we just went through.

14 Q. Okay. Is that technical report in the material, to
15 your knowledge?

16 A. In here?

17 Q. Yes.

18 A. No, I have a copy with me, if you want to see it.
19 It's not in here. Well, it's probably as thick as half
20 this report, anyway.

21 Q. Okay, I don't think we need to see it at this point.

22 COMMISSIONER You might read it over the lunch hour
23 maybe.

24 MR. HEBERT Yeah.

25 A. If you've read the Inquiry Report, you've read the

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1 Devco.

2 Q. There would be nothing in your technical report that
3 wouldn't be in the two articles that you've referenced?

4 A. I don't think anything substantially from an
5 engineering perspective. There may be a level of detail
6 in the technical report on experimental procedure and
7 introductory matter that wouldn't be appropriate for a
8 journal, but engineering content, scientifically, no. I
9 don't think there would be anything substantially
10 different.

11 Q. Okay, all right. Now with respect to the subsequent
12 tests that you conducted or that you reviewed, I believe
13 you did some explosibility tests on dust samples after
14 the explosion. Did you yourself --

15 A. Oh, I'm sorry.

16 Q. For the RCMP?

17 A. Back to the --

18 Q. Sorry, you worked for the RCMP.

19 A. Right, yes.

20 Q. You did do some individual tests.

21 A. Yes.

22 Q. All right, and maybe you can just indicate what
23 those tests were?

24 A. Okay.

25 Q. The tests that you did.

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1 A. Yes. Do you want me to refer you to the appropriate
2 page in the report?

3 Q. That would be helpful.

4 A. It's very near the end of Exhibit 36-B, my final
5 report. Okay, Section 4.5, which is page 15. I took two
6 of the samples, Samples No. 90 and 99 in the reference
7 system that is in this report, which is what was also
8 used by the RCMP CANMET people. Sample 90 was from the
9 floor, a floor sample from the fall of ground on B Road
10 to the intersection of B-2 Road. I'm sorry, I'm
11 referring now to page 13, back two pages, for the
12 descriptive of Samples 90 and 99. And you can see Sample
13 90, the third entry in that table, Table 2.

14 Q. Yes, okay.

15 A. And Sample 99, which was a sample from the floor on
16 Southwest 2 Road, back of the shuttle car and opening on
17 the left-hander. So those two samples I selected and we
18 tested in the explosion chamber, the same explosion
19 chamber that we used for the Inquiry work. So these were
20 samples post-explosion. These were fixed dust
21 concentration of 500 grams per cubic meter, so up in what
22 I thought would be the optimum range for those materials.
23 Both dusts exploded. The pressure time traces are given
24 in Appendix -- Do you want this level of detail, Mr.
25 Hebert? They did explode.

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1 Q. Okay.

2 A. Put it that way. The pressure time traces are in
3 Appendix "C," which show that there was significant over
4 pressure generated and a measurable rate of pressure rise
5 from those samples.

6 Q. I take it that in that particular test you used the
7 dust as you found it. It wasn't sieved or --

8 A. No, that's right. I mean this was a dust that I
9 knew the combustible content of. I knew the particle
10 size. I didn't have to try to see if it would explode.
11 I knew it would explode. But for the sake of
12 completeness, I did it.

13 Q. All right.

14 A. Nothing more.

15 Q. Okay. And you knew the particle size from previous
16 tests by CANMET, is that it?

17 A. No, all of the 65 samples that were extracted and
18 that I've commented on in terms of combustible,
19 incombustible content, they were analyzed for those
20 composition by CANMET. Then some of those 65, seven of
21 those 65, I then took, had analyzed at TUNS at the
22 Minerals Engineering Centre, for the particle size
23 distribution.

24 Q. I see.

25 A. Two of those seven, I took and did the explosion

DR. AMYOTTE, EXAM. BY MR. HEBERT

1 tests.

2 Q. And that would be the extent of the independent
3 tests that you performed on the samples.

4 A. Yes, I actually only performed explosion tests. I
5 had the particle size tests done and I was not involved
6 in the analysis, the CANMET analysis.

7 Q. Fair enough. Now I'm having a little bit of trouble
8 with two aspects in terms of the content of
9 noncombustibles after the explosion. As a lay person, I
10 detect perhaps an inconsistency. You're indicating,
11 first of all, that the sudden or when you look at the
12 graph, the sudden decrease of combustibles may suggest an
13 explosion. I think that was your first point. That
14 appears to me to be inconsistent with the proposition
15 that post and pre-explosion samples would be -- sorry,
16 post-explosion samples would be representative of pre-
17 explosion samples in terms of the proportions of
18 combustible and incombustible. Can you help me out
19 there?

20 A. I'm not sure I understand.

21 Q. All right, let me rephrase it. I believe Mr.
22 Roberts asked you whether or not the post-explosion
23 samples would be representative of pre-explosion
24 conditions.

25 A. Uh-huh.

DR. AMYOTTE, EXAM. BY MR. HEBERT

1 Q. And I take that to be a reference to the percentages
2 of or the ratios of combustible and noncombustible.

3 A. But the amount of incombustible material before --
4 No, I'm sorry, I'm getting confused myself.

5 Q. I don't want to -- Can you see the difficulty that
6 I'm having? Maybe we should just break it down. I
7 understood your evidence to be that a post-explosion
8 sample of dust would be representative of pre-explosion
9 conditions or proportions of combustible and
10 noncombustible. Is that a fair characterization of your
11 evidence?

12 A. The post-explosion, if the dust that you're
13 analyzing has been involved in an explosion, you have to
14 expect the amount of combustibles to decrease. I mean
15 otherwise --

16 Q. Yes, it makes sense.

17 A. You simply can't have an explosion.

18 Q. Certainly. So when you said, or as I understood
19 your evidence, that post-explosion could represent pre-
20 explosion conditions, I take it what you're really saying
21 is that the amount of incombustibles after the explosion,
22 if they are so low that they don't meet the threshold, if
23 you will, of the regulations, you can assume from that
24 that the pre-explosion dust had even less combustibles --
25 or less incombustibles as a percentage.

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1 A. Yeah, the incombustibles after the explosion should
2 be representative of the combustibles before the
3 explosion. And if you think specifically of limestone,
4 of calcium carbonate, if there was calcium carbonate
5 there before the explosion, it should be there after. I
6 think that's the heart to the essence of the post-
7 explosion/pre-explosion analysis. Calcium carbonate, if
8 heated with a long enough resonance time, will decompose
9 into lime, CaO calcium oxide, and CO₂. So one might
10 argue that while in an explosion you can expect the rock
11 dust to decompose and actually have less incombustible
12 material because you've lost the CO₂. That's never been
13 demonstrated, the decomposition of rock dust in a coal
14 mine explosion. I think it's my opinion that it's pretty
15 much accepted that the decomposition of rock dust does
16 not occur during coal mine explosion. So, again, if
17 there was rock dust or limestone there prior to the
18 explosion, you would expect it to show up afterwards.
19 And even if you bought the argument that there was rock
20 dust decomposition as a result of the explosion, you
21 would have to see calcium oxide after the explosion.

22 Q. In the dust sample?

23 A. Yes. Yeah, the CO₂ you -- would be a gas you would
24 lose, obviously.

25 Q. But -- and you didn't find that?

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1 A. No. I mean, the analyses for limestone, as you say,
2 are -- or as you see are very low. And as I mentioned to
3 Mr. Roberts, I can't -- I don't know if anyone can say --
4 or at least I shouldn't say -- I can't say whether those
5 low percentages of limestone are as a result of added
6 limestone or not. I don't know.

7 Q. Yes. Whether it could have been in the coal, is
8 that what you're saying or it could have been present
9 otherwise?

10 A. Presumably, yes.

11 Q. All right, fair enough. Now I just -- if you could
12 help clarify another point for me and this is just really
13 an analysis of I think what the Commissioner referred to
14 as the "coking."

15 A. Yes.

16 Q. Signs that the coal dust itself had been subject to
17 increased temperatures, I guess. I just wasn't clear on
18 what samples you analyzed and what portions of the mine
19 they came from.

20 A. Okay.

21 Q. Could you walk me through that a bit?

22 A. Sure.

23 Q. On Section 4.4 -- actually, the previous page, Table
24 2 on page 13.

25 Q. Yes?

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1 A. Essentially, those are -- the top three samples are
2 from further away from the Southwest section, B Road to
3 the intersection of B-2 Road, the 88, 89 and 90, those
4 samples. Samples 97, 98 and 99 are from the Southwest
5 section, okay? So it was sort of a choice of samples in
6 different locations, and they're rib and floor samples.
7 The final sample, 105, was a sample of stone dust. So we
8 didn't -- or I didn't do SEM work. And, again, I didn't
9 manipulate the scanning electron microscope.

10 Q. Yes.

11 A. This was done by the Advanced Materials Engineering
12 Centre. Those six coal or mine dust samples were the
13 ones that were analyzed with the SEM. And that's
14 described in Section 4.4 on page 14. And the SEMS
15 themselves, the scanning electron micrographs are in
16 Appendix B. Sorry, they're not in here, and I think the
17 reason they're not in here is because they don't
18 reproduce very well. Oh, I'm sorry. Here we are,
19 they're in the back, right.

20 Now it's very difficult, looking at the last three
21 pages of the exhibit at the very back --

22 Q. Yes.

23 A. -- and then you see pictures. Now it's -- it's very
24 difficult to tell because those are photocopies of
25 photographs. I'll see if -- if you look at the first one

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1 and if -- may I hold this up, sir, to demonstrate? If
2 you look at this photograph here --

3 Q. That's the first photograph that we would see in
4 the --

5 A. Right.

6 Q. Okay.

7 A. Upper right-hand corner.

8 Q. Yes.

9 A. Okay? Now that is Sample No. 90 which is from the B
10 and B-2 Road area. And I can't draw your attention to
11 really to a lot of detail on this because the pictures
12 are just not sharp enough. But you can see somewhat
13 angular features to the particle?

14 Q. Uh huh.

15 A. I mean, it's -- it looks kind of blocky, I guess,
16 for lack of a better way of describing it. And now I'm
17 going to look for, if you turn the page, and I guess you
18 sort of have to take my word for this, in this photograph
19 here, which is sample No. 98, it can -- do you believe me
20 that those look like little moon craters, almost, or
21 blowholes from which volatiles may have been released?

22 Q. Right.

23 A. And I think the originals show it much more clearly.
24 I'm not claiming that that in any way concludes, I guess
25 to borrow a phrase, conclusive evidence that there was a

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1 coal dust explosion based solely on this. It is, as the
2 Commissioner pointed out earlier, to me it is simply one
3 additional piece --

4 Q. Sure.

5 A. -- in trying to put this together. So that's what I
6 mean when I refer to the scanning electron micrographs,
7 the blowholes, the volatiles being released. And there
8 are some good papers and reports from the U.S. Bureau of
9 Mines which show very well how you can distinguish
10 between coal dust that has not been involved in an
11 explosion and coal dust that has in terms of the physical
12 appearance under the scanning electron microscope.

13 Q. Right. So I take it then that all six samples
14 showed signs of coal dust burn?

15 A. No, I don't think -- I don't think all six samples
16 did. And what I said is that the SEMs show evidence of
17 both burned and unburned particles. Some of them show it
18 more than others, I think, in one or two. And I really
19 would have to have the originals to view that. Don't
20 show -- to me it was not so important, you know, which
21 samples showed it and which didn't because this -- these
22 are only six samples out of 65 that were taken, and the
23 rationale for choosing these six is three from the
24 Southwest section, three from further away, floor, and
25 both ribs. It's not conclusive that, you know, I don't

DR. AMYOTTE, EXAM. BY MR. HEBERT

1 think you need to analyze every sample that was taken in
2 this manner.

3 Q. Certainly.

4 A. Right?

5 Q. Certainly. But the ones that were -- I guess I'm
6 trying to get some sense --

7 A. Of where?

8 Q. Not so much where, but I understand that three were
9 in the Southwest 2 --

10 A. Right.

11 Q. -- near the working face, if you will.

12 A. Right.

13 Q. And then three were further away. Can you tell us
14 whether or not there was more --

15 A. No. No, I can't. And, in fact, you can't --

16 Q. You couldn't go on those samples?

17 A. I've got the originals here somewhere, but I think
18 what you will see is that even from the Southwest section
19 there is some rounding of the particles. I mean, they've
20 been exposed to heat, regardless of what the source of
21 heat may be. That dust has been moved around
22 particularly down the B and B-2 Road area.

23 Q. Okay.

24 A. So I'm not using that in any way to indicate as
25 conclusive evidence that there was a coal dust explosion

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1 right here because these SEMs show -- and remember in an
2 SEM too you've got this sample of dust and you're
3 focusing down on a minutely small area --

4 Q. Certainly. Yes.

5 A. -- of the material.

6 Q. All right. So I was just trying to clarify that.
7 So I take it then that what we can gather from this, that
8 in all six locations of those samples, if you will, there
9 was some burned coal dust?

10 A. I would have to look at the original photographs
11 again to refresh my memory as to whether it was all six.
12 My recollection is that one or more of the Southwest
13 samples did show some evidence of rounding of the coal
14 particles and that there was some evidence of the
15 blowhole formation in the sample further away. I can't
16 say that all six did without going back to this again.

17 Q. All right. And do you have those -- the original
18 photographs here?

19 A. I may have --

20 COMMISSIONER The examinations you did on these coal
21 dust samples are reflected on this graph, are they not?

22 A. Yes, sir. The combustible contents --

23 COMMISSIONER Yeah.

24 A. Yes.

25 COMMISSIONER I'm just wondering if this graph answers

DR. AMYOTTE, EXAM. BY MR. HEBERT

1 Mr. Hebert's questions?

2 A. I'm not sure because if you were to say that up here
3 in the Southwest section, right, because the combustible
4 content is that high in the coal dust, that there could
5 not have been any coal dust that would show up in a
6 sampling procedure that maybe the particles were fused a
7 bit. I can't say that. I can't say that because of the
8 high combustible content --

9 MR. HEBERT Right.

10 A. -- right, that there was none. I've got better
11 photographs here, I guess, which I can perhaps show you.
12 To me it was less important exactly where it showed in
13 the Southwest section or further away. I'm quite
14 convinced that down the B and B-2 Road area there was a
15 coal dust explosion occurring.

16 MR. HEBERT Yes.

17 A. I believe there's other evidence that shows that.
18 And the fact that these SEMs may show some global
19 formation -- yeah, these are better. These are much
20 clearer. I don't know if you want to --

21 Q. I don't need to see them.

22 A. Okay.

23 Q. I'm just interested in your --

24 A. You want --

25 Q. -- interpretation of them.

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1 A. Okay. This is Sample 98.

2 Q. Okay.

3 A. All right. And sample --

4 Q. That was in the back of the shuttle car?

5 A. Right. Now that sample clearly shows fusing,
6 rounding of the particles, formation of some blowholes.

7 Q. Okay.

8 A. Okay? Sample 88, left-hand rib from the fall of
9 ground on B Road to the intersection of B-2 Road. Again,
10 in my opinion, there's some evidence down in this corner
11 of rounding of the particles and possible fusing. So I
12 don't know if that really answers your question.

13 Q. All right. Just to pick up on something you said
14 earlier, I take it that the existence of these features
15 of the coal dust, post-explosion, the rounding and
16 whatnot, doesn't necessarily indicate a coal dust
17 explosion. Could those effects be seen from a methane
18 explosion creating temperature increases and impacting on
19 the coal dust, or would there be some minor burning of
20 coal dust even in that scenario?

21 A. Well, if a coal dust particle is going to show
22 rounding and the blowholes where the volatiles have been
23 released, it simply means it's been heated.

24 Q. Yes.

25 A. And then you ask yourself the question what's the

DR. AMYOTTE, EXAM. BY MR. HEBERT

1 heat source. Well, I would submit that a methane flame
2 will adequately heat coal particles up to the point --
3 because that's the sequence.

4 Q. That's how it starts.

5 A. Right.

6 Q. Okay.

7 A. Equally as well as, say, coal dust, once it's going,
8 the coal dust feeds on itself. And now the heat for the
9 release of further volatiles from the coal dust is from
10 the coal dust flame because the coal dust explosion has
11 now been set up.

12 Q. All right. With respect to the path of propagation,
13 I take it that that depends in part on the oxygen
14 available as well?

15 A. Yes.

16 Q. It wouldn't propagate backwards because there's no
17 further oxygen to use up?

18 A. Well, if once -- once the flame has swept through
19 and if it's consumed all the available oxygen, then it
20 will keep travelling in a direction where there is fresh
21 fuel and fresh oxygen. And, again, if you look at the
22 requirements for dust explosion, you need the fuel, the
23 oxygen, the ignition source, some degree of confinement
24 and you need that dust to be raised up into suspension.
25 As long as those conditions are satisfied, the flame will

DR. AMYOTTE, EXAM. BY MR. HEBERT

1 travel in that direction.

2 Q. And what about the pressure wave itself, does that
3 follow a similar path or will that go -- that's not
4 related to the oxygen, for example?

5 A. Well, the pressure wave that's being generated ahead
6 of the flame front, I think, is going to be much more
7 complicated. And I'm getting a little bit out of my area
8 of expertise --

9 Q. Fair enough.

10 A. -- when I get into too much of pressure waves
11 picking up coal dust. I know that the pressure wave from
12 a coal dust flame will pick up coal dust that's sitting
13 down. The exact mechanism by which it does it and so on,
14 I'm not an expert in.

15 Q. Okay, fair enough.

16 A. But suffice to say that the pressure wave preceding
17 will be bouncing around and moving in all directions.

18 Q. All right. I noticed in the samples taken with
19 respect to the RCMP samples, let's call them --

20 A. Yes.

21 Q. -- they seem to have been taken to the depth of a
22 quarter inch?

23 A. That's my understanding, yes.

24 Q. All right. And have you examined the method set out
25 in the regulations and the legislation in terms of the

DR. AMYOTTE, EXAM. BY MR. HEBERT

1 procedures for taking and sampling coal dust?

2 A. It's not my area of expertise. What I rely upon is
3 that these samples have been taken in a manner which
4 allows me to do the analysis that I've done. I'm not an
5 expert on sampling of mine dust.

6 Q. Okay. Those are my questions, thank you.

7 COMMISSIONER Ms. Gillis?

8 MS. GILLIS I have no questions.

9 COMMISSIONER Mr. Wells?

10 EXAMINATION BY MR. WELLS

11 Q. Looking at the -- or thinking about this coal dust
12 that you were using was, my understanding, all post-
13 explosion coal dust. Would it be --

14 A. Excuse me, sir. Could you clarify, you're talking
15 about the RCMP report, not the Inquiry report?

16 Q. I'm -- I was going back to when you established the
17 St1 rating.

18 A. Okay, that was done with the Inquiry work -- well, I
19 guess it's all work for the Inquiry, but the report that
20 was specifically done for the Inquiry did not involve
21 post-explosion coal dust. I guess it's safer to say it
22 involved post-explosion coal. And if I can refer Exhibit
23 54, under Tab 3, Chapter 2, page 2, we said, "A sample of
24 Westray coal was obtained from Mr. Tom Smales of the
25 Westray Mine Public Inquiry. It is our understanding

DR. AMYOTTE, EXAM. BY MR. WELLS

1 that the coal was extracted from the No. 10 Crosscut area
2 of the mine on or about August 23rd, 1992." So it would
3 be post-explosion coal, but it would be a bag of chunks
4 of coal which we then ground, sieved and produced the
5 coal dust from. And that, really, in my opinion, you
6 know, post-explosion/pre-explosion coal, it's going to be
7 very representative of the coal in that mine.

8 Q. Okay. The -- when you were talking about fine and
9 coarse coal --

10 A. Yes?

11 Q. -- can you give us a micron estimate as to what
12 would be fine coal dust?

13 A. I think the -- there are some actual definitions
14 that are used. You can go with sort of the U.S. Bureau
15 of Mines' definitions of mine dust and so on, but float
16 coal dust, I think, is typically a 20-micron or mean
17 diameter or so. It's in here.

18 Well, maybe -- I should say that, first, my
19 definition of a fine dust is something of 50 40 micron or
20 less, thereabouts.

21 The standard coal that the U.S. Bureau of Mines uses
22 or Pittsburgh pulverized coal has a mean diameter of 50
23 micron.

24 Something of a mine-size coal or coarse coal, 250,
25 300, 350 micron, something in that range.

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1 In one of my reports there are some definitions from
2 the U.S. Bureau of Mines which give you microns for
3 what's known as dust in coal mines, dust in surface
4 industries, float coal dust, and mine-size dust. I can
5 refer you to those definitions, if you want, in the
6 report.

7 Q. No, that's fine. I guess the mine-size dust would
8 probably have somewhere probably from two microns up?

9 A. Yeah, I don't -- in any dust, material in particular
10 form, you're talking about a particle size distribution.
11 The only dust that I know of in which you can say that
12 virtually all of the particles are this diameter, about
13 30 micron, is something called "lycopodium" which is a
14 pollen spore. And it's nice because you can use it as a
15 standard in your testing. If I test with lycopodium here
16 and someone in Europe does it, we're talking about the
17 same thing, chemical composition and particle size. If I
18 test with coal dust here and someone somewhere else does
19 it, we have to be very careful to ensure that we're
20 talking about materials that have similar composition,
21 similar particle size. So mine-size coal dust, although
22 it would be more heavily weighted to the coarser end,
23 would certainly have -- in the definition here is 20
24 percent of the particles less than 75 micron. So you
25 could expect finer-sized dust down to the low end of the

DR. AMYOTTE, EXAM. BY MR. WELLS

1 range. But you would be more heavily weighted to the
2 upper end, the coarser particles.

3 Q. Okay. You mentioned, I believe it was that 40 grams
4 per meter cube, you would still be able to see a light
5 bulb, I guess a 40-watt light bulb or something, I
6 believe, at a meter.

7 A. Yeah. I would like to correct that later, if I may.

8 Q. Okay. I guess all I'm asking in that type of a dust
9 environment, when I think of a .3 milligram -- or .3 --
10 boy, my metric is really showing up here, isn't it. .3
11 millimeter, and looking at a scale, I estimated about 2
12 1/2 business cards, the thickness of 2 1/2 business cards
13 I think would be somewhere in the -- maybe more than the
14 .3 millimeters. If we're going to have a regulation that
15 talks about stone dusting and the frequency or the
16 continuation of stone dusting, and thinking of a dusty
17 environment where you can actually see the dust and it
18 starts to obscure visibility, could we possibly allow a
19 mine to go 12 hours between applications of stone dust
20 without creating the possibility of an explosive amount
21 of dust on top of that applied stone dust?

22 A. Sir, I'm not trying to avoid your question, but I
23 can tell you how much stone dust you need to inert coal
24 dust. I can translate airborne concentrations to dust
25 layers. But I can't tell you how to go about proper

DR. AMYOTTE, EXAM. BY MR. WELLS

1 stone dusting practices. It's just way outside my area
2 of expertise. I have some knowledge of having talked to
3 people at Devco, having been down in a Devco mine, of
4 seeing the white conditions down there relatively -- I
5 didn't see any dust in the air. I have all of those
6 personal experiences, but I have no expertise on which to
7 give you any recommendation with respect to periods of
8 time between rock dusting, or is it safe for people to
9 work in the area and not -- I -- it's just not what I can
10 do.

11 Q. Fair enough.

12 A. May I correct, Mr. Commissioner? I try not to
13 memorize numbers. It wasn't a 40-watt light bulb at one
14 meter, it was something like a 25-watt light bulb at two
15 meters. And the dust concentration, I think, was 40
16 grams per cubic meter. I hope that's all right.

17 COMMISSIONER Well, I think the only --

18 A. I mean, the point is made, you know --

19 COMMISSIONER The only basis of my question was that it
20 would be visible? It would be --

21 A. Yes.

22 COMMISSIONER Yeah. It would be --

23 A. In fact, if you read the open literature on dust
24 explosions, it will tell you that most dust explosions do
25 not occur in work environments because people cannot work

DR. AMYOTTE, EXAM. BY MR. WELLS

1 in those types of conditions. They typically occur in
2 process units like a spray dryer.

3 COMMISSIONER Okay.

4 MR. HEBERT Those are my questions.

5 COMMISSIONER Okay. Gentlemen, it's just about 12:30.
6 Are you -- you will be some time, I suppose, Mr. Wilson
7 or?

8 MR. WILSON I don't expect to be too long.

9 COMMISSIONER Do you want to carry on now?

10 MR. WILSON Sure. Well, we can carry on now and just
11 see how far we get. Or do you want --

12 COMMISSIONER Well, I don't want to -- you know, if it's
13 easier for you to do your cross all at once, then we
14 could maybe recess.

15 MR. WILSON Well, let's recess then.

16 COMMISSIONER Okay. Recessed until 2:00 then, thank
17 you.

18 INQUIRY RECESSED (TIME: 12:28 p.m.)

19 INQUIRY RESUMED (TIME: 1:59 p.m.)

20 COMMISSIONER Mr. Wilson?

21 MR. WILSON Thank you.

22 COMMISSIONER I got the right one this time, did I?

23 MR. WILSON Yes.

24 EXAMINATION BY MR. WILSON

25 MR. WILSON Mr. Amyotte, you worked in your analysis

DR. AMYOTTE, EXAM. BY MR. WILSON

1 for your report for the Commission from one sample of
2 coal taken from Westray. Is it normal to work with one
3 sample or would you like to have more than one sample?

4 A. It's normal to work with a sample that's
5 representative of the conditions that one would encounter
6 in the actual industrial process. We have tested
7 materials already received in particulate form and what
8 we always tell people is that if you want us to test this
9 dust as received, please be sure that it's representative
10 of the composition and the particle size of the dust that
11 you would actually encounter in your industrial process.
12 One sample of coal, so long as it is representative of
13 the coal in the mine, would certainly be sufficient.

14 Q. But you haven't done any test to determine that?

15 A. No. No, we didn't consider that to be part of our
16 mandate. Our mandate was to test the coal as received.

17 Q. For instance, when you did your work for Devco, you
18 had six or more samples of coal, I take it.

19 A. Right. That's very much a function of the client,
20 if you like. Devco was interested in looking at samples
21 from all three of their mines that were operating at that
22 time: Prince, Phalen and Lingan. And for each of those
23 three coals, we produced two size fractions of coal, a
24 fine and then a much finer fraction.

25 Q. In testing for, I guess, explosivity of coal dust,

DR. AMYOTTE, EXAM. BY MR. WILSON

1 you did your testing in a lab under controlled
2 conditions.

3 A. Yes.

4 Q. What factors can exist in a mine that would have an
5 effect on the explosivity of coal dust?

6 A. I can't comment on factors other than what I've laid
7 out in the reports I've written in terms of the
8 conditions that we select in our laboratory scale test to
9 try and ensure relevance to a full scale situation.
10 Things such as choosing an appropriate ignition source.

11 If we try to do tests in the laboratory with spark
12 ignition of coal dust, we're going to get very different
13 results from what we know to be the case in a mine where
14 there can be a massive ignition source. We also look at
15 again the particle size distribution of the coal to try
16 and ensure that the sizes we're testing in the lab scale
17 are representative of what's in the mine. Methane
18 concentrations, again, are an example where in a mine one
19 can expect low methane concentrations and we test with
20 low methane concentrations at the lab scale.

21 Q. What about things such as humidity in the mine? Is
22 that factored into your testing at all?

23 A. I can relate it in terms of the fact that moisture
24 in coal dust is treated as an incombustible component and
25 that when you calculate inerting requirements on a total

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1 incombustible basis, you look at the added rock dust, the
2 moisture -- sorry, the ash and the moisture that's in the
3 coal. So the more moisture content the coal has, the
4 less explosible it becomes because the moisture acts as
5 inerting material. It also would, coal dust with a high
6 moisture content, it would become difficult to disperse.
7 Dry dust is much more readily dispersed.

8 Q. What about the humidity of the air itself, would
9 humid air be less likely to promote dispersal of coal
10 dust as opposed to dry air?

11 A. I really don't have the background to answer that
12 question. We, in our laboratory scale testing, have not
13 varied the moisture content of the air itself.

14 Q. What about areas in the mine where there may be
15 water accumulation or that type of thing? Does it have
16 an effect on the explositivity of the coal dust?

17 A. I'm not sure what you mean. Water accumulation in
18 what sense?

19 Q. On the floors?

20 A. Well, I'm still not quite sure I understand. Water
21 on the floor covering the coal dust?

22 Q. Yes.

23 A. For example? Well, the coal dust would become very
24 wet and would be very difficult to disperse.

25 Q. And that the cutting heads, we've heard evidence

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1 about water being sprayed at the cutting heads while the
2 continuous miners are actually working.

3 A. I'm sorry, I referred to evidence?

4 Q. No, no, we have had evidence.

5 A. Oh.

6 Q. That water is sprayed at the cutting heads when coal
7 is being cut.

8 A. Right, that's my understanding as well. My
9 background is not in mining, so I can only go on what
10 I've read and my understanding is that the purpose of the
11 water being sprayed while the mining machine is working
12 is essentially to try and wet the coal dust to prevent
13 airborne concentrations, part of the reason.

14 Q. That would affect explositivity at the head, anyway.

15 A. Well, I believe that that is one of the prime
16 purposes in spraying water at the mine face.

17 Q. Okay. Now you have included a chart, I guess it's
18 at Exhibit 73, Tab 13.

19 A. I'm sorry, could you repeat that? Exhibit?

20 MR. MERRICK Tab 13.

21 MR. WILSON This was Mr. Richmond's charts.

22 A. Yes, right.

23 Q. And Mr. Merrick asked you to look at the second
24 chart, the summary analysis of dust samples.

25 A. Yes, sir.

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1 Q. Now we've heard -- First of all, I'm correct in the
2 evidence that you gave that in order for coal dust to
3 become explosive, it has to be dispersed in the air.

4 A. In order to get a coal dust explosion, yes.

5 Q. If one looks at this chart in terms of what this
6 chart shows, I think you made the comment that there
7 seemed to be less combustible material after you got at a
8 certain point, and as it was closer to the head, there
9 seemed to be more combustible material.

10 A. Yes, sir.

11 Q. Could that be explained if we follow the theory that
12 I believe some of the experts are espousing that methane
13 was ignited closer to the head of the workings, built up
14 a pressure zone in front of it, proceeded down the
15 Southwest 2-1 Road, kicking up stone dust as it went
16 along -- or coal dust.

17 A. Coal dust.

18 Q. And then started to ignite an explosion.

19 A. That's my understanding, yes.

20 Q. Would this chart be consistent with that
21 understanding?

22 A. That's what I've used the chart as, as being
23 consistent with, equating the decreasing combustible
24 content of the dust further away from the mine face down
25 in the Southwest 2-B Road, equating that decrease in

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1 combustible content to be due to the occurrence of the
2 dust explosion at that point. Or at least some of the
3 dust being involved in an explosion.

4 Q. That is consistent with the theory that the methane
5 started further up into the Southwest 2-1 and wouldn't
6 have burnt the coal dust as it went along until it had
7 been dispersed into the air.

8 A. Yeah, it's consistent with the model that I used as
9 a starting point of my analysis, which is the release of
10 methane from the mine face and ignition somewhere in that
11 vicinity.

12 Q. And I believe you talked about continuous miners, at
13 or around the continuous miner.

14 A. Yes, sir.

15 Q. Now the CANMET test that you used in your report to
16 the RCMP, you were provided with test results.

17 A. That's correct, sir.

18 Q. Do you know whether or not the samples were sieved
19 before they were tested?

20 A. May I check on mine? I have the analyses here. I
21 know that they were dried because they were in most cases
22 very wet. It's my understanding, and based on the
23 analysis sheet that I'm looking at, which is what I used
24 in order to examine the combustible/incombustible
25 content, some, a few of the samples given a certain

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1 designation here were passed 100 percent through a minus
2 28-mesh sieve. But I believe that beyond that -- I'm
3 sorry. Yeah, the samples were dried and after air
4 drying, all samples were screened through a Tyler 28-mesh
5 sieve. The weight of the 28 -- plus 28-mesh. In other
6 words, the material that remained on top of the sieve was
7 recorded and the material that passed through the minus-
8 28 mesh sieve was then analyzed. So it was the material
9 that passed through the minus 28-mesh sieve.

10 Q. And the minus 28-mesh sieve is what size in terms of
11 -- Is that the fine particles?

12 A. No, that's a very coarse. I have it at the tip of
13 my fingers the mesh correspondence, but it would be a
14 coarse particle size. I'll just refer to --

15 Q. So is minus 28 coarser than minus 50, or does it
16 work the other way?

17 A. As the mesh size increases, the particle size
18 decreases and the designation that's given in front of
19 the mesh is plus or minus. If you say plus 200-mesh, for
20 example, that's material that doesn't go through a 200-
21 mesh sieve. If you say minus 200-mesh, that's the
22 material that passed through the 200-mesh sieve. A 200-
23 mesh sieve is about a 75-micron diameter. A 325-mesh
24 sieve is about a 45-micron diameter. A 28-mesh, I'm
25 sorry, I can't give you the exact correspondence in terms

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1 of the particle size, but it's very large, much larger
2 than 75-micron.

3 Q. Okay. You talked about the test before or the
4 usefulness of the test after an explosion as representing
5 conditions that existed prior to the explosion. In light
6 of a further answer that you gave, I'm not quite sure
7 what you're saying there. Could you explain that a
8 little more fully what comparisons you feel you're able
9 to draw post-explosion as it relates to pre-explosion?

10 A. Certainly. I think I've tried to lay out those
11 points in Exhibit 36-B, the final document on pages 10
12 and 11.

13 Q. Okay.

14 A. So if I start at the top of page 10, my statement:
15 "It is my opinion that post-explosion sampling gives a
16 fair and reasonable indication of pre-explosion
17 conditions." At that starting point. And then I've laid
18 out the points as to why I believe that's the case. The
19 fact that there must be some redistribution of the dust
20 following the explosion so that the dust that's sampled
21 in one location would not necessarily have existed there
22 prior to the explosion, which is my understanding why
23 frequent sampling from rib and floor locations is done.

24 The second point deals with the fact that only the
25 coal dust that would be needed to consume the available

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1 oxygen would participate in the explosion. In my
2 previous testimony this morning, I've commented that that
3 amount of coal dust would correspond to a fairly thin
4 layer. Any other dust that was present there which may
5 have been picked up and didn't participate in the
6 explosion then would remain essentially the same as it
7 was prior to the explosion. So, as I've noted on that
8 point, based on this consideration alone, the
9 incombustible content of the dust would be higher post-
10 explosion than pre-explosion.

11 I've also referred to the Bureau of Mines' opinion,
12 or as expressed by Ken Richmond who has reviewed the work
13 at the Bureau of Mines based on the work there that a
14 reasonable picture of pre-explosion conditions can be
15 gained by post-explosion sampling.

16 I've also commented that, in my opinion, the failure
17 of the mine dust samples that were analyzed by CANMET to
18 meet the provincial regulation of 65 percent
19 incombustible content is not marginal. It's very
20 significant.

21 I further go on to talk about points that were
22 raised in the Elfstrom Report concerning preferential
23 raising of coal dust. Is it possible that coal dust
24 would be raised preferentially over any rock dust that
25 might be present. That is presumably avoided because of

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1 the match-up of the particle size between coal dust and
2 rock dust, and that's one of the ideas, in addition to
3 rock dust being a thermal inhibitor, its particle size is
4 in the same ball park as typical coal dust so that
5 there's not preferential raising of one material over the
6 other or segregation.

7 I've also commented, as I did this morning, I'm now
8 on page 11, on the possibility that one might argue that
9 the incombustible content after an explosion may be less
10 than it was before the explosion, the solid particulate
11 matter, because of the possible decomposition of rock
12 dust, calcium carbonate. There's no evidence in anything
13 that either in our laboratory scale tests or lab scale
14 tests, reports that I've read from other institutions or
15 full scale tests again from the U.S. Bureau of Mines to
16 indicate that either in a lab scale or full scale coal
17 mine explosion there is rock dust decomposition
18 occurring.

19 One of the things that you have to consider is the
20 fact that again the coal dust explosion is propagating by
21 devolatilization of the coal dust and then subsequent gas
22 phase burning. The rate at which the coal devolatilizes
23 is significantly higher than the rate at which rock dust
24 can decompose.

25 The final point that I've put there is that I was

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1 shown evidence of analyses performed by SGS Supervision
2 Incorporated on samples that I was told had been taken
3 from the Westray Mine prior to the explosion. As I've
4 said, assuming that these were, in fact, pre-explosion
5 mine dust samples, they support the validity of post
6 explosion sampling because the two analyses from what are
7 purported to be pre-explosion samples and what I note to
8 be post-explosion samples compare fairly well.

9 Q. Who was SGS Supervision Inc?

10 A. I don't know, sir. It was evidence that I was
11 shown.

12 Q. Do you know how those samples were taken at all?

13 A. No, I don't, sir.

14 Q. The work done by the U.S. Bureau of Mines, were
15 there parameters on that work in terms of the reliability
16 that you can place on the conditions of the sampling pre
17 and post-explosion?

18 A. At this point, I can't recall the specific details
19 of that work and I would have to refer to those
20 documents.

21 Q. You realize in this particular explosion, and you've
22 indicated where the samplings by CANMET were taken. I
23 think they were basically taken, if memory serves me
24 correct, were taken from the Southwest 2-B Road and at
25 the crosscuts?

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1 A. Actually they were taken -- I have for each of the
2 samples the complete listing here, some from the fall
3 ground on B Road to the intersection of B-2 Road, along
4 Southwest 2-B, Southwest 2-A, some from the Southwest
5 section up by the shuttle car and then down through the
6 crosscuts, actually down to No. 3 Crosscut on the mains.

7 Q. While we're looking at those, we're looking at
8 samples taken post-explosion in areas where there was
9 considerable amount of coal on the conveyor belt, coal
10 around the shuttle car that would have been not a source
11 where stone dusting would occur. Would you agree?

12 A. I think that, as I've commented in my report, the
13 possibility of the coal dust explosion propagating up to
14 No. 2 Main, because of the coal dust generated by the
15 movement of coal up the belt, yes, I think that that
16 would be a contributing factor and I do -- sorry.

17 Q. Well, the coal dust was also coming down on a
18 conveyor belt on the Southwest 2-B Road.

19 A. Yes.

20 Q. You're aware of that.

21 A. Yes, and I've commented on that in here as well.

22 Q. Would that not create, and I'm thinking, I'm trying
23 to put this in perspective, would that not create an
24 awful lot of extraneous coal dust that when settled would
25 settle on top of any of the underlying dust? I mean,

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1 that would be the dust -- coal -- We know that the
2 conveyor belts were dislodged. We know that there's a
3 lot of coal on the conveyor belts. Would that not create
4 a lot of dust that would be abnormal for those particular
5 areas?

6 A. I don't think I have the background to give an
7 opinion on that.

8 Q. But you didn't take that into consideration?

9 A. No.

10 Q. When you were expressing your opinions on the --

11 A. No, I was looking at the samples, the analyses of
12 the samples that I was provided with.

13 Q. And I believe those samples were referred to taking
14 the top quarter inch.

15 A. That's correct.

16 Q. Of dust from the areas.

17 A. That's my understanding as well.

18 Q. So that would be taking the last, I guess the last
19 settled coal dust would be the dust that would be taken
20 in those samples.

21 A. I believe that would be correct.

22 Q. So do you know whether or not they talked about that
23 in terms of the U.S. experiments, whether or not one had
24 to be careful that you were in an area that would have,
25 for lack of a better word, extraneous sources of dust

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1 brought into that area.

2 A. No, I don't know.

3 Q. The minimum required coal dust for an explosion, the
4 amount of coal dust used in an explosion, I believe you
5 talked about earlier, depended a lot on the oxygen
6 available. Is there any way that you measure that in
7 terms of how much -- or estimate how much coal dust would
8 be used in that type of an explosion or in the type of an
9 explosion that we're looking at here?

10 A. I can give you an estimate. The -- well, the
11 concentration at which you see in laboratory-scale tests,
12 the optimum explosion parameters in terms of maximum
13 pressure and rate of pressurize is somewhere around 400-
14 500 grams per cubic meter. If you calculate for coal and
15 just take, say, the combustible component, say, if you do
16 an ultimate analysis of coal and get the carbon and the
17 hydrogen and the things that you know will burn, you can
18 calculate what's called the "stoichiometric"
19 concentration of coal. And that's the amount -- that
20 gives you the amount of oxygen that will be required
21 theoretically to burn all of that combustible material in
22 the coal. For dust, typically, you need three-to-four
23 times that stoichiometric concentration because not all
24 of the dust, not all of the combustible material in the
25 dust will burn because some of it's solid.

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1 In the case of coal dust, you need three to four
2 times the stoichiometric concentration of the coal dust
3 to produce a concentration of volatiles which are then at
4 their stoichiometric concentration which will then give
5 you the peak explosion effects. And that corresponds to
6 a concentration of about 400-500 grams per cubic meter of
7 coal dust.

8 Q. If you have more than that, does that -- when you
9 have more than that does that have any more of an effect
10 on the --

11 A. If you have more than that, that dust may somehow
12 get raised into suspension. You may have, I suppose,
13 some heating of the excess dust and some volatiles
14 released, but you're already at the optimum -- or the
15 optimum point. So all you need to get the maximum
16 explosion pressure and rate of pressurize is that three-
17 to-four times the stoichiometric concentration, the 400-
18 500 grams per cubic meter.

19 Q. Okay. Now you were asked questions about your
20 approaches to Westray for the assignment related to
21 testing. Was anyone else approaching Westray at the time
22 that you're aware of? Or do you know whether they
23 were --

24 A. No, I'm not aware of anyone else, sir. As far as I
25 know in this province, institutionally-wise, we're the

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1 only ones with the capability. I could be wrong. But I
2 don't know if anyone else was approaching Westray.

3 Q. And I think you mentioned that you provided Westray
4 with a number of reports of previous studies?

5 A. Yes, sir.

6 Q. One of them was at Devco?

7 A. Yes, sir.

8 Q. It would have much of the same information that
9 would have existed in your report to the Commission?

10 A. Those reports dealt with the same types of things,
11 obviously different materials. We were dealing with
12 Devco coal and not Westray coal. But those reports --
13 that report and those papers dealt with explosion
14 pressures, rates of pressurize, lean flammability limits,
15 and inerting requirements for coal dust for CBDC coal
16 dust.

17 Q. And when did you transmit those reports, you said,
18 in October?

19 A. If I just refer to my can say to the RCMP, excuse
20 me. According to my can say, the -- I wrote another
21 letter to Mr. Phillips and attached a copy of the first
22 paper from the Journal of Loss Prevention, the process
23 industries which dealt with explosion pressures, over
24 pressures, lean flammability limits of coal dust. That
25 was on February 6th, 1991.

DR. AMYOTTE, EXAM. BY MR. WILSON

1 Q. You talked about the U.S. standard for stone
2 dusting. Have they moved from their 65-percent
3 requirement --

4 A. Not to my knowledge, no.

5 Q. -- legislation?

6 A. No.

7 Q. They're still there. When did the -- when was the
8 testing done in the States that you refer to which put
9 suspect on those numbers?

10 A. Okay. The main paper that I've referred to there
11 which was published in the proceedings of Safety and Mine
12 Research Institute's -- was in 1989. That was a report
13 of the large-scale work. As I've stated in my Inquiry
14 report, in that paper published in 1989 by Weiss and
15 coworkers who are the U.S. Bureau of Mines large-scale
16 facility, they've commented that the U.S. regulations of
17 65 percent total incombustible for intakes is based on
18 work from the 1930s when the typical size of dust was
19 approximately 20 percent less than 200 mesh.

20 The requirement of 80 percent total incombustible
21 for returns is based on work from 1965 in the Bruceton
22 Experimental Mine using finer coal dust particles which
23 included up to 81 percent less than 200 mesh.

24 So what you have is one level of 65 percent being
25 based on work done some time ago using a coarser coal, 20

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1 percent less than 200 mesh. And the requirement of 80
2 incombustible being based on more recent work in which
3 the tests use a finer coal, 81 percent less than 200
4 mesh.

5 Q. And that was the U.S. Bureau of Mines that was
6 conducting the testing?

7 A. The U.S. Bureau of Mines would have conducted the
8 work in 1965 because the Bruceton Experimental Mine is
9 theirs. The work that was done in the 1930s which led to
10 setting a level of 65 percent total incombustible, I
11 think one would have to check. I think it's a reasonable
12 presumption that that work was also done by the U.S.
13 Bureau of Mines although I can't definitively say.

14 Q. Okay. In any event, they haven't regulatorily
15 changed their 65 percent mandate limit?

16 A. No. But it's my understanding -- I may be wrong in
17 this, but I don't think the U.S. Bureau of Mines sets the
18 regulations.

19 Q. Okay.

20 A. They do the experimental work.

21 Q. But do you know whether the legislation has changed?

22 A. These would have been current as of this paper in
23 1989 and, to my knowledge, I'm pretty sure that they
24 haven't been changed.

25 Q. Okay. Now the Nova Scotia legislation requires, as

DR. AMYOTTE, EXAM. BY MR. WILSON

1 you mentioned before, 65 percent inerting content and 10
2 percent for every one percent over -- or every one
3 percent of methane?

4 A. Yes, sir.

5 Q. In your testing of the 2.5 percent methane, that
6 would be -- that would work out to a requirement of 90
7 percent? Is that your interpretation of the legislation?

8 A. Yes, sir.

9 Q. And, as well, you're aware that in terms of the
10 Westray operation, they were dealing with diesel-operated
11 engines underground?

12 A. I'm not aware of the details of the operation, but
13 I'm aware that they had been given permission to do that
14 according to certain conditions.

15 Q. And your understanding, and correct me if I'm wrong,
16 was -- I believe it was your understanding that among
17 those conditions was a requirement that there be 85
18 inertion up to and within 300 feet of the working face on
19 the intakes?

20 A. I believe it was either 85 or 90. If you tell me it
21 was 85, then --

22 Q. Well, 15 percent combustible, 85 --

23 A. 15 combustible would be 85 percent incombustible.

24 Q. And your recommendations for inerting that you have
25 suggested to the Commission would be an overall of 80

DR. AMYOTTE, EXAM. BY MR. WILSON

1 percent or 75 percent or 85 percent?

2 A. Yes, sir.

3 Q. Thank you.

4 EXAMINATION BY THE COMMISSIONER

5 Q. That last point, that was without considering
6 methane or with consideration of methane?

7 A. Oh, no, that was without consideration of methane,
8 without consideration of permissible or non-permissible
9 equipment or anything that's outside the scope of my
10 expertise, but simply based on the lab-scale work
11 comparison to full scale.

12 In the presence of methane, it's my opinion that the
13 current regulations of 10 percent additional rock dust
14 for each one percent methane are adequate, one might
15 suggest more than adequate, in fact.

16 Q. I see, okay. Just a couple of points. And you may
17 not have an answer for this, but I would just like to get
18 it in the record. In the course of your experiments with
19 the explosibility of methane and coal dust, have you ever
20 introduced the effect of water barriers or dust barriers
21 in -- factored those into your experiments?

22 A. No. The testing that we've done has -- with rock
23 dust, for example, they've been intimately-mixed mixtures
24 of rock dust and coal dust prior to being dispersed. We
25 haven't looked at the barriers.

DR. AMYOTTE, EXAM. BY COMMISSIONER

1 Q. You haven't looked at the effect of barriers on the
2 explosion, on quelling an explosion?

3 A. No.

4 Q. No, okay.

5 A. I know that there are some places in the world are
6 and that there have been large-scale tests done on that -
7 - on the issue of barriers, both water and rock dust.

8 Q. One other point, have you ever done any
9 experimenting on fluid inerting of coal dust?

10 A. For example, spraying with water?

11 Q. Nitrogen, introducing nitrogen in the system?

12 A. Ah.

13 Q. Or there's another product that's something -- it's
14 a "K," a "Purple K" or --

15 A. Yeah, Purple K, yeah.

16 Q. Yeah.

17 A. I remember if it's the same as "ABC" which is a
18 principal ingredient in fire extinguishers, there's salt
19 and other materials that, it's my understanding from what
20 I've read, have been tried but which have been found to
21 generally not be practical. Something like the ABC, that
22 the active ingredient in a dry-chemical fire extinguisher
23 is a much more effective suppressant material than rock
24 dust because it chemically interferes with the combustion
25 reactions. It's a different -- operates in a different

DR. AMYOTTE, EXAM. BY COMMISSIONER

1 mode than does rock dust. The Bureau of Mines in the
2 States has done a lot of research on that, and I guess my
3 opinion that no one has really come up with anything
4 better or cheaper than rock dust.

5 Q. Okay, fair enough. Thank you very much. Mr.
6 Merrick?

7 EXAMINATION BY MR. MERRICK

8 Q. Just a couple of questions, Doctor. Just picking up
9 on that last point, I take it that although nobody has
10 come up with anything better, stone dust, particularly if
11 it has to be applied at ratios of four to one or even
12 higher, is not really a particularly good inerting
13 substance or can you say that?

14 A. No, I think you can. I'm a little hesitant to say
15 it because the danger in saying that is then you say
16 well, why bother rock dusting. But purely
17 scientifically, looking at the effectiveness on a per-
18 mass basis, you know, how much of the material do you
19 need to inert an explosion, rock dust is not nearly as
20 effective as some other materials. Other materials that
21 are less practical for a coal mine environment and more
22 costly. I think rock dusting has been around for
23 decades, '30s, '40s, perhaps. And I'm not sure that
24 there have been a lot of major improvements in the use of
25 rock dust. If you add it in sufficient amounts, you will

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 suppress, but the fact remains that you need -- and I
2 just during the break put this quick ratio up here, that
3 in some of our tests we showed an inerting ratio of four,
4 which means you need four times as much rock dust as you
5 do coal dust. So in that sense it can be viewed as not
6 particularly effective. But when applied in the proper
7 amount, it will effectively suppress an explosion. There
8 is no doubt about that.

9 Q. I suppose again though, just using that ratio for a
10 moment, and again this is a very simplistic description,
11 but if one were to properly or adequately rock dust a
12 mine, one would expect the mine operator to be lugging
13 into that mine four times the amount of rock dust than
14 the coal dust that's in that mine?

15 A. Well, I think, again, my lack of expertise in coal
16 mining can only allow me to say, yeah, that makes sense.
17 But one of the principles of explosion prevention in
18 industry is good housekeeping and the concept of removing
19 potential fuel. So I think that in addition to adding
20 inert material, be it rock dust to coal dust or another
21 inhibitor to another explosable dust, one can also look
22 at the possibility of removing, from the industrial
23 situation, the fuel. And whatever is left, whatever is
24 unavoidable or whatever can then be treated with an
25 explosion inhibitor.

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1 Q. Quite so. Just three last quick points. Number
2 one, I want to clarify something so that there is no
3 misunderstanding from your evidence this morning. What
4 you were being -- what you were proposing to Westray to
5 do was a testing program on their coal dust. You were
6 not proposing in any way to set up or run a sampling
7 program --

8 A. Oh, no.

9 Q. -- for them?

10 A. No. And -- no, in fact --

11 Q. Well, I think that gets it.

12 A. That's kind of surprising because there's a world of
13 difference there.

14 Q. I know. I just wanted to make that clear.

15 A. And I would not -- I couldn't imagine trying to set
16 up a sampling -- dust sampling program for anyone because
17 I have no idea how to do it.

18 Q. All right.

19 A. I can take the coal or the material you provide me.
20 I can produce the size fraction, I can take the
21 particulate dust, we can in our lab, and we can tell you
22 how explosive that material is. We can't tell you how to
23 sample for that.

24 Q. I just wanted to make that clear.

25 A. Thank you.

DR. AMYOTTE, EXAM. BY MR. MERRICK

1 Q. Next point, you were asked by Mr. Roberts whether
2 the addition of methane to coal dust might enhance the
3 explosion. I forget his exact terminology. I want to
4 make sure I've got this clear, adding methane to coal
5 dust, coarse or fine, has a significant or noticeable
6 impact on the rate of pressure increase, but am I correct
7 in saying that it does not significantly increase the
8 high pressure that is created in a dust explosion?

9 A. Based on the laboratory-scale tests that we had
10 done, yes, you're correct.

11 Q. So that --

12 A. I can agree with that.

13 Q. -- adding methane doesn't necessarily mean that a
14 given amount of coal dust will create a bigger or more
15 violent -- noticeably a more bigger or more violent
16 explosion, but it may cause a faster rate of pressure
17 rise, faster flame speed, that sort of thing?

18 A. I agree with the latter part of your statement that
19 it will cause a more rapid explosion, a higher rate of
20 pressure rise. But I think what you also have to be
21 concerned about is that more rapid rate of pressure rise,
22 and I'm thinking now of enclosed vessels leading to
23 deformation or rupture simply based on the speed -- the
24 violence with which the explosion is happening. If the
25 vessel could contain or could withstand that rate of

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1 pressure rise, then eventually, without methane, you, for
2 coal dust, you would approach about the same peak
3 pressure.

4 Q. All right. The last question I've got comes back to
5 this chart that we put in this morning that's in Exhibit
6 73, Tab 13. And, again, I just want to make it clear
7 that we're putting this in the right perspective.

8 A. Yes, sir.

9 Q. That chart indicates that according to the sampling
10 program carried out by Mr. Richmond, he determined that
11 there was a higher percentage of combustibles the closer
12 you got to the face on the Southwest 2-1 Road. I assume
13 -- but the thing that struck me is that the drop in his
14 graph occurs at about the junction point of the Southwest
15 1 Road -- Southwest 2-1 Road and the Southwest 2-B and A
16 Roads. I assume that one possible explanation for that
17 might also be if there had been some stone dusting
18 occurring only on the main roadways and not up into the
19 heading. I guess, this shows the ratio of combustibles
20 to incombustibles.

21 A. Right.

22 Q. It doesn't show absolutes?

23 A. No, that's correct.

24 Q. So that if somebody had happened to stone dust in
25 the main Southwest 2-A and B Roads but not up into the

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1 headings, that might be an explanation for this graph?

2 A. I suppose. But I think if you look at the bottom
3 curve which is the average limestone in the sample
4 percent --

5 Q. Yes?

6 A. -- you don't see a significant or corresponding --
7 as you see the decrease in the combustible, you don't see
8 a corresponding increase in the limestone. So how do you
9 account -- if the combustibles decrease by that much and
10 the limestone can't account for that by increasing
11 enough, then the only thing I'm left with to conclude is
12 that there's some variation in the other incombustibles
13 in the dust, for example, the ash.

14 Q. All right, good point. All right, that's all I've
15 got. Thank you.

16 COMMISSIONER Thank you, Doctor.

17 WITNESS WITHDRAWS

18 COMMISSIONER One major housekeeping item that I was
19 asked to discuss or decide on here was the question of
20 the March break. Apparently there are some people who
21 want to be -- want to get their plans made well in
22 advance. Whenever it is, we can go for it. Now if you
23 just tell me when it is, I'll plug that out or take that
24 out of the -- Deirdre, would you care to comment on that?

25 MS. WILLIAMS-COOPER From the 11th to the 15th.

DISCUSSION

1 COMMISSIONER Is that in agreement with everybody, from
2 the 11th to the 15th? Okay, that's the March break and
3 some of us will be other places than here, I guess.

4 The only other thing I would like to mention is that
5 we are adjourning now until the 8th of January and I
6 understand the first witness at that session will be
7 Miklos Salamon who will be completing his evidence,
8 having been interrupted earlier on in this session.

9 Before I close off here this afternoon, I would just
10 like to thank counsel and the parties for their obvious
11 cooperation over the past three and a half to four weeks
12 in allowing this hearing to run as smoothly as it had --
13 or has it has, I should say. I'm not naive enough to
14 feel that or to assume that this is going to continue
15 during the entire hearing because there are areas that
16 will be maybe a little bit more controversial as we get
17 into the anecdotal evidence in the new year. But I think
18 it does suggest one thing to me and that is that we are
19 pretty well all here for the same reason and that's to
20 get at all the facts to the extent that they are
21 discoverable. And I thank you for that.

22 Have a good festive season and we will see you
23 January the 8th, same time, same place. Thank you very
24 much.

25 INQUIRY ADJOURNED (TIME: 2:43 p.m.)

REPORTER'S CERTIFICATE

I, Margaret E. Graham, Court Reporter, certify that the foregoing is a true and accurate transcript of the evidence taken by way of recording and reduced to typewritten copy.

Margaret E. Graham

DATED this 28th day of November, 1995, at Stellarton,
Nova Scotia.