

# DISCUSSION PAPER

## 1. TITLE

Firefighters and Certain Cancers

## 2. ISSUE

In light of current scientific and medical knowledge, is a statutory or policy provision required to address the issue of cancer among firefighters?

## 3. BACKGROUND

### 3.1 Law and Policy

There is no statutory provision or policy specifically addressing cancer in firefighters. Instead, the general provisions of the *Workers Compensation Act* (“*Act*”) would apply in the same manner as for any other worker.

Section 6(1) of the *Act* gives the Workers’ Compensation Board (“WCB”) authority to compensate workers for occupational diseases. It establishes that three criteria must be met before compensation is provided to a worker:

1. The disease in question is recognized by the WCB as an occupational disease.
2. The occupational disease is due to the nature of the worker’s current or past employment. Thus, once it is determined that a worker has a recognized occupational disease, the WCB must consider in each case whether the worker’s employment caused the disease.
3. The worker is disabled from earning full wages as a result of the occupational disease.

In the case of a worker’s death, compensation is provided to surviving dependants where the death was caused by an occupational disease due to the nature of the worker’s current or past employment.

As noted above, the first criterion for compensation is that the worker has a recognized occupational disease. The *Act* sets out four methods by which the WCB may recognize an occupational disease<sup>1</sup>:

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<sup>1</sup> Three of these methods are described in the definition of “occupational disease” in section 1 of the *Act*. Section 6(4.2) of the *Act* sets out the fourth method of recognition.

- by inclusion in Schedule B of the *Act*;
- under section 6(4.2) of the *Act*;
- under the *Occupational Disease Recognition Regulation* (“*ODR Regulation*”); and
- by order dealing with a specific case.

The manner in which a disease is recognized is primarily based on the strength of medical and scientific evidence about the role of employment in causing the disease. A brief discussion of each method of recognition is provided below.

### **3.1.2 Recognition by Inclusion in Schedule B**

Inclusion of a disease in Schedule B of the *Act* is the highest level of recognition as it affords a rebuttable presumption that the disease and the corresponding process or industry are causally related. The WCB may amend Schedule B by regulation.

If a worker develops a disease listed in Schedule B and, at or immediately before the date of disablement, was employed in the process or industry described for the disease, it is presumed the disease was caused by employment unless the contrary is proved. Where the worker was not employed in the relevant industry or process at or immediately before the date of disablement, the worker is not entitled to a presumption that the disease is due to employment. In such cases, the WCB must determine, based upon all of the relevant evidence, whether the disease is work-related. This is often referred to as case-by-case adjudication.

The primary purpose of Schedule B is to avoid the repeated effort of producing and analyzing medical and other evidence of work-relatedness where the WCB has concluded, based on the research, that a disease is specific to a particular industry or process.

The WCB lists a disease in Schedule B in connection with a process or an industry when it is satisfied from the expert medical and scientific advice it receives that there is a substantially greater incidence of the disease in a particular employment than there is in the general population.<sup>2</sup> This involves a consideration of whether the disease is common in the particular employment and not common in the general population, and whether the disease is specific to the employment.

Mesothelioma, where there is exposure to airborne asbestos dust, is an example of a disease and process listed on Schedule B. The scientific evidence of a clear link between mesothelioma and exposure to asbestos dust is strong and well substantiated.

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<sup>2</sup> See policy item #26.01 of the *Rehabilitation Services & Claims Manual* (“*RS&CM*”).

### **3.1.3 Recognition as a Disease Peculiar to a Specific Process**

Section 6(4.2) of the *Act* gives the WCB authority to designate or recognize a disease as peculiar to or characteristic of a particular process, trade or occupation. The WCB may limit the scope of the recognition by specifying whatever terms or conditions it deems appropriate.

Section 6(4.2) may be used to recognize a disease where the expert medical and scientific information is insufficient to warrant listing the disease in Schedule B, but is sufficient to create the need for an institutional memory. By designating a disease under section 6(4.2), the WCB recognizes a possibility that employment may have contributed to causing the disease where the worker was employed in a specific process, trade or occupation. However, there is no presumption that the disease is work-related.<sup>3</sup>

At present, there is only one disease recognized in this manner - osteoarthritis of the first carpo-metacarpal joint of both thumbs for physiotherapists who perform deep friction massage.

### **3.1.4 Recognition by Regulation**

Section 1 of the *Act* gives the WCB authority to recognize a disease as an occupational disease by regulation of general application. When listed in the *ODR Regulation*, a disease gains the status of a recognized occupational disease for the purposes of workers' compensation. However, the regulation does not specify any accompanying process, trade, industry or occupation. Thus, the recognition as an occupational disease is not specific.

This method of recognition is used when the WCB concludes that the disease is sometimes due to the nature of a particular employment covered by the *Act*, but it does not appear that the disease is more likely to occur in connection with that employment than elsewhere.<sup>4</sup> The WCB currently recognizes 37 occupational diseases by regulation, including chicken pox and food poisoning. Each claim involving a disease listed on the *ODR Regulation* is considered on its own merits.

### **3.1.5 Recognition by Order in a Specific Case**

Section 1 of the *Act* grants the WCB authority to recognize a disease as an occupational disease in a particular case.

A disease may not have been previously recognized due to weak or a complete absence of medical and scientific information linking the disease with employment. If the merits and justice of an individual claim for such a disease warrant its recognition as an occupational disease, the WCB may do so by order dealing with a specific case.

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<sup>3</sup> See policy item #26.02 of the *RS&CM*.

<sup>4</sup> See policy item #26.03 of the *RS&CM*.

The disease is recognized as an occupational disease limited to the specific facts of the individual claim.<sup>5</sup> No institutional memory or precedent is established.

Since 1985, the WCB has accepted approximately six claims for brain cancer in firefighters by order in a specific case.

### **3.2 Adjudication of Claims for Cancer in Firefighters**

Claims made by firefighters who have developed cancer are currently adjudicated on the same basis as claims filed by any other worker in another occupation. Some cancers, such as leukemia, are listed in Schedule B along with a corresponding industry or process. In the case of leukemia, for instance, where there is evidence of prolonged exposure to benzene at or immediately before the date of disablement, the worker is entitled to a rebuttable presumption that the cancer is due to employment.

Other cancers, such as brain cancer, primary kidney cancer and multiple myeloma, are not recognized in a general sense as occupational diseases. This means they are neither listed in Schedule B, nor included in the *ODR Regulation*, nor recognized under section 6(4.2) of the *Act*. However, these cancers may be recognized as occupational diseases by order dealing with a specific case. Over the years, a number of claims by firefighters for brain cancer, kidney cancer and multiple myeloma have been accepted on this basis.

Since approximately 1985, the WCB has received 47 claims for cancer by firefighters, 17 of which have been accepted. The table in Appendix 1 provides a summary of the number and type of cancer claims made by firefighters. Some of these claims were accepted as a result of appellate decisions.

### **3.3 How This Issue Arose**

In 1997, the BC Professional Fire Fighters' Association ("BCPFFA") requested that brain cancer in firefighters be added to Schedule B of the *Act*. The former Policy and Regulation Development Bureau of the WCB subsequently obtained an expert report on firefighting and brain cancer in 1999.<sup>6</sup> The report found inadequate evidence to conclude there was an increased risk of brain cancer among firefighters.

A peer review of the expert report was obtained in 2000.<sup>7</sup> The peer reviewer indicated there was consistent evidence in the literature that the subgroup of firefighters employed during the 1940s and 1950s were at increased risk to develop brain cancer during the late 1960s and 1970s. However, all firefighters

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<sup>5</sup> See policy item #26.04 of the *RS&CM*.

<sup>6</sup> The report was prepared by Dr. Marie Swanson, Director, Cancer Center, College of Human Medicine, Michigan State University.

<sup>7</sup> The peer review report was prepared by Dr. John Vena, a professor in the Department of Social and Preventive Medicine, University at Buffalo, State University of New York.

were not at increased risk of brain cancer. In individual cases, the work history, temporality of exposure and latency<sup>8</sup> must be taken into consideration to determine the work-relatedness of brain cancer among firefighters.

Work on the firefighter/brain cancer project was not complete in 2001 when policy development related to occupational diseases was temporarily interrupted during the provincial government's Core Services Review. At the same time, the Occupational Disease Advisory Committee, a stakeholder advisory committee that played a key role in occupational disease policy development, ceased to function.

More recently, the governments of four other Canadian provinces have amended their workers' compensation legislation to include a statutory presumption for a number of cancers in firefighters. Following a report by Dr. Tee Guidotti, the Manitoba government was the first to introduce a statutory presumption in 2002 for brain, bladder and kidney cancers, non-Hodgkin's lymphoma and leukemia. Alberta, Nova Scotia and Saskatchewan followed suit in 2003.<sup>9</sup>

In early 2003, the BCPFFA provided the WCB with a report by Dr. Tee Guidotti evaluating the association between selected cancers and occupation as a firefighter. Dr. Guidotti's report found that it would be reasonable to adopt a presumption for brain cancer, bladder cancer, kidney cancer, testicular cancer, non-Hodgkin's lymphoma, leukemia and lung cancer among firefighters who do not smoke. He also suggested that it would be worth considering colon cancer for addition to a presumptive list.

In response, the Greater Vancouver Regional District ("GVRD") submitted a report to the WCB by Dr. Geoffrey Howe criticizing the methodology in Dr. Guidotti's report. Dr. Guidotti and Dr. Howe have expressed differing views on the correct approach to determining whether there is a causal link between a disease and exposure to an agent. The differing views are discussed in greater detail below in section 3.6 of this submission.

A rigorous scientific review of the association between certain cancers and the occupation of firefighting was subsequently accorded a high priority on the work schedule of the WCB's Policy and Research Division ("PRD"). The review was to consider the following types of cancer:

- primary site brain cancer
- primary site kidney cancer
- primary site bladder cancer
- primary site ureter cancer
- primary site colon cancer

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<sup>8</sup> The term "latency" refers to the period between exposure to a disease-causing agent or process and the appearance of symptoms.

<sup>9</sup> Nova Scotia has also included colon cancer in its presumption, while Alberta has included colon and ureter cancers.

- non-Hodgkin's lymphoma
- leukemia
- primary site lung cancer in non-smokers
- multiple myeloma
- primary site testicular cancer

### **3.4 The Scientific Review Process**

In October 2003, the WCB commissioned Cancer Care Ontario (“CCO”) to conduct a systematic review of the scientific and medical literature on the relationship between the occupation of firefighting and the cancers listed above.<sup>10</sup> CCO submitted a final report to the WCB in June 2004.

The BCPFFA and the GVRD each nominated a peer reviewer to review the CCO report. Dr. Pierre Band and Dr. David Parker are both physicians with backgrounds in occupational epidemiology.<sup>11</sup> Dr. Band and Dr. Parker submitted a joint peer review report (“Peer Review Report”) to the WCB in October 2004.

CCO provided the WCB with a response to the peer review report in November 2004.

### **3.5 Stakeholder Involvement**

The BCPFFA and the GVRD have been provided with regular updates throughout the scientific review process.

As discussed above, these two stakeholder groups each nominated a peer reviewer to review the CCO report. In addition, they have been provided with copies of the draft and final CCO reports and given an opportunity to raise questions of a scientific nature about the CCO report for consideration by the peer reviewers. These stakeholders have also been provided with copies of the Peer Review Report and the CCO response.

### **3.6 Approaches to Evaluating the Science**

#### **3.6.1 Differing Approaches of Dr. Guidotti and Dr. Howe**

In his report to the BCPFFA, Dr. Guidotti indicated that the logic of assessing causality in adjudication was not the same as for concluding causation in a scientific study. He stated that the legal standard of “more likely than not” used to adjudicate workers’ compensation claims was not as stringent as the scientific standard of 95% certainty. Dr. Guidotti also suggested that the general criteria for assessing causality in epidemiological studies were inappropriate if the standard of proof is “more likely than not”. As a result, he asserted the *Act*

<sup>10</sup> The BCPFFA and the GVRD were consulted about the selection of CCO before the scientific review got underway. Neither group objected to CCO conducting the review.

<sup>11</sup> Dr. Band was nominated by the GVRD and Dr. Parker by the BCPFFA.

required that scientific evidence of an association between firefighting and specific cancers be weighed based on a standard of proof of “50+%

In his report, Dr. Howe suggested that Dr. Guidotti had appeared to confuse the 95% value used in scientific studies with a standard of proof or certainty. He indicated that the 95% value was used to measure statistical significance in scientific studies.<sup>12</sup> It was not a standard of proof and it made no sense to compare it with the standard of proof in a legal setting. Dr. Howe also observed that generally accepted scientific criteria of causality were used to assess overall causality between a disease and exposure and had nothing to do with level of proof in an individual case.

### **3.6.2 WCB Criteria for Assessing Scientific and Medical Information**

Under the workers' compensation system, the standard of proof is that used in the civil law system: the balance of probabilities. The *Act* also directs that where the evidence in a worker's case is equally weighted on an issue, the WCB must resolve the issue in a manner that favours the worker.

The balance of probabilities and the benefit of doubt apply when the WCB is adjudicating an individual worker's case. The concepts are less relevant when the WCB is considering, at a policy level, whether there is, in general, evidence of an association between a disease and an industry, process, trade or occupation. The *Act* does not direct the WCB to apply a particular standard of proof when recognizing an occupational disease, either by inclusion in Schedule B or by one of the other general methods of recognition. When considering whether there is evidence of an overall association between a disease and a particular employment, the WCB's practice has been to consider recognized scientific criteria for assessing causality.

The identification of occupationally related diseases is a difficult and complex task. In an effort to describe in a concise manner the sort of medical/scientific information that is useful in deciding questions about occupational causation of disease, the former Governors of the WCB adopted the *Protocol for the Assessment of Medical/Scientific Information* (“*Protocol*”) in 1993.

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<sup>12</sup> The 95% value is generally used to measure the confidence interval for the results of a study. A confidence interval is a range of values calculated from the results of a study, within which the true value is likely to fall. A 95% confidence interval means the range set by the interval will contain the true risk 95% of the time. A confidence interval that includes the relative risk of 1.0 is not considered statistically significant.

The *Protocol* largely adopts the criteria suggested in 1965 by British statistician Sir Austin Bradford Hill for evaluating when a causal relationship can reasonably be assumed on the basis of human observational studies. The Bradford Hill criteria are generally recognized in the scientific community.<sup>13</sup>

The WCB uses the criteria listed in the *Protocol* to evaluate scientific information and in particular whether the evidence warrants including a disease in Schedule B. The criteria in the *Protocol* are summarized in Appendix 2.

Both CCO and the peer reviewers were asked to prepare their respective reports with reference to the criteria listed in the *Protocol*. In turn, the PRD used the *Protocol* to evaluate the reports.

## **4. DISCUSSION**

### **4.1 Systematic Review and Meta Analysis**

CCO was commissioned to conduct a systematic review of the scientific and medical literature on the relationship between certain cancers and the occupation of firefighting. A systematic review has been defined as “a review of a clearly formulated question that uses systematic and explicit methods to identify, select and critically appraise relevant research, and to collect and analyze data from studies that are included in the review”.<sup>14</sup> The elements of a systematic review are described in Appendix 3.

The rationale for systematic reviews has been described as follows:

- People making decisions about health-related issues require reliable information.
- There is too much information available for decision makers to keep up to date.
- Reviews can be unscientific and biased in the way they collect, appraise and summarize information.
- Systematic reviews attempt to minimize these biases to provide a reliable basis for making decisions.<sup>15</sup>

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<sup>13</sup> See, for instance, J.M. Last, *A Dictionary of Epidemiology*, 3<sup>rd</sup> ed. (New York: Oxford University Press, 1995) at p. 77. In addition, the Ontario Draft Report of the Chair of the Occupational Advisory Panel recommends at p. 28 that the Bradford Hill criteria play a major role in assessing whether causation has been sufficiently established for scheduling and policy development.

<sup>14</sup> See *Glossary of Cochrane Collaboration Terms* at [www.cochrane.org/resources/glossary](http://www.cochrane.org/resources/glossary).

<sup>15</sup> See Cochrane Collaboration Open Learning Material at [www.cochrane-net.org/openlearning](http://www.cochrane-net.org/openlearning).

CCO also conducted a meta-analysis, pooling the results of studies where considered appropriate. A meta-analysis is a two-stage process. The first stage involves the extraction of data from each individual study and the calculation of a result for that study. The second stage involves deciding whether it is appropriate to calculate a pooled average result across studies and, if so, calculating and presenting such a result.<sup>16</sup>

## 4.2 CCO Report

The CCO report describes the process used to conduct a systematic literature search, the inclusion and exclusion criteria and the data extraction method. Through its quality assessment process, CCO eliminated 15 of the potential 33 studies which were considered for the review. As a result, the systematic review was based upon a detailed analysis of 18 studies.

For each cancer site, CCO analyzed incidence and mortality studies separately.<sup>17</sup> In addition, CCO combined the results for colon and rectal cancers, including them in a colorectal meta analysis. CCO indicated that it adopted this approach because studies have reported a high chance for misclassification of colon and rectal cancers on death certificates.

CCO was asked to consider the literature in relation to full-time urban firefighters, part-time urban firefighters, volunteer firefighters and forest firefighters. CCO reported they were not able to address the risk of cancer among specific sub-groups of firefighters. While some studies that were reviewed included only full-time firefighters, others did not specify types of firefighter.

The table below describes the conclusions CCO reached for each cancer site. The criteria for these conclusions are found in Appendix 4.

Cancer Site	Findings
Bladder	Insufficient data
Brain	Limited evidence of increased risk associated with the occupation of firefighting

<sup>16</sup> *Ibid.*

<sup>17</sup> Incidence studies collect data on the number of new cases of a disease in an exposed group and a control group or population, while mortality studies collect data on cases of death as a result of a disease in an exposed group and a control group or population. CCO reported that incidence studies were analyzed separately and given greater weight because of the greater certainty around accuracy of diagnosis and presence of disease. Mortality studies often rely on the information contained in death certificates, which may not always be accurate.

Cancer Site	Findings
Colorectal	Limited evidence of increased risk associated with the occupation of firefighting
Kidney	No evidence of increased risk associated with the occupation of firefighting
Leukemia	Insufficient data
Lung <sup>18</sup>	No evidence of increased risk associated with the occupation of firefighting
Multiple Myeloma	Insufficient data
Non-Hodgkin's Lymphoma	Insufficient data
Testicular	Insufficient data
Ureter	With one exception, studies did not report findings for ureter cancer specifically

CCO noted that there were several limitations of the studies reviewed, including small numbers of cases resulting in low statistical power and inadequate measures of individual exposures or exposure indices. CCO also observed that:

There is evidence to suggest that firefighters have reasonable potential for exposure to a number of substances which have been shown to be carcinogenic to humans or to animals. Studies have documented concentrations at some structural and wildland fires which are in excess of recommended short-term or ceiling exposure levels.<sup>19</sup> Further research is recommended.

<sup>18</sup> CCO reported they were not able to comment on the risk of lung cancer in non-smoking firefighters because they had found no studies considering this issue. Smoking status was available in one study; but that study did not provide analysis by smoking history. The study in question reported smoking rates for firefighters similar to that of the general working population and police officers.

<sup>19</sup> A short-term occupational exposure limit ("OEL") is the time-weighted average concentration of a substance in air which may not be exceeded over any 15 minute period. A ceiling OEL is the concentration of a substance in air which may not be exceeded at any time during the work period.

### 4.3 Peer Review Report

The two peer reviewers made a number of general observations about the CCO report, including the following main points:

- The review of firefighter exposure to carcinogens although good, is incomplete. There is minimal discussion of the possible relationship between mortality, cancer and known or hypothesized exposure to carcinogens as a firefighter. This discussion is necessary in order to assure that adequate weight is given to all of the Bradford Hill criteria of causation.
- The decision to exclude certain types of studies appears arbitrary and questionable.<sup>20</sup> There were discrepancies between CCO and the peer reviewers and between the peer reviewers themselves on the exclusion of studies from the systematic review.

Each of the peer reviewers also provided a separate assessment of the CCO findings.

#### 4.3.1 Dr. Band's Assessment of the CCO Report

After making his own determination about the exclusion of studies, Dr. Band re-analyzed the data for each cancer site. His conclusions are summarized in the table below. The criteria for Dr. Band's conclusions are found in Appendix 5.

Cancer Site	Finding
Bladder	Insufficient evidence
Brain	Probable risk <sup>21</sup>
Colorectal	Insufficient evidence
Colon	Insufficient evidence

<sup>20</sup> CCO excluded occupational surveillance and Proportionate Mortality Ratio (“PMR”) studies from the review. PMR studies compare the proportion of deaths in an exposed group due to the disease of interest with the proportion of such deaths in the control group. CCO indicated that these studies were excluded because they were intended as a surveillance tool for identifying areas warranting further study, rather than an assessment of causal associations. The peer reviewers found there were benefits to including PMR studies, whose results may add to conclusions, point to risks that have been explained by others and provide information on exposure that is not reported in other work.

<sup>21</sup> Dr. Band defined “probable risk” to mean more studies show the effect than not, but the findings are not felt to be certain because of some contradictions or the inability to rule out with confidence alternative explanations.

Cancer Site	Finding
Rectum	Possible risk <sup>22</sup>
Kidney	Insufficient evidence
Leukemia	Insufficient evidence
Lung	No evidence
Multiple Myeloma	Insufficient evidence
Non-Hodgkin's Lymphoma	Insufficient evidence
Testicular	Insufficient evidence
Ureter	Not addressed

#### 4.3.2 Dr. Parker's Assessment of the CCO Report

Dr. Parker observed that the CCO report places a great deal of weight on the strength of statistical association, but appears to largely ignore the other Bradford Hill criteria. However, there is no inherent reason for weighting statistical significance more heavily than other criteria, such as consistency or biological plausibility.

In particular, Dr. Parker found that CCO did not go far enough in evaluating consistency between known or hypothesized exposure and the types of cancer at issue. Dr. Parker suggested that greater consideration of the exposure – disease relationship would argue in favour of stronger conclusions for several cancer sites than those made in the CCO report. For instance, it was noted that leukemia has been associated with exposure to benzene, formaldehyde, styrene, 1-3 butadiene and vinyl chloride. Firefighters have the opportunity for exposure to all of these agents. Dr. Parker noted that it was unclear how CCO accounted for this exposure information in reaching their conclusion that there was insufficient data to determine whether there is an increased risk for leukemia associated with the occupation of firefighting. Dr. Parker, however, did not make specific conclusions about the strength of association between each cancer site and the occupation of firefighting.

<sup>22</sup> Dr. Band defined "possible risk" to mean some positive results exist in the studies, but these findings have not been generally corroborated and significant questions remain about whether there is any effect.

A table comparing CCO's conclusions with those of Dr. Band and Dr. Parker is found at Appendix 6.

#### 4.4 CCO Response to the Peer Review

CCO submitted a response to the Peer Review Report to the WCB in November 2004. CCO indicated that following consideration of points raised by the reviewers and given the current state of evidence, they remained satisfied that the conclusions presented in their report were sound and supported.

#### 4.5 Analysis of Expert Findings

The tables contained in Appendix 7 provide a summary of the expert advice in relation to the criteria of causality listed in the WCB's *Protocol*.

#### 4.6 Other Jurisdictions

##### 4.6.1 Canada

##### Manitoba, Alberta, Saskatchewan and Nova Scotia

Since 2002, the governments of Manitoba, Alberta, Saskatchewan and Nova Scotia have amended their respective workers' compensation legislation to establish a presumption that certain types of cancers are related to firefighting. All four jurisdictions require the same minimum period of employment or exposure before the presumption applies. A report submitted to the Manitoba Workers' Compensation Board by Dr. Tee Guidotti and Dr. David Goldsmith in March 2002 was instrumental to the adoption of a presumption in these jurisdictions.

Of note, neither Manitoba nor Saskatchewan has a presumptive schedule of occupational diseases similar to Schedule B. In these two jurisdictions only firefighters are entitled to a presumption that certain cancers are work-related.

The table below summarizes the cancers covered in each jurisdiction and the minimum employment period.

CANCER	Alberta	Saskatchewan	Manitoba	Nova Scotia	Minimum Period of Employment (yrs)
Leukemia ("primary site")	Yes	Yes	Yes	Yes	5
Non-Hodgkin's lymphoma ("primary site")	Yes	Yes	Yes	Yes	20
Primary site brain cancer	Yes	Yes	Yes	Yes	10

<b>CANCER</b>	<b>Alberta</b>	<b>Saskatchewan</b>	<b>Manitoba</b>	<b>Nova Scotia</b>	<b>Minimum Period of Employment (yrs)</b>
Primary site bladder cancer	Yes	Yes	Yes	Yes	15
Primary site ureter cancer	Yes	No	No	No	15
Primary site kidney cancer	Yes	Yes	Yes	Yes	20
Primary site colon cancer	Yes	No	No	Yes	20

The presumptions in Alberta, Manitoba and Saskatchewan apply to full-time firefighters who have been regularly exposed to the hazards of a fire scene, other than a forest-fire scene. The legislation in Alberta and Manitoba also contains a provision requiring the Workers' Compensation Boards in these jurisdictions to research and report on the association between casual or part-time firefighting and the specified cancers within a certain time frame.

The Nova Scotia presumption applies to a worker who has been a member of a fire protection service of a municipality or a volunteer fire department and who has been regularly exposed to the hazards of a fire scene, other than a forest fire scene. The wording of the Nova Scotia legislation is unclear on whether part-time firefighters are covered. The Nova Scotia Workers' Compensation Board has advised that this issue has yet to be determined.

### **Ontario**

Ontario does not have a statutory presumption relating certain cancers to firefighting. In 1999, however, the Ontario Workplace Safety and Insurance Board introduced policy with respect to brain cancer and lymphoid leukemia among full-time urban firefighters.

Policy states that a minimum employment period of 20 years in full-time firefighting involving on-call fire smoke exposure is "highly persuasive evidence" that a worker's brain cancer is due to the nature of the worker's employment. The minimum employment period for lymphoid leukemia is 30 years. It is worth noting that these minimum periods differ significantly from the 10 years for brain cancer and the 5 years for leukemia adopted by Alberta, Saskatchewan, Manitoba and Nova Scotia.

### **Quebec**

Quebec does not have a statutory presumption for cancer in firefighters. However, the Quebec Commission de la santé et de la sécurité du travail

("CSST") has commissioned literature reviews of firefighting and brain cancer, bladder cancer, kidney cancer, non-Hodgkin's lymphoma, leukemia, colon cancer and other cancers which could be related to firefighting.

As a result of the brain cancer review, the CSST has adopted the position that there is no link between firefighting and an increased risk of brain cancer. However, the reviews of bladder and kidney cancers prompted the CSST in April 2004 to recognize a causal link between firefighting and these diseases where the worker has<sup>23</sup>:

- professional experience as an urban firefighter exposed to fires and fumes during fire suppression activities or the overhaul and investigation stages; and
- a minimum of 20 years' employment as a firefighter – a part-time firefighter may meet this condition if his or her cumulative experience is equivalent to 20 years as a full-time firefighter.

The CSST reports that work on assessing the association between firefighting and other cancers is ongoing.

### **New Brunswick**

In August 2003, a private member's bill that would create a presumption for certain cancers in firefighters was introduced in the New Brunswick legislature. To date, the Bill has not progressed to second reading.

### **4.6.2 United States**

Twenty-three of 50 states have legislation specifically addressing cancer in firefighters. The table found at Appendix 8 indicates which US jurisdictions cover the cancers at issue in this discussion paper.

Nine of the 23 states with a firefighter-cancer presumption include that presumption in their workers' compensation legislation.<sup>24</sup> Seven states have placed the presumption under pension or retirement statutes,<sup>25</sup> while eight have

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<sup>23</sup> The reviews of brain cancer, bladder cancer and kidney cancer are not yet publicly available.

<sup>24</sup> Specifically, the following states include the presumption in their workers' compensation legislation: Arizona, Maryland, Missouri, Minnesota, Nevada, New Hampshire, North Dakota, Virginia and Washington.

<sup>25</sup> The following states include the presumption in pension or retirement codes: Illinois, Kansas, Massachusetts, New York, Oklahoma, South Dakota and Texas. (New York has two firefighter/cancer presumptions. One is located under retirement and social security legislation and the other is under general municipal laws.)

included the presumption in other pieces of legislation, such as labour or municipal codes.<sup>26</sup>

The strength of the presumption varies among states. A strong presumption provides that a particular cancer in a firefighter is presumed to be an occupational disease caused by duties as a firefighter, with no additional requirements. A weaker presumption requires proof on such matters as exposure and length of time performing hazardous duties. Oklahoma has one of the strongest rebuttable presumptions, covering any cancer and applying to any member of a fire department who has passed an entrance physical exam. Arizona has a weaker presumption, requiring, among other conditions, assignment to hazardous duty for at least 5 years and exposure to a known carcinogen reasonably linked to the cancer.

Some states, such as Alabama and California, restrict the presumption to cancers that appear during active duty or within a limited time after employment as a firefighter has ended. For instance California extends the presumption beyond employment by three months for each year of employment to a maximum of 60 months.

#### **4.6.3 Additional Jurisdictions**

The PRD researched legislation in Australia, New Zealand and the United Kingdom. No provisions regarding cancer among firefighters were found.

## **5. OPTIONS AND IMPLICATIONS**

The PRD is seeking stakeholder feedback on the options discussed below. The options are addressed under the following two headings:

- disease recognition options
- review options

### **6.1 Disease Recognition Options**

#### **Option I Status quo**

Under this option, claims by firefighters for cancer would continue to be adjudicated in the same way as a claim for cancer by any other worker.

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<sup>26</sup> The following states provide for a firefighter/cancer presumption under other types of legislation: Alabama, California, Louisiana, Nebraska, New York, Rhode Island, Tennessee and Wisconsin.

### *Analysis/Implications*

- Scientific and other evidence would be reviewed in each individual case to determine whether a given claim is compensable.
- Both the CCO report and the Peer Review Report indicate there is some evidence of an increased risk for a number of cancers associated with firefighting. This suggests that a higher level of disease recognition may be appropriate for certain cancer(s). On the other hand, CCO and peer reviewer Dr. Band found no or insufficient evidence for many cancer sites, supporting case-by-case adjudication for these conditions.

### **Option II - Amend Schedule B**

Under this option Schedule B would be amended to include one of the following sub-options in relation to a full-time firefighter regularly exposed to the hazards of a fire scene, other than a forest fire scene. Minimum periods of employment would also be adopted for each cancer site.

- (a) brain cancer;
- (b) brain cancer and colorectal cancer;
- (c) brain cancer and rectal cancer; or
- (d) brain cancer, kidney cancer, bladder cancer, non-Hodgkin's lymphoma, leukemia, lung cancer in non-smokers, testicular cancer and colon cancer (per Dr. Guidotti's report to the BCPFFA).

### *Analysis/Implications*

#### **General**

- A worker who contracts a cancer listed in Schedule B in relation to firefighting and who, at or immediately before the date of disablement, is a full-time firefighter regularly exposed to the hazards of a fire scene would be entitled to a rebuttable presumption that the cancer is work-related.
- A worker who develops a cancer listed in Schedule B a long time after ceasing to be a full-time firefighter would not be entitled to the rebuttable presumption that the cancer is work-related. This is because section 6(3) of the *Act* stipulates that to benefit from the rebuttable presumption that a disease is work-related, the worker must be employed in the relevant process or industry "at or immediately before the date of disablement".

- Listing a disease in Schedule B in relation to full-time firefighting means the WCB has concluded there is a substantially greater incidence of the disease among firefighters than among the general population.<sup>27</sup> It also means the WCB is satisfied that scientific research clearly supports this conclusion.<sup>28</sup>

**(a) brain cancer**

- CCO concluded there is limited evidence of an increased risk of brain cancer associated with the occupation of firefighting. Dr. Band concluded there is a probable risk for the disease. These scientific conclusions do not appear to provide the degree of certainty required for listing a disease on Schedule B.
- Peer reviewer Dr. Parker suggested the evidence for brain cancer points to stronger conclusions than those reached by CCO. However, Dr. Parker did not indicate how strong the evidence of causal association is.
- The evidence of a link between brain cancer and firefighting in the CCO report and the Peer Review Report meets many of the criteria in the *Protocol* for assessing whether it is reasonable to conclude there is a causal association. However, it is noted that, based on the research, the strength of association may not be viewed as high. As well, the results of the mortality studies are inconsistent. Finally, the evidence of a dose-response relationship is limited. Arguably, it is not clear based on the evidence that there is a substantially greater incidence of brain cancer among firefighters than among the general population.<sup>29</sup>
- Including brain cancer in firefighters on Schedule B would be consistent with the presumptions adopted in Manitoba, Alberta, Saskatchewan and Nova Scotia, as well as in 21 US states.

**(b) brain cancer and colorectal cancer**

- See above for the analysis/implications of including brain cancer in Schedule B.
- Under this option, claims for both colon cancer and rectal cancer by full-time firefighters would benefit from a presumption that they are work-related.

<sup>27</sup> See policy item #26.01 of the *RS&CM*, which provides that a disease is listed in Schedule B when the WCB is satisfied, based on expert medical and scientific advice, that there is a substantially greater incidence of the disease in a particular employment than there is in the general population.

<sup>28</sup> See policy item #26.21 of the *RS&CM*, which states that “where the research does not clearly relate the disease to particular employments, the disease is not listed in Schedule B and the issue of work-relatedness must be determined on a case-by-case basis”.

<sup>29</sup> It is worth noting, however, that brain cancer is a relatively rare disease in the general population. According to statistics compiled by the BC Cancer Agency (“BCCA”), the rate of brain cancer in BC is approximately 6.6 cases per 100,000 people.

- CCO found limited evidence of an increased risk of colorectal cancer associated with the occupation of firefighting. While one peer reviewer, Dr. Parker, found this conclusion reasonable, Dr. Band did not agree, finding the evidence insufficient. These conclusions do not appear to provide the degree of certainty required for including a disease on Schedule B.
- Compared against the criteria in the *Protocol*, the evidence for colorectal cancer in the CCO report and the Peer Review Report does not appear to clearly indicate a causal relationship between the disease and firefighting. The strength of association may not be viewed as high and there is no clear evidence of a dose-response relationship. Arguably, it is not clear based on the evidence that there is a substantially greater incidence of colorectal cancer among firefighters than among the general population.<sup>30</sup>
- No other Canadian jurisdiction has a presumption for colorectal cancer in firefighters, although Alberta and Nova Scotia have a presumption for colon cancer. Nineteen US states have presumptions for colon and rectal cancers in firefighters.

### **(c) brain cancer and rectal cancer**

- See the discussion above for the analysis/implications of including brain cancer in firefighters on Schedule B.
- Neither CCO nor Dr. Parker reached any conclusions on the association between rectal cancer and firefighting specifically.<sup>31</sup> Dr. Band found that there is a possible risk for the disease in firefighters. This conclusion does not appear to provide the degree of certainty required for including a disease on Schedule B.
- Compared against the criteria in the *Protocol*, the evidence does not appear to clearly suggest a causal relationship between rectal cancer and firefighting. Dr. Band noted that the criterion of biological plausibility was not met, as information on associations between exposures and rectal cancer risk is insufficient. In addition, there is no evidence of a dose-response relationship. Arguably, it is not clear based on the evidence that there is a substantially greater incidence of rectal cancer among firefighters than among the general population.

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<sup>30</sup> Compared to other forms of cancer, colorectal cancer is relatively common. The BCCA estimates that the rate of colon and rectal cancers in BC is about 57 cases per 100,000 people. BCCA also reports that colon cancer was the third most frequently diagnosed type of cancer in 2002 for both men and women. Rectal cancer ranked as the fourth most common type of cancer diagnosis in 2002 for men.

<sup>31</sup> CCO researchers pooled the results of studies on colon cancer and rectal cancer because of the reported high chance of misclassification of these cancers on death certificates.

- No other Canadian jurisdiction has a presumption for rectal cancer in firefighters. However, 21 US states have such a presumption.
- (d) brain cancer, kidney cancer, bladder cancer, non-Hodgkin's lymphoma, leukemia, lung cancer in non-smokers, testicular cancer and colon cancer**
- This approach would be consistent with the recommendations in Dr. Guidotti's report to the BCPFFA.
  - Incorporating all of the above cancers in Schedule B in relation to firefighting would not be consistent with evidence in the CCO report and the Peer Review Report. CCO found that there was insufficient evidence to reach a conclusion for many of the above cancer sites (bladder, leukemia, multiple myeloma, non-Hodgkin's lymphoma and testicular) or that there was no evidence (kidney and lung). Dr. Band generally reached the same conclusions. Dr. Parker found that for several sites (bladder, brain, leukemia, lung, multiple myeloma and testicular), data argued in favour of stronger conclusions than those reached by CCO. However, it is uncertain from his discussion of these cancer sites how strong the conclusion on causal association should be.
  - Compared against the criteria in the *Protocol*, the evidence does not appear to clearly indicate a causal relationship between the above cancer sites and the occupation of firefighting.
  - Incorporating the above cancers into Schedule B in relation to firefighting would indicate a significant shift away from the WCB's past approach to assessing the causal association between a disease and an industry, process, trade or occupation. This would raise questions about the continued relevance of the *Protocol* for assessing scientific information.

### **Option III – Recognize Certain Cancers as Peculiar to or Characteristic of the Occupation of Firefighting**

Under section 6(4.2) of the *Act*, the WCB would recognize one of the following sub-options as peculiar to or characteristic of the occupation of a full-time firefighter regularly exposed to the hazards of a fire scene, other than a forest fire scene. Minimum periods of employment would also be adopted for each cancer site:

- (a) brain cancer;
- (b) brain cancer and colorectal cancer;
- (c) brain cancer and rectal cancer; or

- (d) brain cancer, kidney cancer, bladder cancer, non-Hodgkin's lymphoma, leukemia, lung cancer in non-smokers, testicular cancer and colon cancer (per Dr. Guidotti's report to the BCPFFA).

### *Analysis/Implications*

#### **General**

- Although it represents the second highest level of occupational disease recognition, section 6(4.2) of the *Act* has been used only once, almost 30 years ago.<sup>32</sup>
- Firefighters would not be entitled to a rebuttable presumption that the cancers designated under section 6(4.2) are work-related. However, the WCB would recognize the possibility that work as a full-time firefighter regularly exposed to the hazards of a fire scene may have significantly contributed to the causation of the cancer.
- Scientific and other evidence would be reviewed in each individual case to determine whether a given claim is compensable.
- Section 6(4.2) does not stipulate that the worker be employed in the relevant process, trade or occupation at or immediately before the date of disablement. Thus, a worker may benefit from the recognition of a cancer under 6(4.2) of the *Act* after ceasing to be a full-time firefighter.

#### **(a) brain cancer**

- Arguably, the scientific evidence does not clearly indicate a substantially greater incidence of brain cancer among firefighters than among the general population. (See the discussion under option II(a) above.) Thus, the evidence may not support giving the disease the highest level of recognition by including it in Schedule B. However, there is evidence suggesting a possible causal association between brain cancer and firefighting. Thus, recognition of brain cancer under section 6(4.2) in relation to the occupation of a full-time firefighter may be warranted.
- Since approximately 1985, the WCB has received eight claims by firefighters for brain cancer. The majority of these claims have been accepted.<sup>33</sup> As brain cancer does not have general recognition as an occupational disease, each claim was accepted by order dealing with a specific case. The

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<sup>32</sup> The provision was used in 1977 to recognize osteoarthritis of the first carpo-metacarpal joint of both thumbs in physiotherapists who do deep friction massage, where certain conditions are met.

<sup>33</sup> Of the eight brain cancer claims by firefighters since at least 1985, six were allowed, one disallowed and one suspended. See Appendix 1 for more information on allow/disallow rates for firefighter cancer claims.

acceptance of most firefighter brain cancer claims may suggest that a higher level of disease recognition may be appropriate.

**(b) brain cancer and colorectal cancer**

- See above for the analysis/implications of recognizing brain cancer under section 6(4.2) as peculiar to the occupation of a full-time firefighter.
- Arguably, the scientific evidence does not clearly indicate a substantially greater incidence of colorectal cancer among firefighters than among the general population. Inclusion in Schedule B may not be appropriate; however, designation under section 6(4.2) would recognize the possibility of an association between colorectal cancer and firefighting.
- Recognizing colorectal cancer, rather than rectal cancer in accordance with Dr. Band's analysis, may be the more cautious approach, given the potential misclassification of colon and rectal cancers in mortality studies.
- Since at least 1985, the WCB has received seven claims for colon cancer and two claims for rectal cancer. Only one of these nine claims, a claim for colon cancer, was accepted.

**(c) brain cancer and rectal cancer**

- See above for the analysis/implications of recognizing brain cancer under section 6(4.2) as peculiar to the occupation of a full-time firefighter.
- The scientific evidence does not appear to clearly indicate that there is a substantially greater incidence of rectal cancer among firefighters than among the general population. Inclusion in Schedule B may not be appropriate; however, designation under section 6(4.2) would recognize the possibility of an association between rectal cancer and firefighting.
- Recognizing rectal cancer as opposed to colorectal cancer would not acknowledge the possibility that misclassification of colon and rectal cancers in mortality studies may have impacted the findings for these cancer sites.
- Since at least 1985, the WCB has received two claims by firefighters for rectal cancer. Both claims were disallowed.

**(d) brain cancer, kidney cancer, bladder cancer, non-Hodgkin's lymphoma, leukemia, lung cancer in non-smokers, testicular cancer and colon cancer**

- As discussed under option II(d), CCO found that there was insufficient or no evidence to reach a conclusion for many of the above cancer sites. Dr. Band generally reached the same conclusions. While Dr. Parker found that data

argued in favour of stronger conclusions than those reached by CCO for several cancer sites, he was unclear about how strong the evidence of causal association is. These conclusions suggest that the high level of recognition under section 6(4.2) of the *Act* may not be appropriate for all of these cancers.

#### **Option IV – Amend the *ODR Regulation***

Under this option, the *ODR Regulation* would be amended to recognize the following cancers as occupational diseases. These cancers do not currently have general recognition as occupational diseases, although they may be recognized by order dealing with a specific case.<sup>34</sup>

- (a) brain cancer
- (b) kidney cancer
- (c) multiple myeloma

In addition, under this option, policy could be developed for brain cancer and perhaps colorectal cancer or rectal cancer, providing more guidance with respect to a possible link to firefighting and minimum periods of employment.

#### *Analysis/Implications*

- The *ODR Regulation* is a list of diseases that the WCB has recognized as “occupational diseases” and which, in a given case, may or may not be due to the nature of a worker’s employment. The diseases are not linked to any particular process, trade or occupation. Thus, under this option, the above cancers would not be linked to the occupation of full-time firefighting. However, policy could be developed providing more guidance on those cancers for which the evidence suggests a link with firefighting, including brain cancer and possibly colorectal or rectal cancer, similar to the approach in Ontario.
- Policy provides little guidance on when a disease should be recognized under the *ODR Regulation*, other than to note that a disease may be listed where the WCB concludes it is sometimes due to the nature of an employment covered by the *Act*, but does not appear more likely to occur in connection

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<sup>34</sup> Most of the other cancer sites which were the subject of CCO’s systematic review, specifically bladder cancer, colorectal cancer, colon cancer, rectal cancer, leukemia, lung cancer and ureter cancer are already recognized as occupational diseases because they are listed in Schedule B of the *Act*. However, there is no presumption that these diseases are due to employment as a full-time firefighter.

with that employment than elsewhere.<sup>35</sup> When 15 diseases were added to the *ODR Regulation* in 1995, the then Chair of the WCB indicated this step was taken because claims for the conditions had been accepted (by order dealing with a specific case) with sufficient frequency to warrant a higher level of recognition.<sup>36</sup>

- The WCB has accepted most of the claims it has received from firefighters for brain cancer, kidney cancer and multiple myeloma, normally by order dealing with a specific case.<sup>37</sup> This acceptance rate suggests that a more general recognition of these diseases as occupational diseases may be warranted, even though the scientific evidence may not support a stronger policy response.
- Including the above diseases under the *ODR Regulation* means that any worker who contracts one of the cancers would be considered to have an occupational disease. However, there would be no presumption that the disease is work-related. The WCB would adjudicate claims on a case by case basis to determine whether the disease is due to the nature of the worker's employment.
- Including the diseases in the *ODR Regulation* would heighten awareness of these conditions, possibly leading to claims being submitted which would not otherwise have been filed with the WCB.

### **Option V – Amend Schedule B and the *ODR Regulation***

Under this option, brain cancer and possibly colorectal cancer or rectal cancer would be added to Schedule B in relation to a full-time firefighter regularly exposed to the hazards of a fire scene, other than a forest fire scene. Minimum periods of employment would also be adopted for each cancer site. In addition, certain cancers not currently recognized, specifically kidney cancer and multiple myeloma, would be added to the list of diseases in the *ODR Regulation*.

#### *Analysis/Implications*

- This option would give those cancers for which there is some evidence of an association with firefighting a higher level of recognition, with a rebuttable presumption that the condition was caused by employment as a full-time firefighter. In turn, cancers for which the overall evidence is weaker would be

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<sup>35</sup> See policy item #26.03 of the *RS&CM*. The *ODR Regulation* has not been frequently used to recognize occupational diseases. In 2000, heart disease was added to the list and in 1995, 15 conditions were added. Before 1995, the *ODR Regulation* had not been amended for 17 years.

<sup>36</sup> Memo, dated October 20, 1994, from James Dorsey, WCB Chair, to the WCB Governors.

<sup>37</sup> See Appendix 1 for allow/disallow rates for specific cancers in firefighters.

given general recognition as occupational diseases, but without a presumption that they are causally related to any given occupation or employment.

- See the discussion under option II(a), (b) and (c) for the analysis/implications of including brain cancer, colorectal cancer and rectal cancer in Schedule B in relation to a full-time firefighter.
- See the discussion under option IV for the analysis/implications of amending the *ODR Regulation*.

### **Option VI – Recognize Certain Cancers under Section 6(4.2) of the Act and Amend the *ODR Regulation***

Under this option, brain cancer and possibly colorectal cancer or rectal cancer would be recognized under section 6(4.2) of the *Act* as peculiar to or characteristic of the occupation of a full-time firefighter regularly exposed to the hazards of a fire scene, other than a forest fire scene. Minimum periods of employment would also be adopted for each cancer site. In addition, certain cancers not currently recognized, specifically kidney cancer and multiple myeloma, would be added to the list of diseases in the *ODR Regulation*.

#### *Analysis/Implications*

- The evidence does not appear sufficient to include brain cancer, colorectal cancer or rectal cancer in Schedule B in relation to firefighting. However, designation under section 6(4.2) would recognize a possible link with the occupation of a full-time firefighter. In turn, cancers for which the overall evidence is weaker would be given general recognition as occupational diseases, but without a presumption or a link to any specific employment or occupation.
- See the discussion under option III(a), (b) and (c) for the analysis/implications of recognizing brain cancer, colorectal cancer and rectal cancer under section 6(4.2) as peculiar to the occupation of a full-time firefighter.
- See the discussion under option IV for the analysis/implications of amending the *ODR Regulation*.

## 6.2 Review Options

### Option I – No Review Within a Specified Period

#### *Implications*

- There would be no requirement for the WCB to review the literature on firefighters and cancer within a specified time period.

### Option II – Review Within a Specified Period

Under this option, the BOD would direct the PRD to commission another review of the scientific and medical literature on firefighting and cancer within a certain number of years.

#### *Implications*

- This option would require the WCB to review its approach to the issue of cancer among firefighters in light of research that is currently underway in other jurisdictions and which has not yet been completed.<sup>38</sup>

## 7.0 CONSULTATION

Stakeholders are invited to review the discussion paper and provide feedback on the **proposed policy options** by **March 1, 2005**.

Comments may be sent by mail, fax or e-mail to:

By mail: Susan Furlong  
Senior Policy Analyst  
Policy and Research Division  
Workers' Compensation Board  
P.O. Box 5350, Stn Terminal  
Vancouver, BC V6B 5L5

By fax: 604 279-7599

By e-mail: [policyd1@wcb.bc.ca](mailto:policyd1@wcb.bc.ca)

When responding, please provide your name, organization, and address.

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<sup>38</sup> As discussed in the section of this submission on other jurisdictions, Quebec is currently reviewing the link between firefighting and a number of cancers. As well, both Alberta and Manitoba are required by their legislation to undertake research on the link between firefighting and casual and part-time firefighting.

The WCB's governing body, the Board of Directors, will consider the opinions expressed by stakeholders before it adopts any amendments to the current policies.

Please note that all comments become part of the Policy and Research Division's database and may be published, including the identity of organizations and those participating on behalf of organizations. The identity of those who have participated on their own behalf will be kept confidential according to the provisions of the [Freedom of Information and Protection of Privacy Act](#).

## APPENDIX 1

### Cancer Claims by Firefighters (1985 to October 2004)

Type of Cancer	Total	Accepted	Denied	Other
Skin (melanoma)	4	2	2	
Skin (squamous cell)	2	1	1	
Brain	8	6	1	1 suspended
Colon/Rectum	9	1	8	
Bladder	1	0	1	
Kidney	5	4	1	
Leukemia	1	0	1	
Lung	1	0	1	
Non-Hodgkin's Lymphoma	5	0	5	
Hodgkin's Lymphoma	2	0	2	
Multiple Myeloma	3	3	0	
Esophagus	1	0	1	
Larynx	1	0	1	
Digestive system	2	0	2	
Testicular	1	0	1	
Thyroid	1	0	1	
<b>Total</b>	<b>47</b>	<b>17</b>	<b>29</b>	<b>1</b>

## APPENDIX 2

### Summary of the *Protocol for the Assessment of Medical/Scientific Information* (“*Protocol*”)

The *Protocol* cautions that the criteria listed below are not a set of rigid rules, but guidelines for evaluating when a causal relationship can reasonably be assumed based on human observational studies. The relative importance of each criterion may vary according to the circumstances. The main value of the criteria is to highlight the components of an epidemiological study and assist in assessing reliability and validity.

The criteria are as follows:

- strength of association
- consistency
- dose-response
- coherence (biological plausibility)
- temporal relationship
- specificity
- statistical significance

#### 1. **Strength of Association**

Generally, the bigger the relative risk the greater the likelihood that there is a true cause-and-effect mechanism at work. The term relative risk refers to the ratio of the risk of disease or death among people exposed to an agent to the risk among unexposed individuals.

In general, if the relative risk is 1.0, the risk in exposed individuals is the same as the risk in unexposed individuals. There is no association between exposure to the agent and disease. If the relative risk is greater than 1.0, the risk in exposed individuals is greater than the risk in unexposed individuals. There is a positive association between exposure to the agent and disease, which could possibly be causal. However, the association may also be due to other factors, known as confounding variables.<sup>39</sup>

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<sup>39</sup> A study may find, for instance, that carrying matches is strongly associated with lung cancer with a high relative risk. However, carrying matches does not cause lung cancer. Instead, carrying matches and lung cancer are both related to a common underlying condition – smoking. In this case, smoking acts as a confounding variable in that it is a risk factor for lung cancer and a factor associated with carrying matches.

## APPENDIX 2

### Summary of the *Protocol for the Assessment of Medical/Scientific Information ("Protocol")*

#### 2. Consistency

Consistency refers to the extent to which the same results are found repeatedly in studies of different populations under different conditions and with different designs.

#### 3. Dose-Response

Dose-response refers to a relationship in which a change in the amount, intensity or duration of exposure to an agent is associated with a change – either an increase or decrease – in the risk of disease.<sup>40</sup> In studies of firefighters, dose has been frequently measured by duration of employment or number of years of service.

Under this criterion, consideration is given to whether the effect increases in a predictable way, for example whether the risk of disease increases with an increase in exposure intensity, duration or dose. In some cases, however, a certain level of exposure must be reached before a disease develops. Thus, a dose-response relationship is strong, but not essential, evidence that the relationship between an agent and disease is causal.

#### 4. Coherence (Biological Plausibility)

This criterion is concerned with how the apparent cause-and-effect relationship fits with other knowledge, including clinical, experimental or toxicological knowledge. Biological plausibility is sometimes a difficult criterion to apply or interpret because it depends upon existing knowledge about the mechanism by which the disease develops.

#### 5. Temporal relationship

Temporal relationship means a cause must precede an effect.

#### 6. Specificity

An association exhibits specificity if the exposure is associated with only a single disease or type of disease. While evidence of specificity may strengthen the

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<sup>40</sup> See M.D. Green, D. M. Freedman and L. Gordis, "Reference Guide on Epidemiology" in Federal Justice Center, *Reference Manual on Scientific Evidence*, 2<sup>nd</sup> ed, 2000.

## APPENDIX 2

### **Summary of the *Protocol for the Assessment of Medical/Scientific Information* (“*Protocol*”)**

case for causation, lack of specificity does not necessarily undermine it where there is a plausible biological explanation for its absence.

#### **7. Statistical Significance**

A finding is described as statistically significant when it can be demonstrated that the probability of obtaining the result by chance alone is relatively small. Statistical significance is closely tied to, and should be considered with strength of association.

## APPENDIX 3

### Required Elements of a Systematic Review<sup>41</sup>

The required elements of a systematic review include:

1. A precise definition of the question to be considered.
2. A literature search and selection of references. This would include an explanation of databases searched, terms used and reports consulted as well as an explicit description of inclusion and exclusion criteria.
3. The rating or grading of evidence based on standardized criteria.
4. A critical evaluation of the evidence that acknowledges controversies, apparent conflicts of interest or other instances of bias.
5. References that provide sources of support for key statements.

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<sup>41</sup> Sources of information include the Cochrane Collaboration Reviewers' Handbook 4.1.4 and articles published in the scientific literature on how to write systematic, evidence-based reviews.

## APPENDIX 4

### Cancer Care Ontario Criteria for Conclusions

Conclusion	Criteria
Insufficient data to determine whether there is an increased risk associated with the occupation of firefighting	<ul style="list-style-type: none"> <li>• Insufficient number of studies or no pooled estimate of incidence studies</li> </ul>
No evidence of increased risk associated with the occupation of firefighting	<ul style="list-style-type: none"> <li>• Pooled estimate available for both incidence and mortality studies</li> <li>• Pooled estimates less than or close to 1 for both incidence and mortality studies</li> <li>• Reasonable confidence that effects were not missed due to methodological issues</li> </ul>
Limited evidence of increased risk associated with the occupation of firefighting	<ul style="list-style-type: none"> <li>• Pooled estimates available for both incidence and mortality studies</li> <li>• Pooled estimates are greater than 1 for both the incidence and mortality studies, with borderline or greater statistical significance for at least one of them</li> <li>• At least one substance to which firefighters may be exposed at work is carcinogenic for this cancer site</li> <li>• Reasonable confidence that observed effects are not due to methodological issues</li> <li>• Insufficient data to evaluate a dose-response relationship</li> </ul>
Sufficient evidence of risk associated with the occupation of firefighting	<ul style="list-style-type: none"> <li>• Pooled estimates available for both incidence and mortality studies</li> <li>• Pooled estimates are greater than 1 for both incidence and mortality studies, with borderline or greater statistical significance for at least one of them</li> <li>• At least one substance to which firefighters may be exposed at work is carcinogenic for this cancer site</li> <li>• Reasonable confidence that observed effects are not due to methodological issues</li> <li>• Evidence of a dose-response relationship</li> </ul>

## APPENDIX 5

### Pierre Band's Criteria for Conclusions

Pooled estimates of:

- (I) incidence studies
- (M) mortality studies
- (PMR) Proportionate Mortality Studies

Statistically significant (+) or not significant (-)

Insufficient evidence	I(-) M(-) P(-) I(-) M(-) P(+) I(-) M(+) P(-)
Possible cancer risk	I(-) M(+) P(+) I(+) M(-) P(+) I(+) M(-) P(-)
Probable cancer risk	I(+) M(+) P(+) I(+) M(+) P(-)

**APPENDIX 6**  
**Comparison of Findings**

<b>Cancer site</b>	<b>CCO</b>	<b>PB (Peer Reviewer)</b>	<b>DP (Peer Reviewer)</b>
<b>Bladder</b>	Insufficient data	Insufficient evidence	It appears that most of the data point to a small and consistent increase in bladder cancer among firefighters. The increase is not statistically significant, but appears reasonably well founded based on several criteria: (1) consistency; (2) exposure and (3) biologic plausibility. These factors argue in favour of stronger conclusions than those made by the authors of the CCO report.
<b>Brain and CNS</b>	Limited evidence of increased risk	Probable risk	Given the relatively rare nature of the disease(s) in question it is surprising to find the strength of the relationships seen. In addition, the failure to consider confounding exposure is understandable given our poor understanding of the epidemiology of central nervous system malignancies. These factors argue in favour of stronger conclusions than those made by the authors of the CCO report.
<b>Colorectal</b>	Limited evidence of increased risk	Insufficient evidence	CCO conclusions appear reasonable based on available evidence.
<b>Colon</b>	No conclusion	Insufficient evidence	No conclusion
<b>Rectum</b>	No conclusion	Possible risk	No conclusion
<b>Kidney</b>	No evidence	Insufficient evidence	CCO's elimination of so many studies from its review has limited justification. Indeed such a limitation in the case of a relatively rare disease impairs the ability to detect disease. A summary estimate should be computed for kidney cancer inclusive of these studies.
<b>Leukemia</b>	Insufficient data	Insufficient evidence	Inclusive of data from proportional mortality studies, the evidence appears to tilt in favour of concluding there is a relationship between firefighting and leukemia. This is supported by the statement in the CCO report that "leukemia has been associated with exposure to benzene, formaldehyde, styrene, 1-3 butadiene

**APPENDIX 6**  
**Comparison of Findings**

<b>Cancer site</b>	<b>CCO</b>	<b>PB (Peer Reviewer)</b>	<b>DP (Peer Reviewer)</b>
			and vinyl chloride. Firefighters have the opportunity for exposure to all of these agents. Studies have reported concentrations of benzene and formaldehyde at structural fires which exceed NIOSH or SCHIH ceiling or short-term exposure levels.” It is not clear how (or if) the authors account for exposure data in reaching their conclusions.
<b>Lung</b>	No evidence	No evidence	CCO should include more discussion of the possible impact of cigarette smoking. Increased attention should be given to possible exposure to respiratory carcinogens. Data argue in favour of stronger conclusions than those made by CCO.
<b>Multiple Myeloma</b>	Insufficient data	Insufficient evidence	Although there is considerable variability in the risk relationship between firefighting and risk of multiple myeloma, a number of studies support the contention that there is a relationship. The authors of the CCO report need to include more discussion on environmental causes of multiple myeloma.
<b>Non-Hodgkin’s Lymphoma</b>	Insufficient data	Insufficient evidence	As with other cancer sites, statistical data should be weighted with data on exposure and occupational causes of morbidity.
<b>Testicular</b>	Insufficient data	Insufficient evidence	The authors of the CCO report conclude that the studies taken together provide insufficient data to determine whether there is an increased risk of testicular cancer associated with the occupation of firefighting. However, the evidence presented in the report appears to conflict with this conclusion.
<b>Ureter</b>	No studies found	Not discussed	Not discussed

## APPENDIX 7

### Summary of Expert Advice Regarding Criteria of Causality Listed in *Protocol*

The criteria “temporal relationship” and “specificity” were accorded less weight for the following reasons:

- Cohort studies, especially prospective type cohort studies, by design meet the temporal relation criterion. For the most part, this criterion is also met by retrospective (historic) studies. Properly conducted case-control studies will always ensure that the exposure of interest preceded the disease. Generally all the studies included in the analysis performed by Cancer Care Ontario meet this criterion.
- Most cancers reviewed by Cancer Care Ontario are not specific to any one exposure or occupation; most have several risk factors. As a result, the specificity criterion is not particularly pertinent in evaluating causality of cancer among firefighters.

**Table 1: Bladder Cancer**

Criterion	Cancer Care Ontario	Peer review – Dr. Pierre Band	Peer review – Dr. David Parker
<b>Strength of Association</b>	<p>Incidence CCO examined two studies that reported results for bladder cancer incidence. Both studies reported slightly elevated risks of 1.20 (95% CI: 0.70, 1.90) and 1.14 (95% CI: 0.40, 2.70). CCO explained that a pooled risk estimate was not calculated due to insufficient data.</p> <p>Mortality CCO examined seven studies that reported mortality from bladder cancer. Five studies reported an increased risk ranging from 1.25 to 3.15. Two studies reported a reduced risk of 0.23 (95% CI: 0.03-0.83) and 0.57 (0.21, 1.52). A</p>	<p>Dr. Band acknowledged that the summary of the studies which CCO examined was accurate. He calculated the following pooled risk estimates for the 2 incidence and 7 mortality studies examined by CCO<sup>42</sup>:</p> <p style="padding-left: 40px;">Incidence = 1.17 (95% CI 0.74-1.75). Mortality = 1.10 (95% CI 0.81-1.47).</p> <p>In addition, Dr. Band calculated a pooled risk estimate of 1.15 (95% CI 0.86-1.50) for three PMR studies that CCO excluded from their analysis.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>

<sup>42</sup> Cancer Care Ontario and Dr. Band used different software to conduct their meta-analyses and this may account for the difference in reported pooled risk estimates for each cancer site. Cancer Care Ontario carried out the meta-analysis using Review Manager Software developed and made available by the Cochrane Collaboration Group. Dr. Band summed up the observed cases and expected numbers to obtain pooled risk estimates and calculated 95% confidence intervals around these pooled risk estimates using the software Strata.

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<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
	pooled risk estimate of 1.36 (95% CI: 0.79, 2.35) was calculated.		
<b>Consistency</b>	<p>Incidence CCO recognized that both incidence studies reported estimates which were similar in magnitude.</p> <p>Mortality CCO noted that a wide range of estimates (0.23 to 3.15) were reported (i.e, findings are inconsistent).</p>	Dr. Band concluded that the results of the two incidence studies were consistent with each other but the results of the mortality studies were less consistent. Dr. Band examined three PMR studies which CCO excluded. The data from these studies had a summary estimate in the same range.	Dr. Parker concluded that a small, yet consistent increase in bladder cancer was reasonably well founded.
<b>Dose-Response</b>	CCO noted that three studies reported dose-response analyses by duration of service in relation to bladder cancer. CCO recognized that only one of these studies found a dose-response relationship. CCO concluded that no consistent trend was observed.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Coherence (Biological Plausibility)</b>	CCO did not directly comment on this criterion. However, they recognized that an increased risk of bladder cancer has been observed in workers exposed to high levels of PAHs.	Dr. Band did not directly comment on this criterion.	Dr. Parker concluded that a small, yet consistent increase in bladder cancer was reasonably well founded.
<b>Temporal Relationship</b>	Although not explicitly included, CCO addressed this criterion through exclusion of cross-sectional studies.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Specificity</b>	CCO did not directly comment on specificity, however it can be inferred from their discussion about risk factors for bladder cancer (e.g., smoking, coffee, artificial sweeteners) that the relationship between firefighting and bladder cancer is not specific.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Statistical</b>	Incidence	Dr. Band did not directly comment on this	Dr. Parker noted that the observed

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<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Significance</b>	<p>CCO recognized that neither study which reported slightly elevated risks of bladder cancer reached statistical significance.</p> <p>Mortality</p> <p>CCO recognized that only one study out of five that reported an increase in mortality from bladder cancer reached statistical significance. CCO concluded that the pooled risk estimate was not significant.</p>	<p>criterion. However, it can be inferred from his calculations that the pooled risk estimates are not statistically significant.</p>	<p>increases were not statistically significant.</p>

**Conclusions**

	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Conclusion</b>	<p>Insufficient data to determine whether there is an increased risk associated with the occupation of firefighting.</p>	<p>Insufficient data to determine whether there is an increased risk associated with the occupation of firefighting.</p>	<p>Dr. Parker found that the data pointed to a small and consistent increase in bladder cancer among firefighters. The increase is not statistically significant, but appears reasonably well founded based on several criteria: (1) consistency; (2) exposure and (3) biologic plausibility. These factors argue in favour of stronger conclusions than those made by CCO. The basis for Dr. Parker's conclusion is not provided.</p>

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**Table 2: Brain and Nervous System Cancers**

Criterion	Cancer Care Ontario	Peer review – Dr. Pierre Band	Peer review – Dr. David Parker
<b>Strength of Association</b>	<p>Incidence CCO examined four studies that reported results for brain cancer incidence. All reported increased risks ranging from 1.10 to 2.85. CCO calculated a pooled risk estimate of 1.45 (95%CI: 0.84, 2.49).</p> <p>Mortality Of the nine studies that reported results for brain cancer mortality, CCO identified five that reported an increased risk ranging from 1.47 to 2.79; three reported a decreased risk ranging from 0.61 to 0.81; and one reported no association. CCO calculated a pooled risk estimate of 1.41 (95% CI: 0.97, 2.06).</p>	<p>Dr. Band acknowledged that the summary of the studies which CCO examined was accurate. Re-analyses of the incidence and mortality studies considered by CCO showed significant increased risks.</p> <p>Incidence Dr. Band calculated the following additional summary risk measures for the four incidence studies examined by CCO:            (a) incidence with case control study 1.62 (95% CI 1.02-2.43)            (b) incidence without case control study 1.25 (95% CI 0.68-2.10)            (c) incidence with usual occupation 1.63 (95% CI 1.00-2.53)            Dr. Band concluded that the incidence studies showed a moderate increased risk with attributable risk of up to 47%.</p> <p>Mortality Dr. Band calculated a summary risk measure for the nine mortality studies of 1.37 (95% CI 1.07-1.72). He concluded that the mortality studies had an attributable risk of 27%.</p> <p>Dr. Band also examined three PMR studies that were not included by CCO. These studies revealed a small excess risk (PMR 1.12 (95% CI 0.84-1.48) with an attributable risk of 11%.</p>	<p>Dr. Parker commented that it is surprising to find the strength of association seen given the relatively rare nature of the disease(s).</p>
<b>Consistency</b>	<p>CCO did not directly comment on this criterion. However, it is clear that the results are inconsistent. CCO also examined one incidence</p>	<p>Dr. Band did not directly comment on this criterion.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>

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<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
	study which compared firefighters to police and reported a higher non-significant risk than expected, at 1.40.		
<b>Dose-Response</b>	CCO commented that although none of the studies identified a significant dose-response relationship, there was some suggestion of an increased risk with longer duration of service.	Dr. Band recognized that three mortality studies were suggestive of an increased risk with employment duration.	Dr. Parker did not directly comment on this criterion.
<b>Coherence (Biological Plausibility)</b>	CCO did not directly comment on this criterion, however they recognized that vinyl chloride, formaldehyde and acrylonitrile have been associated with brain cancers. CCO clearly stated that firefighters may be exposed to all three of these agents.	Dr. Band indicated that there is a probable increased risk of brain and central nervous system cancer associated with firefighting. He commented that this conclusion is further substantiated by the criterion of biological plausibility since firefighters are exposed to vinyl chloride, which has been associated with a risk of brain cancer. In addition, Dr. Band recognized that exposure to coal, oil, petrochemical compounds and rubber also carry a risk of brain cancer. Dr. Band concluded that it is likely that exposure to combustion products of these compounds are also associated with a brain cancer risk.	Dr. Parker suggested that a broad discussion of the relationship between each exposure and cancer is required for all malignancies.
<b>Temporal Relationship</b>	Although not explicitly included, CCO addressed this criterion through exclusion of cross-sectional studies.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Specificity</b>	CCO did not directly comment on specificity, however it can be inferred from their discussion about risk factors for brain cancer (e.g., ionizing radiation) that the relationship between firefighting and brain cancer is not specific.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Statistical</b>	Incidence	Dr. Band recognized that two of the	Dr. Parker did not directly comment

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<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Significance</b>	<p>CCO determined that of the four studies that reported results for brain cancer incidence, none reached statistical significance. They determined that the pooled risk estimate was not significant.</p> <p>Mortality</p> <p>CCO found that of the five studies that reported an increased risk for brain cancer, two reached statistical significance. They determined that the pooled risk estimate was of borderline significance.</p>	<p>mortality studies showed a statistically significant excess risk. It can be inferred from his calculations that the pooled risk estimate for the mortality studies was also significant.</p>	<p>on this criterion.</p>

**Conclusions**

	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Conclusion</b>	<p>Limited evidence of an increased risk associated with the occupation of firefighting.</p>	<p>Probable risk of an increased risk associated with the occupation of firefighting.</p>	<p>Dr. Parker commented that it is surprising to find the strength of association seen given the relatively rare nature of the disease(s). He recognized that the failure to consider confounding exposures was understandable given the poor understanding of the epidemiology of central nervous system malignancies. Dr. Parker concluded that these factors argue in favor of stronger conclusions than those made by CCO.</p>

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**Table 3: Colorectal Cancer\***

<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Strength of Association</b>	<p>Incidence            Three of the four studies that CCO examined which reported results for colorectal cancer incidence found an increased risk ranging from 1.10 to 1.36. One study reported a decrease of 0.81 (95% CI: 0.50, 1.32). CCO calculated a pooled risk estimate of 1.08 (95% CI: 0.86, 1.35).</p> <p>Mortality            Of the nine studies that CCO examined which reported mortality outcomes, seven reported an increased risk ranging from 1.12 to 1.90. Two studies reported a decreased risk of 0.87 (95% CI: 0.62, 1.23) and 0.93 (95% CI: 0.62, 1.39). CCO calculated a pooled risk estimate of 1.24 (95% CI: 1.04, 1.47).</p>	<p>Dr. Band acknowledged that the summary of the studies which CCO examined was accurate. He calculated the following summary risk measures for the four incidence and nine mortality studies examined by CCO:</p> <p style="padding-left: 40px;">Incidence = 1.06 (95% CI 0.84-1.33).            Mortality = 1.31 (95% CI 1.15-1.49).</p> <p>He concluded that the incidence studies showed no increased risk, whereas the mortality studies revealed a significantly increased risk. In addition, Dr. Band calculated a pooled risk estimate of 1.35 (95% CI 0.80-1.56) for three PMR studies that CCO excluded from their analysis. These studies revealed a moderate excess risk with an attributable risk of about 25%.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Consistency</b>	<p>CCO recognized that the estimates for studies of cancer incidence were consistent with the estimates from the mortality studies.</p>	<p>Dr. Band did not directly comment on this criterion.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Dose-Response</b>	<p>CCO noted that analyses by duration of service were not reported in any of the three studies which reported results for colorectal cancer. CCO recognized that of the studies which reported results for colon cancer and rectal cancer and which also reported</p>	<p>Dr. Band did not directly comment on this criterion.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>

\* Studies which reported results for the sites of colon and rectum separately were combined and included in the colorectal meta-analysis.

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<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
	analyses by duration of service, there was no clear evidence of a relationship with duration of service.		
<b>Coherence (Biological Plausibility)</b>	CCO did not directly comment on this criterion, however they recognized that asbestos, concrete dust, monocyclic aromatic hydrocarbons, soot and combustion gases from coal/coke/wood have been associated with colorectal cancers.	Dr. Band did not directly comment on this criterion.	Dr. Parker suggested that a broad discussion of the relationship between each exposure and cancer is required for all malignancies.
<b>Temporal Relationship</b>	Although not explicitly included, CCO addressed this criterion through exclusion of cross-sectional studies.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Specificity</b>	CCO did not directly comment on specificity, however it can be inferred from their discussion about risk factors for colorectal cancer (e.g., diet, smoking, physical inactivity) that the relationship between firefighting and colorectal cancer is not specific.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Statistical Significance</b>	<p>Incidence            CCO found that of the three studies that reported an increased risk, none reached statistical significance. They determined that the pooled risk estimate was not significant.</p> <p>Mortality            CCO found that of the seven studies that reported an increased risk, two reached statistical significance. They determined that the pooled risk estimate was significant.</p>	Dr. Band recognized that in two of the mortality studies, the excess risk was statistically significant and the pooled risk estimate for all mortality studies was also significant.	Dr. Parker did not directly comment on this criterion.

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**Conclusions**

	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Conclusion</b>	Limited evidence of an increased risk associated with the occupation of firefighting.	Insufficient evidence to determine risk associated with the occupation of firefighting.	Dr. Parker acknowledged that CCO's conclusions "appear to be reasonable based on available evidence".

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**Table 4: Colon Cancer**

<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Strength of Association</b>	<p><b>Incidence</b>  Two of the three studies that CCO examined which reported results for colon cancer incidence found no association. One study reported a decreased risk of 0.60 (95% CI: 0.24, 1.47). CCO calculated a pooled risk estimate of 0.97 (95% CI: 0.69, 1.36).</p> <p><b>Mortality</b>  Of the seven studies that CCO examined which reported mortality outcomes, three reported an increased risk ranging from 1.19 to 1.83. Three studies reported a decreased risk ranging from 0.60 to 0.85, and one found no association. A pooled risk estimate was not calculated.</p>	<p>Dr. Band acknowledged that the summary of the studies which CCO examined was accurate. He calculated the following summary risk measures for the three incidence and seven mortality studies examined by CCO:</p> <p style="padding-left: 40px;">Incidence = 0.91 (95% CI 0.65-1.25).  Mortality = 1.12 (95% CI 0.95-1.32).</p> <p>He concluded that the incidence studies showed a risk deficit and the mortality studies a small excess risk. In addition, Dr. Band calculated a pooled risk estimate of 1.00 (95% CI 0.63-1.51) for three PMR studies that CCO excluded from their analysis.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Consistency</b>	<p>CCO did not directly comment on this criterion for colon cancer. However, it is evident from the mortality studies that the results are not consistent.</p>	<p>Dr. Band did not directly comment on this criterion.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Dose-Response</b>	<p>CCO recognized that among the mortality studies, there was no clear evidence of a relationship with duration of service.</p>	<p>Dr. Band recognized that two of the seven mortality studies with a significant excess, also showed a significantly increased risk associated with employment duration of 20 or more years and 40 years and over.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Coherence (Biological Plausibility)</b>	<p>CCO did not directly comment on this criterion, however they recognized that asbestos, concrete dust, monocyclic aromatic hydrocarbons and soot have been associated with colon cancer.</p>	<p>Dr. Band did not directly comment on this criterion.</p>	<p>Dr. Parker suggested that a broad discussion of the relationship between each exposure and cancer is required for all malignancies.</p>

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<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Temporal Relationship</b>	Although not explicitly included, CCO addressed this criterion through exclusion of cross-sectional studies.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Specificity</b>	CCO did not directly comment on specificity, however it can be inferred from their discussion about risk factors for colon cancer (e.g., diet, smoking, physical inactivity) that the relationship between firefighting and colon cancer is not specific.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Statistical Significance</b>	<p>Incidence</p> <p>CCO determined that the pooled risk estimate was not significant.</p> <p>Mortality</p> <p>CCO recognized that of the seven mortality studies, two reported significant positive associations, and one reported a non-significant positive association. A pooled risk estimate was not calculated.</p>	Dr. Band recognized that in two of the mortality studies the excess risk was statistically significant. It can be inferred from Dr. Band's calculations that the pooled risk estimates were not significant.	Dr. Parker did not directly comment on this criterion.

**Conclusions**

	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Conclusion</b>	No conclusion	Insufficient evidence to determine risk associated with the occupation of firefighting.	Dr. Parker acknowledged that CCO's conclusions "appear to be reasonable based on available evidence".

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**Table 5: Rectal Cancer**

<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Strength of Association</b>	<p><b>Incidence</b>  Two of the three studies that CCO examined which reported results for colorectal cancer incidence found an increased risk of 1.15 (95% CI: 0.50, 2.20) and 1.70 (95% CI: 0.81, 3.12). On study reported no association. CCO calculated a pooled risk estimate of 1.25 (95% CI: 0.84, 1.85).</p> <p><b>Mortality</b>  Of the seven studies that CCO examined which reported mortality outcomes, five reported an increased risk ranging from 1.21 to 2.08. Two studies reported no evidence of an association. A pooled risk estimate was not calculated.</p>	<p>Dr. Band acknowledged that the summary of the studies which CCO examined was accurate. He calculated the following summary risk measures for the three incidence and seven mortality studies examined by CCO:</p> <p style="padding-left: 40px;">Incidence = 1.21 (95% CI 0.83-1.73).  Mortality = 1.36 (95% CI 1.04-1.73).</p> <p>He concluded that the incidence and mortality studies showed a small to moderate excess risk with attributable risk of 17.4% and 26% respectively. In addition, Dr. Band calculated a pooled risk estimate of 1.38 (95% CI 1.03-1.81) for three PMR studies that CCO excluded from their analysis. These studies revealed an attributable risk of 27.5%.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Consistency</b>	<p>CCO did not directly comment on this criterion for rectal cancer. However, the mortality studies consistently reported an increased risk.</p>	<p>Dr. Band did not directly comment on this criterion.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Dose-Response</b>	<p>CCO noted that there is no suggestion of an increased risk of rectal cancer with longer duration of employment.</p>	<p>Dr. Band did not directly comment on this criterion.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Coherence (Biological Plausibility)</b>	<p>CCO did not directly comment on this criterion, however they recognized that asbestos, monocyclic aromatic hydrocarbons, soot and combustion gases from coal/coke/wood have been associated with rectal cancers.</p>	<p>Dr. Band concluded that the studies taken together provided evidence for a possible increased risk of rectal cancer associated with the occupation of firefighting. However, he acknowledges that this conclusion is not substantiated by the criterion of biological plausibility, as information on associations between</p>	<p>Dr. Parker suggested that a broad discussion of the relationship between each exposure and cancer is required for all malignancies. He critiqued the CCO report by stating that there is "little discussion to help the reader clearly understand the nature (i.e., magnitude and extent) of exposure</p>

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Criterion	Cancer Care Ontario	Peer review – Dr. Pierre Band	Peer review – Dr. David Parker
		exposures and rectal cancer risk is insufficient.	and how this might be mitigated through the use of personal protective equipment”.
<b>Temporal Relationship</b>	Although not explicitly included, CCO addressed this criterion through exclusion of cross-sectional studies.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Specificity</b>	CCO did not directly comment on specificity, however it can be inferred from their discussion about risk factors for rectal cancer (e.g., diet, smoking, physical inactivity) that the relationship between firefighting and colorectal cancer is not specific.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Statistical Significance</b>	<p>Incidence            CCO found that of the two studies that reported an increased risk, none reached statistical significance. They determined that the pooled risk estimate was not significant.</p> <p>Mortality            CCO found that of the five studies that reported an increased risk, none reached statistical significance. A pooled risk estimate was not calculated.</p>	Dr. Band recognized that re-analysis of the mortality studies showed a significant excess. In addition, it can be inferred from his calculations that the pooled risk estimate for the PMR studies was statistically significant.	Dr. Parker did not directly comment on this criterion.

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**Conclusions**

	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Conclusion</b>	No conclusion	Possible risk associated with the occupation of firefighting.	Dr. Parker acknowledged that CCO's conclusions "appear to be reasonable based on available evidence".

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**Table 6: Kidney Cancer**

<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Strength of Association</b>	<p><b>Incidence</b>            CCO explained that one of the four studies examining the incidence of kidney cancer reported an increased risk of 3.51 (95% CI: 2.09, 5.92). The other three studies reported risk reductions ranging from 0.36 to 0.57. CCO calculated a pooled risk estimate of 0.89 (95% CI: 0.23, 3.39).</p> <p><b>Mortality</b>            CCO explained that of the seven studies examining mortality outcomes, two reported an increased risk of 1.30 (95% CI: 0.26, 3.80) and 4.14 (95% CI: 1.66, 8.53). Three studies reported reduced risks ranging from 0.27 to 0.68, and two did not report an association. CCO calculated a pooled risk estimate of 1.08 (95% CI: 0.58, 2.03).</p>	<p>Dr. Band acknowledged that the summary of the studies which CCO examined was accurate. He calculated the following pooled risk estimates for the three incidence and seven mortality studies examined by CCO:</p> <p style="padding-left: 40px;">Incidence = 0.48 (95% CI 0.19-0.99).            Mortality = 1.04 (95% CI 0.72-1.46).</p> <p>He concluded that there is no evidence of an increased risk from the incidence and mortality studies. In addition, Dr. Band calculated a pooled risk estimate of 1.36 (95% CI 1.03-1.77) for two PMR studies that CCO excluded from their analysis. The attributable risk of the two pooled PMR studies is reported as 26.47%.</p>	<p>Dr. Parker suggested that the work of Burnett (a PMR study) be included in the pooled risk estimates.</p>
<b>Consistency</b>	<p>CCO recognized that a wide range of estimates was reported among the mortality and incidence studies.</p>	<p>Dr. Band did not directly comment on this criterion.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Dose-Response</b>	<p>CCO did not directly comment on this criterion, however they identified two studies which demonstrated higher mortality in firefighters with long duration of service.</p>	<p>Dr. Band did not directly comment on this criterion.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Coherence (Biological Plausibility)</b>	<p>CCO did not directly comment on this criterion. However, they recognized that increased risks of kidney cancer</p>	<p>Dr. Band did not directly comment on this criterion.</p>	<p>Dr. Parker suggested that a broad discussion of the relationship between each exposure and cancer is required</p>

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<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
	have been observed in petroleum-based occupations.		for all malignancies.
<b>Temporal Relationship</b>	Although not explicitly included, CCO addressed this criterion through exclusion of cross-sectional studies.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Specificity</b>	CCO did not directly comment on specificity, however it can be inferred from their discussion about risk factors for kidney cancer (e.g., smoking and obesity) that the relationship between firefighting and kidney cancer is not specific.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Statistical Significance</b>	<p><b>Incidence</b>            CCO recognized that the one study which reported an increased risk reached statistical significance. The other three studies which reported risk reductions did not reach statistical significance. They determined that the pooled risk estimate was not significant.</p> <p><b>Mortality</b>            CCO recognized that of the two studies that reported an increased risk, only one reached statistical significance. They determined that the pooled risk estimate was not significant.</p>	Dr. Band recognized that one of the PMR studies was statistically significant. It can be inferred from his calculations that the summary risk estimate for the PMR studies was statistically significant.	Dr. Parker did not directly comment on this criterion.

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**Conclusions**

	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Conclusion</b>	No evidence of an increased risk associated with the occupation of firefighting.	Insufficient evidence to determine risk associated with the occupation of firefighting.	Dr. Parker commented that CCO's elimination of so many studies from its review has limited justification. Indeed such a limitation in the case of a relatively rare disease impairs the ability to detect disease. Dr. Parker suggested that a pooled risk estimate be computed for kidney cancer inclusive of the studies.

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**Table 7: Leukemia**

<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Strength of Association</b>	<p>Incidence  The two incidence studies examined by CCO reported no association. One study observed no cases of leukemia and the second reported a risk estimate of 1.00. A pooled risk estimate was not calculated.</p> <p>Mortality  CCO explained that of the three studies which examined cancer mortality, one reported an increased risk of 1.27 (95% CI: 0.71, 2.09). The other two studies reported decreased risks of 0.83 (95% CI: 0.50, 1.37) and 0.61 (95% CI: 0.22, 1.33). CCO calculated a pooled risk estimate of 0.94 (95% CI: 0.64, 1.36).</p>	<p>Dr. Band recognized that CCO's summary, as reported in Figure 5, did not consider the Aronson study which included eight cases of leukemia. He calculated the following summary risk measures for the two incidence and four mortality studies (including Aronson) examined by CCO:</p> <p style="padding-left: 40px;">Incidence = 1.00 (95% CI 0.36-2.11).  Mortality = 0.96 (95% CI 0.71-1.31).</p> <p>He concluded that there was no evidence of an increased risk from the incidence or mortality studies. In addition, Dr. Band calculated a pooled risk estimate of 1.27 (95% CI 0.91-1.48) for three PMR studies that CCO excluded from their analysis. The attributable risk for the three pooled PMR studies was 21.3%.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Consistency</b>	<p>CCO did not directly comment on this criterion. However, they recognized that one incidence study reported a risk estimate of 1.00 and the three mortality studies reported estimates ranging from 0.61 to 1.27.</p>	<p>Dr. Band did not directly comment on this criterion.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Dose-Response</b>	<p>CCO did not directly comment on this criterion. However, they identified one study which demonstrated higher mortality in firefighters with long duration of service. CCO also identified two studies which did not detect an association with duration of employment.</p>	<p>Dr. Band recognized that one of the mortality studies showed a significantly increased risk with employment duration of 40 years and over, and one of the PMR studies indicated a significantly increased risk of leukemia for firefighters less than 65 years of age.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Coherence</b>	<p>CCO reported that leukemia has been</p>	<p>Dr. Band did not directly comment on this</p>	<p>Dr. Parker suggested that the</p>

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Criterion	Cancer Care Ontario	Peer review – Dr. Pierre Band	Peer review – Dr. David Parker
<b>(Biological Plausibility)</b>	associated with exposure to benzene, formaldehyde, styrene, 1-3 butadiene and vinyl chloride. They recognized that firefighters have the opportunity for exposure to all these agents. CCO also commented that studies have reported concentrations of benzene and formaldehyde at structural fires which exceed NIOSH and ACGIH ceiling or short-term exposure levels.	criterion.	relationship between firefighting and leukemia is supported by CCO's statement: "Leukemia has been associated with exposure to benzene, formaldehyde, styrene, 1-3 butadiene, and vinyl chloride. Firefighters have the opportunity for exposure to all these agents". Dr. Parker commented that it is not clear how (or if) CCO accounts for exposure data in drawing their final conclusions.
<b>Temporal Relationship</b>	Although not explicitly included, CCO addressed this criterion through exclusion of cross-sectional studies.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Specificity</b>	CCO did not directly comment on specificity, however it can be inferred from their discussion about risk factors for leukemia (e.g., smoking and ionizing radiation) that the relationship between firefighting and leukemia is not specific.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Statistical Significance</b>	<p>Incidence  CCO explained that the two incidence studies reported no association.</p> <p>Mortality  CCO explained that the one study which reported an increased risk, and the two which reported a decreased risk, did not reach statistical significance. They determined that the pooled risk estimate was not significant.</p>	Dr. Band recognized that one of the PMR studies was statistically significant. It can be inferred from his calculations that the pooled risk estimates for the incidence, mortality and PMR studies were not significant.	Dr. Parker did not directly comment on this criterion.

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**Conclusions**

	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Conclusion</b>	Insufficient data to determine risk associated with the occupation of firefighting.	Insufficient evidence to determine risk associated with the occupation of firefighting.	Dr. Parker concluded that the evidence weighs in favor of a relationship between firefighting and leukemia. The factors on which Dr. Parker bases his conclusion are not provided.

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**Table 8: Lung Cancer**

<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Strength of Association</b>	<p><b>Incidence</b>            CCO explained that of the four studies that examined cancer incidence, two reported reductions in risk of 0.77 (95% CI: 0.28, 1.68 ) and 0.89 (95% CI: 0.51, 1.45). Two studies found no evidence of an association or only slightly elevated risks. CCO calculated a pooled risk estimate of 0.99 (95% CI: 0.79, 1.24).</p> <p><b>Mortality</b>            CCO examined eight studies that reported results of mortality from lung cancer. CCO noted that three studies reported an increased risk of lung cancer ranging from 1.13 to 1.63, and five studies reported reductions in risk ranging from 0.84 to 0.96. CCO calculated a pooled risk estimate of 1.02 (95% CI: 0.91, 1.15).</p>	<p>Dr. Band acknowledged that the summary of the studies which CCO examined was accurate. He calculated the following summary risk measures for the four incidence and seven mortality studies examined by CCO:</p> <p style="padding-left: 40px;">Incidence = 0.96 (95% CI 0.77-1.19).            Mortality = 1.01 (95% CI 0.91-1.11).</p> <p>In addition, Dr. Band calculated a pooled risk estimate of 1.02 (95% CI 0.94-1.10) for three PMR studies that CCO excluded from their analysis.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Consistency</b>	<p>CCO recognized that the magnitude of risk estimates reported by the mortality and incidence studies were similar.</p>	<p>Dr. Band concluded that all study designs (incidence, mortality and PMR) were consistent in documenting no increased risk of lung cancer.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Dose-Response</b>	<p>CCO acknowledged that none of the studies which reported additional analyses by duration of service found a relationship with increasing years of service.</p>	<p>Dr. Band recognized that with the exception of one study that indicated a non significant excess risk associated with employment duration, all of the other studies showed no evidence of increased risk with employment duration.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Coherence</b>	<p>CCO recognized that a number of</p>	<p>Dr. Band did not directly comment on this</p>	<p>Dr. Parker suggested that a broad</p>

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<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>(Biological Plausibility)</b>	agents to which firefighters are exposed, namely PAHs, asbestos, vinyl chloride, diesel exhaust and formaldehyde, have been associated with increased risk of lung cancer.	criterion.	discussion of the relationship between each exposure and cancer is required for all malignancies.
<b>Temporal Relationship</b>	Although not explicitly included, CCO addressed this criterion through exclusion of cross-sectional studies.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Specificity</b>	CCO did not directly comment on specificity, however it can be inferred from their discussion about risk factors for lung cancer, most notably smoking, that the relationship between firefighting and lung cancer is not specific.	Dr. Band did not directly comment on this criterion.	Dr. Parker suggested that the review of lung cancer mortality should include more discussion on the possible impact of cigarette smoking.
<b>Statistical Significance</b>	<p><b>Incidence</b>  CCO explained that both studies which reported reductions in risk did not reach statistical significance. They determined that the pooled risk estimate was not significant.</p> <p><b>Mortality</b>  CCO acknowledged that the three studies which reported an increased risk of lung cancer did not reach statistical significance. They determined that the pooled risk estimate was not significant.</p>	Dr. Band did not directly comment on this criterion. However, it can be inferred from his calculations that the pooled risk estimates for the incidence, mortality and PMR studies were not statistically significant.	Dr. Parker did not directly comment on this criterion.

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<b>Conclusions</b>			
	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Conclusion</b>	No evidence of an association with the occupation of firefighting.	No evidence of an association with the occupation of firefighting.	Dr. Parker concluded that the data argue in favor of stronger conclusions than those made by CCO. He suggested that analysis of available work should include estimates of mortality from smoking-related non-cancer (e.g., emphysema) and determinations made about the possible impact of smoking.

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**Table 9: Multiple Myeloma**

<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Strength of Association</b>	<p>Incidence CCO examined one study that reported a reduction in risk of 0.70 (95% CI: 0.10, 2.60) and another reported an increase of 1.90 (95% CI: 0.50, 9.40). A pooled risk estimate was not calculated.</p> <p>Mortality CCO examined one study that reported an increased risk of 1.68 (95% CI: 0.90, 3.11). A pooled risk estimate was not calculated.</p>	<p>Dr. Band acknowledged that the summary of the studies which CCO examined was accurate. He calculated the following summary risk measure for the two incidence studies examined by CCO:            Incidence = 0.89 (95% CI 0.36-1.90).</p> <p>He concluded that the one mortality study showed a non significant excess. In addition, Dr. Band calculated a pooled risk estimate of 1.39 (95% CI 0.99-1.91) for three PMR studies that CCO excluded from their analysis.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Consistency</b>	<p>CCO did not directly comment on this criterion. However, it is evident from the three reported studies, that there is no consistency in the results.</p>	<p>Dr. Band did not directly comment on this criterion.</p>	<p>Dr. Parker recognized that there is considerable variability in the risk relationship between firefighting and multiple myeloma.</p>
<b>Dose-Response</b>	<p>CCO commented that there is a suggestion of increased risk with increasing years of employment in two studies. They recognized however, that the numbers in both studies were small.</p>	<p>Dr. Band did not directly comment on this criterion.</p>	<p>Dr. Parker noted that CCO found a suggestion of increased risk with increasing years of employment in two studies. However, he did not indicate whether he agreed with this analysis.</p>
<b>Coherence (Biological Plausibility)</b>	<p>CCO recognized that multiple myeloma has been associated with exposure to benzene, engine exhaust, and ionizing radiation. They acknowledged that benzene has been recorded at levels in excess of recommended short-term and ceiling exposure levels in nearly all fires.</p>	<p>Dr. Band did not directly comment on this criterion.</p>	<p>Dr. Parker suggested that a broad discussion of the relationship between each exposure and cancer is required for all malignancies.</p>
<b>Temporal</b>	<p>Although not explicitly included, CCO</p>	<p>Dr. Band did not directly comment on this</p>	<p>Dr. Parker did not directly comment</p>

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<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Relationship</b>	addressed this criterion through exclusion of cross-sectional studies.	criterion.	on this criterion.
<b>Specificity</b>	CCO recognized that non-occupational risk factors for multiple myeloma have not been well established.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Statistical Significance</b>	<p>Incidence            CCO explained that both studies which reported on incidence did not reach statistical significance.</p> <p>Mortality            CCO explained that the one study which reported an increased risk did not reach statistical significance.</p>	Dr. Band recognized that one of the PMR studies showed a significant excess. It can be inferred from his calculations that the pooled risk estimates for the incidence and PMR studies were not significant.	Dr. Parker did not directly comment on this criterion.

**Conclusions**

	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Conclusion</b>	Insufficient data to determine risk associated with the occupation of firefighting.	Insufficient evidence to determine risk associated with the occupation of firefighting.	Dr. Parker concluded that the data presented by CCO supports a relationship between firefighting and multiple myeloma. Dr. Parker suggested that CCO include more discussion on environmental causes of multiple myeloma.

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**Table 10: Non-Hodgkin Lymphoma**

<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Strength of Association</b>	<p>Incidence CCO examined one study that reported a reduction in risk of 0.90 (95% CI: 0.40, 1.90) and another reported an increase of 1.85 (95% CI: 0.50, 4.74). A pooled risk estimate was not calculated.</p> <p>Mortality CCO examined one study that reported an increased risk of 1.41 (95% CI: 0.91, 2.19). A pooled risk estimate was not calculated.</p>	<p>Dr. Band recognized that CCO's summary, did not consider the Aronson study which included three cases of lymphosarcoma. He calculated the following summary risk measures for the two incidence and two mortality studies (including Aronson) examined by CCO:</p> <p style="padding-left: 40px;">Incidence = 1.40 (95% CI 0.46-3.28). Mortality = 1.47 (95% CI 0.93-2.21).</p> <p>In addition, Dr. Band calculated a pooled risk estimate of 1.37 (95% CI 1.08-1.71) for three PMR studies that CCO excluded from their analysis.</p>	Dr. Parker did not directly comment on this criterion.
<b>Consistency</b>	CCO did not directly comment on this criterion. However, it is evident from the three reported studies, that there is no consistency in the results.	Dr. Band concluded that "excess risk was around 40%, consistent between the incidence, mortality and PMR studies, with attributable risks of 27% to 32%".	Dr. Parker did not directly comment on this criterion.
<b>Dose-Response</b>	CCO noted that of the two studies which report analyses by duration of service, neither reported a dose-response relationship.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Coherence (Biological Plausibility)</b>	CCO recognized that exposure to benzene has been associated with increased risk of lymphoma, a carcinogen to which firefighters are exposed.	Dr. Band did not directly comment on this criterion.	Dr. Parker suggested that a broad discussion of the relationship between each exposure and cancer is required for all malignancies.
<b>Temporal Relationship</b>	Although not explicitly included, CCO addressed this criterion through exclusion of cross-sectional studies.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.

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<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Specificity</b>	CCO did not directly comment on specificity. However, it can be inferred from their discussion about risk factors (ionizing radiation, inherited and acquired immune disorders), that the relationship between firefighting and lymphoma is not specific.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Statistical Significance</b>	<p><b>Incidence</b>            CCO explained that both studies which reported on incidence did not reach statistical significance.</p> <p><b>Mortality</b>            CCO acknowledged that the one study which reported an increased risk did not reach statistical significance.</p>	Dr. Band recognized that one of the PMR studies showed a significant excess. It can be inferred from this calculations that the pooled risk estimate for the PMR studies was significant.	Dr. Parker did not directly comment on this criterion.

**Conclusions**

	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Conclusion</b>	Insufficient data to determine risk associated with the occupation of firefighting.	Insufficient evidence to determine risk associated with the occupation of firefighting.	Dr. Parker suggested that statistical data be weighted with data on exposure and occupational causes of morbidity.

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**Table 11: Testicular Cancer**

<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Strength of Association</b>	<p>Incidence            CCO examined three studies that reported an elevated risk of 1.55 (95% CI: 0.80, 2.80), 1.15 (95% CI: 0.13, 4.17) and 4.30 (95% CI: 0.70, 30.5). They explained that pooled risk estimates were not presented because one study of the three would have carried considerable influence and the estimate would have essentially reflected findings of this one study.</p> <p>Mortality            CCO examined one study that reported an increased risk of 2.52 (95% CI: 0.52, 7.37). A pooled risk estimate was not calculated.</p>	<p>Dr. Band acknowledged that the summary of the studies which CCO examined was accurate. He calculated the following summary risk measure for the two incidence studies examined by CCO:            Incidence = 1.47 (95% CI: 0.82-2.64).</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Consistency</b>	<p>CCO reported that the risk estimates of the three incidence studies ranged in magnitude from 1.15 to 4.30, with the highest estimate being reported by a case control study. CCO recognized that the estimate of the mortality study, at 2.52, fell within the range of these studies.</p>	<p>Dr. Band did not directly comment on this criterion.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Dose-Response</b>	<p>CCO recognized that of the three studies which reported analyses by duration of service, two did not show a dose-response relationship. They found that there was some suggestion of an increased risk with increasing duration of employment in one study.</p>	<p>Dr. Band did not directly comment on this criterion.</p>	<p>Dr. Parker did not directly comment on this criterion.</p>
<b>Coherence</b>	<p>CCO did not directly comment on this</p>	<p>Dr. Band did not directly comment on this</p>	<p>Dr. Parker suggested that a broad</p>

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<b>Criterion</b>	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>(Biological Plausibility)</b>	criterion.	criterion.	discussion of the relationship between each exposure and cancer is required for all malignancies.
<b>Temporal Relationship</b>	Although not explicitly included, CCO addressed this criterion through exclusion of cross-sectional studies.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Specificity</b>	CCO did not directly comment on specificity, however it can be inferred from their discussion about an established risk factor (although rare), an undescended testicle, that the relationship between firefighting and testicular cancer is not specific.	Dr. Band did not directly comment on this criterion.	Dr. Parker did not directly comment on this criterion.
<b>Statistical Significance</b>	<p><b>Incidence</b>  CCO explained that none of the three studies which reported an elevated risk of testicular cancer reached statistical significance.</p> <p><b>Mortality</b>  CCO recognized that the one study which reported an increased risk of mortality did not reach statistical significance.</p>	Dr. Band recognized that the one mortality study showed a non significant excess. It can be inferred from his calculations that the pooled risk estimate for the incidence studies was not statistically significant.	Dr. Parker did not directly comment on this criterion.

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<b>Conclusions</b>			
	<b>Cancer Care Ontario</b>	<b>Peer review – Dr. Pierre Band</b>	<b>Peer review – Dr. David Parker</b>
<b>Conclusion</b>	Insufficient data to determine risk associated with the occupation of firefighting.	Insufficient evidence to determine risk associated with the occupation of firefighting.	Dr. Parker found that the evidence presented by CCO conflicted with their conclusion that there is insufficient data to determine whether there is an increased risk of testicular cancer associated with firefighting. Dr. Parker suggested that the small number of cases reflects the relative rarity of the disease.

**APPENDIX 8**  
**US Jurisdictions - Specific Cancers Covered**

(jurisdictions highlighted with an “\*” include the presumption in workers’ compensation legislation)

State/Cancer Type	Brain	Bladder	Colon	Kidney	Leukemia	Non-Hodgkin's Lymphoma	Rectal	Ureter	Lung	Testicular	Specific term used or other comments
Alabama	x	x	x	x	x	x	x	x	x	x	Cancer
Arizona*	x	x	x		x	x	x				Plus aden carcinoma and mesothelioma of the respiratory tract <sup>43</sup>
California	x	x	x	x	x	x	x	x	x	x	Cancer including. Leukemia
Illinois	x	x	x	x	x	x	x	x	x	x	Disabling cancer
Kansas	x	x	x	x	x	x	x	x	x	x	Cancer
Louisiana	x	x	x		x	x					Plus liver pancreas, skin or gastrointestinal
Maryland*					x		x				Plus pancreatic, prostate and throat cancers

<sup>43</sup> [sic] It is presumed this reference is intended to be to “adenocarcinoma”, a neoplasm arising from a glandular organ (Taber’s Cyclopedic Medical Dictionary, 1993).

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US Jurisdictions - Specific Cancers Covered**

<b>State/Cancer Type</b>	<b>Brain</b>	<b>Bladder</b>	<b>Colon</b>	<b>Kidney</b>	<b>Leukemia</b>	<b>Non-Hodgkin's Lymphoma</b>	<b>Rectal</b>	<b>Ureter</b>	<b>Lung</b>	<b>Testicular</b>	<b>Specific term used or other comments</b>
<i>Massachusetts</i>	x	x	x	x	x	x	x	x	x		Cancer affecting the skin, CNS, lymphatic, digestive, hematological, urinary, skeletal, oral or prostate systems, lung or respiratory tract
<b>Minnesota*</b>	x	x	x	x	x	x	x	x	x	x	Disabling cancer
<b>Missouri*</b>	x	x	x	x	x	x	x	x	x	x	Carcinoma
<b>Nebraska</b>	x	x	x	x	x	x	x	x			Cancer including but not limited to cancer affecting the skin, CNS, lymphatic, digestive, hematological, urinary, skeletal, oral or prostate systems
<b>Nevada*</b>	x	x	x	x	x	x	x	x	x	x	Cancer

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US Jurisdictions - Specific Cancers Covered**

<b>State/Cancer Type</b>	<b>Brain</b>	<b>Bladder</b>	<b>Colon</b>	<b>Kidney</b>	<b>Leukemia</b>	<b>Non-Hodgkin's Lymphoma</b>	<b>Rectal</b>	<b>Ureter</b>	<b>Lung</b>	<b>Testicular</b>	<b>Specific term used or other comments</b>
<b>New Hampshire*</b>	x	x	x	x	x	x	x	x	x	x	Cancer disease
<b>New York</b>	x	x	x	x	x	x	x	x		x	melanoma, lymphatic, digestive, hematological, urinary, neurological, breast, reproductive, or prostate system cancers
<b>North Dakota*</b>	x	x	x	x	x	x	x	x	x	x	Occupational cancer
<b>Oklahoma</b>	x	x	x	x	x	x	x	x	x	x	Any cancer
<b>Rhode Island</b>	x	x	x	x	x	x	x	x	x	x	Disabling occupational cancer
<b>South Dakota</b>	x	x	x	x	x	x	x	x	x	x	Cancer
<b>Tennessee</b>	x	x	x	x	x	x	x	x	x	x	Cancer and disease

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US Jurisdictions - Specific Cancers Covered**

<b>State/Cancer Type</b>	<b>Brain</b>	<b>Bladder</b>	<b>Colon</b>	<b>Kidney</b>	<b>Leukemia</b>	<b>Non-Hodgkin's Lymphoma</b>	<b>Rectal</b>	<b>Ureter</b>	<b>Lung</b>	<b>Testicular</b>	<b>Specific term used or other comments</b>
<b>Texas</b>	x	x	x	x	x	x	x	x	x	x	Cancer
<b>Virginia*</b>					x		x				Leukemia, pancreatic, prostate rectal, throat, ovarian and breast cancers
<b>Washington*</b>	x	x		x	x	x		x			Plus malignant melanoma
<b>Wisconsin</b>	x	x	x	x	x	x	x	x		x	skin, breast, CNS, lymphatic, digestive, hematological, urinary, skeletal, oral or reproductive system