



**Soil Vapour and Indoor Air Monitoring Assessments  
A Pandora's Box for the Insurance Industry and the Homeowner**

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## INTRODUCTION

In July of 2006, The Atlantic PIRI committee issued a document called Guidance for Soil Vapour and Indoor Air Monitoring Assessments. The document adds another layer of apparent scientific justification to the concept that it is possible to have a home heating oil tank release be the cause of chronic disease in the human population. While the application of the previous versions of Atlantic PIRI RBCA (1998, 2003) have already fostered that perception, of particular concern is that the guidance in this document indicates the potential for impacts to indoor air quality for adjacent structures between 10 and 35 metres in all directions from a spill. This new document adds a new level of complication and cost to the assessment and the successful remediation of fuel oil heating spills in the Atlantic Region. Of particular concern is that implementation of this guidance will result in the unwarranted escalation of third party claims for trespass, nuisance and the alleged causation of chronic disease.

Within the Guidance for Soil Vapour and Indoor Air Monitoring Assessments, the Atlantic PIRI committee (2006) present a “Pathway Operability” Table (see attached Table 1). In this table, if the total residual petroleum hydrocarbon concentration (TPH) in soil is between 39 and 100 mg/kg, and the benzene concentration is between 0.16 and 1.0 mg/kg, then there could be impacts at a horizontal or vertical distance of 10 metres (ca 30 feet). In addition, the table indicates, if the concentrations in a soil sample are >100 to 1,000 mg/kg TPH, or the benzene concentration is >1 to 10 mg/kg it is suggested that there could be significant impact as far away as 20 meters (ca 60 feet) in all directions. If there are any underground services, this distance of potential impact could expand. No guidance is given as to the total mass of fuel in the soil needed to create this field of risk.

Using the Tier I default parameters it is acceptable to leave 405 cubic meters of contaminated soil with 140 mg/kg of diesel fuel (Atlantic PIRI, 2003). Assuming that a cubic metre of soil weighs 1.8 tonnes and that diesel weighs approximately 900,000 mg/litre, it is possible to leave up to 110 litres of fuel, 0.3 metres beneath a basement floor as long as every single sample is below 140 mg/kg. It is easy to imagine leaving, as an example, 10 litres on a property, but having one or more samples from the area with the 10 litres which contain concentrations of more than 1,000 mg/kg (i.e. ¼ teaspoon per 2.2 lbs of soil). In this case, according to this guidance (Atlantic PIRI, 2003), a risk of indoor air contamination in a 25-meter radius in all directions must be addressed for this 10 litres while for 110 litres, no further risk need be investigated.

Careful examination of this guidance reveals three important points:

The first is that the scientific database does not support that fuel oil or heavy oil spills of small sizes that have been remediated to below the odour detection limit, pose any significant risks to indoor air quality either locally or at a distance. A significant risk is defined as a risk that a medical or epidemiological investigation could demonstrate would be attributable to the spill. An example of this type of risk

is that there are studies that show that bus drivers and mechanics have a potential increased risk of lung disease due to constant breathing of exhaust fumes (USEPA, 2002). No such data exists for fuel oil (ATSDR, 1995).

The second is that the criteria used to determine the potential for off-site impacts were taken from data and models of very large and unmanaged gasoline and chlorinated solvent releases. This assumption is a gross over estimation of the volatile components that will be released from diesel, fuel oil or heavy oil.

The third is that vapour intrusion is the only issue for which there are not separate criteria for gasoline, fuel oil and heavy oil under Atlantic PIRI RBCA. No explanation of the reason for deviation from the standard practice has been provided.

The following paper provides a brief history of the vapour intrusion issue, the data used by Atlantic PIRI to develop their guidance, and the scientific difficulties that the guidance presents.

## **HISTORY OF THE VAPOUR INTRUSION ISSUE**

The issue of vapour intrusion has become a significant focus of activity across the United States and this has spread to Canada. A short description of the events that have triggered this interest follows.

In a presentation describing the history of vapour intrusion issue given in 2004, Ameter, (2004) points out that the explosion potential of vapours from gasoline was probably the earliest example of a concern related to vapours in indoor air from volatile substances. Residential indoor air became a topic of widespread interest in the 1980's especially due to the identification of radon gas in homes across certain sections of North America. Buried wastes and hidden wastes were also brought to the spotlight through the publicity surrounding Love Canal. During the late 1980's and beyond, indoor air investigations of a chlorinated solvents site in Kodak Park, State of New York, USA in 1989/1990, the 1989 investigation of chlorinated solvents in groundwater in the State of New Hampshire, USA, the 1991 investigation of chlorinated solvents in groundwater in the US States of Colorado and Indiana, the investigation of chlorinated solvents at a site in the State of California, USA in 1992 and the investigation of chlorinated solvents from an military base in the State of Utah, USA were cited by Ameter as the historical precedents for the current interest in vapour intrusion.

In addition to the work cited by Ameter (2004) in the late 1980s and early 1990's there were a series of published papers in journals and conference proceedings describing the monitoring of gasoline and chlorinated solvent vapours in the subsurface environment. Ostendorf and Kampbell (1991) using the techniques of soil vapour monitoring developed by a number of investigators in the mid 1980's, which they cite, describes the detailed analysis of soil vapours from a release of about 100,000 litres of aviation fuel from a Coast Guard Station in the State of Michigan, USA which formed a plume on the

groundwater 80 m wide by 250 m in length. These authors focused on the observation that the vapours were rapidly decreasing as they neared the surface, attributing this to the action of biodegradation which “prevented the escape of appreciable contamination to the atmosphere for most locations on the site.”

In 1989 the Hillside School was investigated in the State of Massachusetts, USA because of the presence of chlorinated solvents in a groundwater plume from the nearby Microwave Development Plant (Monosson, 2008). In 1990 Kullman and Hill (1990) reported on complaints of odours in an office building near abandoned gasoline underground storage tanks.

In 1992, Mosely and Meyer (1992) reported on the investigation of strong hydrocarbon odours within a school. It was discovered that 20,000 gallons of gasoline was released from a nearby service station to the groundwater located between 9 and 17 feet beneath the school. The authors concluded that groundwater contamination from a gasoline spill could contaminate the indoor air of a building. In 1993, Kaplan et al. (1993) published a study which modeled the potential for significant indoor vapours from spills of 21 gallons (79.4 litres) and 85 gallons (321.7 litres) of fuel oil to a depth of a quarter inch on a basement floor that were not cleaned up at all. Using xylene as their marker for contamination, they concluded that there would be a risk for adverse effects on human central nervous and reproductive systems for 8 days or possibly longer. While they mentioned periodic inspection of home heating oil tanks and supervision of fuel deliveries, they did not mention cleaning the spills as an effective way to reduce risk.

Mushrash et al. (1994) reported on a release of approximately 200,000 gallons of a mix of Jet Fuel A (48%), Diesel (45%), Gasoline (5%) and Fuel Oil (2%) in the State of Virginia, USA that had formed a plume 200 feet wide by 2,300 feet in length at the top of the water table 27 feet (ca. 8 metres) beneath the surface. They observed over a foot of free product in a monitoring well along the plume. Soil vapour measurements were made at 10 feet (3 metres) from the surface. The authors reported total vapours of 10,000 ppm and expressed concern about the potential for explosive concentrations forming due to the vapours from the gasoline and jet fuel components of the hydrocarbon plume floating on the groundwater. In 1996, in the State of Illinois, USA, residents began complaining about gasoline odours in their homes that was eventually traced to the release of greater than 1.16 million gallons (ca. 6 million litres) of gasoline into the groundwater from three nearby refineries (Illinois Environmental Protection Agency, 2003)

Fischer et al. (1996) reported on soil vapours from a gasoline station that had three leaking underground storage tanks. Their field study of soil gas vapours indicated a million-fold dilution between soil gas measured 0.7 meters beneath the surface of the station and measurements made within the service station. The authors concluded that the sharp attenuation was due to biologically mediated degradation of the soil vapours. Fischer et al. cited Mosely and Meyer (1992) and Kullman and Hill (1990) as authors who had previously reported indoor air contamination by soil gases.

The State of Maine, USA (Vorhees et. al, 1998) investigated the air quality in 21 homes during and following the remediation of spills of #2 fuel oil by measuring the concentrations of seven chemical compounds believed to be markers of fuel oil in the air. Only naphthalene was suspected of being present in any significant concentration following remediation and this was not certain due to a lack of background data on this compound.

Fitzpatrick and Fitzgerald (1999), scientists with the Massachusetts Department of Environmental Protection (USA), reported on an evaluation of over 6,000 files of spills of substances with volatile organic compounds (VOCs). They initially reduced the number of sites to 167 with some combination of contaminated soil, groundwater and indoor air. The authors identified 28 sites with releases of chlorinated VOCs or gasoline releases that had the characteristics most likely to result in unacceptable indoor air concentrations of vapour. Of these 28 sites, 11 had unacceptable concentrations of gasoline components in soil or groundwater. The rest had unacceptable concentrations of chlorinated solvents. Of the 28 sites, 15 sites had unacceptable concentrations groundwater contamination and vapours in indoor air. Of these 15, 1 was related to gasoline and 14 were related to chlorinated solvents. Thus, of the eleven sites with unacceptable concentrations of gasoline in soil and groundwater, only 1 had a vapour problem based on measurements of benzene. The unacceptable concentration of benzene from gasoline in the indoor air was attributed to the presence of an open sump in the basement of the building, which was contaminated with gasoline. Based on their analysis of the data, the authors concluded that significant biodegradation of petroleum hydrocarbons such as benzene, toluene, ethyl benzene and xylenes were occurring in the vadose zone. The authors reported that their findings were similar to those reported by Fischer et al. (1996) in their investigation of indoor air impacts at a gasoline-contaminated site in the State of California, USA. Fitzpatrick and Fitzgerald (1999) also concluded that the potential for vapour releases from petroleum hydrocarbons in groundwater is overestimated and the potential for vapours from chlorinated solvents is underestimated.

In the United States, national focus was galvanized by the discovery of chlorinated solvent plumes in groundwater from the Colorado Department of Transportation Materials Testing Laboratory Site, the Redfield rifle scope factory site and the Rocky Mountain Arsenal Site in the State of Colorado. The first two sites contributed to the presence of chlorinated solvents within homes built over these plumes. This discovery was not predicted by the version of the indoor air quality model being used by the USEPA at the time and this fact made front-page headlines in Denver, Colorado (Hartman, 2007). These sites were extensively studied (i.e. millions of dollars were spent in studies and according Folkes and Arell (2003), most of the real world knowledge of vapour intrusion is based on the study of these two sites.

In 2003, the State of Wisconsin (2003) issued a competitive bid for the remediation of a service station in downtown Cedarburg, WI. The State reported that up to 5.8 feet of 98.5% diesel oil and 1.5% gasoline mixture was found in monitoring wells on the property in 1999. According to the Wisconsin Department of Health and Family Services

(Warzecha, 2003), who reported on their health assessment of a nearby church, the free product on the site has been reduced to 1 foot. No vapours or odours had been reported from any adjoining properties, including the church. According to the author, since petroleum contaminants have a propensity to degrade over distance and time, the ability of the soil gases from these substances to migrate significant distances is severely limited. Therefore, intrusion of petroleum vapours into indoor air was unlikely in the absence of contaminated groundwater coming into direct contact with the building or contaminated groundwater being present directly beneath the building. The lack of any past observations of petroleum odour in the indoor air of the church basement was reported to be a strong indication that a vapour intrusion-related health concerns were not likely. Finally, commenting on future development for the property where the spill occurred, the author stated that the presence of free-product in the groundwater was the reason to be concerned about vapour intrusion and that when the free-product was removed, vapour intrusion would no longer be a risk.

Davis et al (2004) concluded that the most common source of vapours from petroleum products when present in the subsurface was gasoline (which is more highly volatile than fuel oil). According to these authors, diesel and kerosene fuels do not usually contain high concentrations of volatile compounds. In addition to Hers et al, (2000) and Laubacker et al (1997), Davis et al. cited 5 additional field studies of soil vapours from petroleum contaminated sites: Ostendorf and Kampbell, 1991; Davis et al, 1998; Franzmann et al. 1999; Davis et al. 2000, and Davis et al, 2001. All these studies were of gasoline or aviation gas spills. (Note that aviation gas is similar to gasoline; there is just tighter control of the potential for water content).

McHugh et al. (2004) completed an analysis of 270 paired groundwater and indoor air measurements of volatile organic compounds from 1 site in California, 3 sites in Colorado and 27 sites in Massachusetts. They found no correlation between petroleum constituent concentrations measured in groundwater and the concentrations of the volatile organic compounds in indoor air of the overlying structures. For chlorinated solvents there was correlation.

According to Tillman and Weaver (2005) there were not many documented cases of vapour intrusion in the scientific literature. This was particularly true for organic vapours, which are subject to biodegradation such as gasoline compounds (petroleum hydrocarbons). These authors cited Mosely and Meyer, (1992), Fitzgerald and Fitzgerald (1999) and Fischer et al, 1996. Tillman and Weaver also cited Laubacker et al. (1997) who studied a 70-year-old petroleum distribution facility that leaked gasoline into the groundwater beneath a residential development. While there was no free-product mentioned, there was between 12 and 39 mg/l of BTEX reported. No vapour impacts were noted in any homes. Tillman and Weaver also cited Hers et al. (2000) who studied a leaking petrochemical plant with “BTX residual NAPL distributed over a 1 meter interval” in the groundwater.

## LITERATURE CITED BY ATLANTIC PIRI SOIL VAPOUR AND INDOOR AIR MONITORING ASSESSMENTS GUIDANCE, JULY 2006

Atlantic PIRI (2006) describes the information that went into developing their “Pathway Operability” criteria as coming from “residential properties in Colorado”, supported by USEPA (2002a), Golder Associates (2004) and API (2005). Atlantic PIRI also claims that data in Abreu and Johnson (2005) support the conclusions represented by this table.

The data from “residential properties in Colorado”, as previously described, was massive contamination of groundwater with chlorinated solvents. The USEPA (2002a) vapour intrusion guidance manual states in its introduction:

“This guidance is suggested for use at RCRA Corrective Action, CERCLA (National Priorities List and Superfund Alternatives Sites) and Brownfields sites but is not recommended for use at Subtitle I Underground Storage Tank (UST) site at this time. *The draft guidance recommends certain conservative assumptions that may not be appropriate at a majority of the current 145,000 petroleum releases from UST’s. As such the draft guidance is unlikely to provide appropriate mechanisms for screening the vapor pathway at UST sites.* (emphasis ours)“

In other words, the USEPA (2002a) specifically states that their document is not recommended for use with petroleum fuels.

Abreu and Johnson (2005) modeled a 900 square metre gasoline groundwater plume for the American Petroleum Institute (API, 2005) to provide methods guidance for the analysis of vapour intrusion at heavily contaminated sites when ordered to do so. No discussion of the rationale for the need for the study of vapour intrusion is provided in this document. Golder and Associates (2004) is a draft document prepared for Health Canada and is not publicly available. Tillman and Weaver (2005), described by Atlantic PIRI (2006) as a key reference, concluded that there was little basis for vapour intrusion being an issue except when chlorinated solvents were involved.

Of the remaining references in the Atlantic PIRI guidance document (2006), the only reports describing actual contaminated sites with vapour intrusion are DiGiulio (2003) who described a manufacturing site contaminated by chlorinated solvents and Sanders and Hers (2004) who described results from a site with groundwater heavily contaminated by gasoline from leaking underground storage tanks. Sander and Hers reported only one component of the gasoline, the additive MTBE, was found in significant concentrations within any home. The remaining references in Atlantic PIRI (2006) are methods, documents or studies of various aspects of the Johnson-Ettinger model. (The Johnson-Ettinger model is the indoor air quality model within the Atlantic PIRI RBCA model (Atlantic PIRI, 1999, 2003). The conclusion is clear; the Pathway Operability Table is based on large gasoline or chlorinated solvents releases. Fuel oil or heavy oils were not involved. Home heating oil tanks were not involved.

## CONTRADICTIONARY SCIENCE

The USEPA (2008) website on soil vapor extraction in 2004-2006 indicated that attempting to remediate contaminated sites using vapour extraction is generally more successful for gasoline contaminated sites and is not a recommended method for clean-up of diesel and fuel oil contaminated sites because these fuels do not have a strong enough vapour pressure (USEPA, 1994). Furthermore, this technology requires that a vacuum be applied to the soils to promote vapours to move efficiently, which is significantly different than passive migration under atmospheric conditions. Factors such as type of soil and water content of soil can also reduce the effectiveness of this method. Also, there is a point of stability for hydrocarbon components when vapours no longer volatilize from the soils in measurable quantities. The technology has been found to be effective in removing vapours during the initial stages of a fuel oil or diesel spill if no remediation or very limited remediation was anticipated; however, within a few years, no more detectable hydrocarbon vapours are released and these vapour control systems are usually removed. In summary, it is not apparent how natural processes (naturally occurring pressure gradients which will fluctuate based on atmospheric pressure changes) would result in significant quantities of fuel oil vapour entering a building following removal of all free product when active technology has been shown to be generally ineffective.

There is evidence that spills that are cleaned up have no vapour impacts (State of Maine, 1999). There is evidence that even un-remediated small spills may not be an indoor air issue after more than a year (Kaplan et al. 1993).

USEPA (2002a) recommends that one consider the possibility of exposure from vapour inhalation if you have volatile chemicals that exceed a Henry's Law constant of  $1 \times 10^{-5}$ . The Henry's Law constant for fuel oil ( $5.9$  to  $7.4 \times 10^{-5}$ ) exceeds this value by a factor of 5.9 to 7.4 while the constant for gasoline exceeds it by a factor of 33 to 45 ( $3.3$  to  $4.8 \times 10^{-4}$ ). Gasoline has 100% of its PIRI fractions in the volatile ranges while fresh fuel oil has 69%. In addition the aliphatic fractions are expected to be significantly more volatile than the aromatic fractions. Gasoline has 82% of its fractions in the aliphatic ranges while fuel oil has 50% in these ranges.

In the Atlantic PIRI system this guidance for vapour intrusion is the only instance where fuel oil is regulated as if it is gasoline (Atlantic PIRI, 1999, 2003). For all other routes of exposure, gasoline, fuel oil and heavy oils are treated separately, recognizing the different chemical and physical properties; therefore, treating fuel oil as having the same physical and chemical properties as gasoline is a significant problem when attempting to apply Table 1 criteria where there is a potential claim for off-site impact at up to 35 meters from the source.

There is a logical inconsistency that arises from Table 1. Assume that there is residual contamination in a sample with a concentration greater than 1,000 mg/kg, left under a basement floor. The Atlantic PIRI committee approach under Atlantic RBCA has been to

model this residual as if all of it were going to enter the house above. The committee suggests that the soil gases be examined to be sure that there is no migration up to 35 meters away and in all directions. Atlantic PIRI ignores downward gas migration, which is also possible (Hartman, 1998) so it is really 6 directions of vapour release from a source. The soil gas cannot be in 6 places at once without dissipating. The problem here is conceptual. The data and the concern that gave rise to Table 1 comes from the modeling of a 35 metre by 35 metre gasoline groundwater plume (Abreu and Johnson, 2005) and from chlorinated solvents in a groundwater plume covering several city blocks. The distance of 35 metres refers to houses at the edges of these massive plumes of contamination. No one has modeled or even conceived of modeling vapours from 100 litres of fuel oil beneath a house, with migration in any direction but into the house. In fact the most recent PIRI RBCA Guidance (Atlantic PIRI, 2003) indicates that all the fuel oil within a metre outside of the basement foundation must be assumed to enter the house. We know this not possible as only approximately 69% is volatile, not to mention all the other attenuation processes that will also reduce the concentrations.

Another question revolves around the Johnson-Ettinger model. The only time this model appears to have been observed to underestimate indoor vapours is when it was used for chlorinated solvents (Hartman, 2007). According to Hartman (2007), for petroleum hydrocarbons, the Johnson-Ettinger model over predicts indoor air impacts in almost all cases. Why is this not the first issue to be addressed by PIRI?.

## **PROBLEMS WITH MEASUREMENTS**

The first problem with measurement is that the Atlantic PIRI committee requires that only contaminated soil or groundwater samples be used to describe the condition of the residual contamination following remediation. In general, the accepted practice is that the most contaminated sample be used as input to the Johnson-Ettinger model for indoor air quality found within the Atlantic PIRI RBCA model and as the one to be compared against the Pathway Operability table. There is no possibility provided to represent that formerly contaminated soil has been replaced with clean soil. No provision is made for presenting the actual quantity of residual petroleum remaining. Thus, trivial quantities of petroleum can and are often used to indicate the need for further investigation. According to Dr. Ettinger, for other than screening purposes, this practice is a misuse of the Johnson-Ettinger model (R. Ettinger, personal communication).

Once a concern is raised, either via output of the Atlantic PIRI model or by comparison with the Pathway Operability table, the PIRI vapour guidance (Atlantic PIRI, 2006) emphasizes the utility of making measurements of soil gases as opposed to indoor air quality measurements. There are a number of very good reasons for this. First, there is the issue of background vapour concentrations. For example, if a person has a fuel oil tank in their basement, this tank could be the source of vapours through the seals of the fill and vent pipes. Also, the furnace could give off fuel oil vapours through incomplete combustion, especially right at the time of initial ignition. In addition, the vent pipe of an outside fuel oil tank can be placed within 600 mm (2 feet) of an open window (CSA, 2004). Thus, there is a concern that indoor air quality measurements will appear to

identify problems arising from residual contamination from the spill that are actually unrelated to it.

This problem is compounded by the measurement methods required by Atlantic PIRI, which provide such a non-specific indicator for fuel oil that any elevated concentrations of hydrocarbon containing compounds (such as cleaning agents, glues, deodorizers, gasoline stored in the garage) are very difficult to separate from other sources. The driver for the need for soil gas studies is the reality that the interpretation of indoor measurements is easily confounded by background, pre-existing and/or totally unrelated factors.

Even with soil gases, there is still the issue of previous releases that may also be giving off soil gases. There is no method to distinguish one type of gas from another, with the exception of methane. Inside a house, the recommendation is that sampling ports be drilled through the concrete floor to sample the sub floor gases. Now one is faced with the prospect of pouring a brand new concrete floor post remediation and then drilling holes through it which may reduce its ability to prevent water or vapour intrusion over the lifetime of the house. In addition, it has been observed that the measurement of soil gas concentrations can be affected by weather and climatic conditions. It is necessary to demonstrate that time of year or change in weather conditions does not significantly change the measurements (Hartman, 2006). This may involve recording of barometric data and subsurface pressure data for a period of time before and after gas measurements.

With the application of the Separation Distances as described in Table 1 of Atlantic PIRI (2006) all these complications can be multiplied when properties are brought into play in a 35-metre radius in all directions. What if the house next door has previously had a spill? Finally there is a whole other topic of the technical issues surrounding the measurements of soil gases that are many and technically difficult to resolve (Hartman, 2006). Extensive manuals and guidance have been recently published (USEPA, 2002a; GeoSyntec and ASU, 2005; ITRC, 2007).

The fact that there are many technical difficulties is not what is at issue. What is at issue is that these difficulties are brought into play to eliminate concerns that are artificially created and without foundation in the scientific literature or in real world experience for domestic and small commercial fuel oil releases. Previous to the new vapour intrusion guidance, experts could provide advice to homeowners, that if there were no odours, there was no issue with indoor air quality. The State of Wisconsin (2003a) still provides this advice. With the new guidance, it will be necessary to keep files open for at least a year to demonstrate that time of year or change in weather conditions does not significantly change the measurements (Atlantic PIRI, 2006). The impression is created that there are invisible gases that are potentially affecting residents' health and one cannot be sure that this is not the case without extensive monitoring. Again, what is at issue is that this impression is created without foundation in the scientific literature or real world experience for fuel oil. On the other hand, for large gasoline releases, there appears to be justification for concern.

## IMPLICATIONS

The new vapour intrusion guidance from the Atlantic PIRI adds to the impression that there is a risk to human health from vapour intrusion from small amounts of residual fuel oil following a spill. This impression is not based on any observational data. This impression is contrary to the available data in the scientific literature. There are ethical considerations that must be considered when theoretical possibilities without empirical evidence (called “nomological possibilities”), which are really uncertainties, are presented as quantifiable risk (Guzelian et al. 2005).

If generally accepted, the vapour intrusion guidance from Atlantic PIRI will create the impression that proper due diligence for an environmental professional will require a recommendation for the investigation of soil vapours, no matter how trivial. In British Columbia, the Ministry of Environment now requires that all contaminated sites with any petroleum or other solvent contamination above background be investigated for soil vapour (British Columbia Ministry of Environment, 2007).

The application of vapour intrusion guidance will create a new basis for third party claims for trespass, nuisance and adverse impact to human health, which in many cases will not realistically exist. In Appendix D of the Guidance, the Atlantic PIRI Committee (2006) provides guidance on how to make estimates of vapour intrusion for historic sites; in other words, how to go back to closed files where vapour intrusion was never assessed and reanalyze these sites.

There are no other regulatory criteria for air quality in residential properties in Atlantic Canada. There is no database for expected and acceptable air quality in residential properties in Atlantic Canada. There are no regulatory criteria that address the impact of the use of fuel oil on residential indoor air quality other than that which might result from a spill. There has been no other initiative that has identified residential air quality as a potential public health issue in Atlantic Canada from any source and no analysis of whether current practices related to spills are a significant factor in this issue. This guidance brings the insurance industry into an area of public health and regulation, which has very little scientific foundation in this region of the country. In addition, there is very little legal foundation for the analysis of liability. The implications for the industry under the various approaches for apportioning liability are impossible to estimate at this time.

As previously stated, there are jurisdictions such as the State of Wisconsin (2003a) that have continued to follow the traditional approach of the use of odour as a guide to the assessment of risk. There is a toxicological basis for this approach. It also has the added advantage of allowing the homeowner some sense of control over their risk which is well known to be an important influence on the perception of risk (Sandman, 1993

## CONCLUSIONS

The adoption of vapour intrusion guidance by the Atlantic PIRI Committee has added a new level of complication and cost to the assessment and the successful remediation of fuel oil heating spills in the Atlantic Region. Of particular concern is that the implementation of this guidance will result in the escalation of third party claims for trespass, nuisance and the causation of chronic disease that has no valid basis in scientific theory or real world experience. Furthermore, there is also the suggestion that closed files could be reopened.

The Atlantic PIRI Committee has adopted this guidance in the absence of public health data that indicate that an issue exists in relation to home heating oil spills. In fact, available evidence indicates that there is no public health issue. The Atlantic PIRI committee has also changed its procedures for adopting regulation by applying rules for gasoline to both fuel oil and heavy oils.

The insurance industry has been brought into the regulatory sphere of residential indoor air quality that is poorly developed, from both a scientific and regulatory perspective. The implications for the industry are difficult, if not impossible, to predict; however, it will surely result in:

- An increase the costs of domestic fuel oil clean ups.
- An increase the length of time these files are open.
- Unnecessary litigation and costs.
- Health concerns where none exists.

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