
RESIDENTIAL ENVIRONMENTAL HAZARD POLICIES IN OTHER COUNTRIES

Final Report

**Prepared for:
Canada Mortgage & Housing Corporation**

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The ARA Consulting Group Inc.**

January, 1994

DISCLAIMER

This study was conducted for Canada Mortgage and Housing Corporation under Part IX of the National Housing Act. The analysis, interpretations and recommendations are those of the consultant and do not necessarily reflect the views of Canada Mortgage and Housing Corporation or those divisions of the Corporation that assisted in the study and its publication.

Abstract

In order to contribute to Canada Mortgage and Housing Corporation's (CMHC) policy development process, the ARA Consulting Group Inc. was contracted to conduct a review of the public and protective policy options developed in various jurisdictions external to Canada to address residential environmental hazards. The broad objective of this study was to determine whether a review and assessment of the policies developed and implemented to address environmental hazard issues in other jurisdictions would provide new and unique alternatives for CMHC to explore, or particular insights for CMHC to consider. The study indicated that, with the exception of the United States, policy activity with respect to residential environmental hazard issues is very much in its infancy. As a consequence, in terms of public policies, the study concluded that very little new information can be garnered from the international community with respect to emerging environmental hazard issues of concern, or the types of public policy measures available to address environmental hazards in the residential sector. Similarly, with respect to protective policies, again the analysis was not very revealing. A small number of protective measures were identified in the analysis. However, none of the tools provided a particularly novel approach to limiting and/or shifting liability. Rather, for the most part, the protective measures identified in the course of the study simply represent formal expressions of common sense solutions to limiting legal and financial risks.

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Executive Summary

Over the past two decades, considerable research and governmental regulatory effort has been devoted to the identification and measurement of pollutants suspected of posing risks to human health; to assessing the significance of these health risks; and to the implementation of measures directed at the abatement, control and avoidance of hazardous pollutants. Historically, much of this effort has been directed towards ameliorating the health risks posed by pollutant exposures in outdoor environments and industrial/occupational indoor environments. However, in recent years, these efforts have engendered an increasing awareness and concern for the potential health risks associated with exposure to environmental hazards in residential indoor environments.

Residential environmental hazards are taken to include any contaminant that is situated on, contained in, or is produced as a result of the residential housing structure, site, system or associated infrastructure.¹ Recent research has indicated that there is a wide range of environmental hazards which may reach concentration in residential environments which are sufficient to pose significant risks to human health. Given Canada Mortgage and Housing Corporation's (CMHC) role as administrator of the *National Housing Act*, the risks associated with residential environmental hazards could have an important impact on the Corporation and its ability to facilitate the attainment of the goals of the *National Housing Act*. Furthermore, the presence of environmental hazards on properties owned, administered or insured by CMHC could result in significant financial risks to the Corporation in terms of remediation expenses, property devaluation, legal costs, etc.

CMHC is in the process of developing policy options with respect to residential environmental hazards and, as part of this process, the ARA Consulting Group Inc. was contracted to evaluate the residential environmental hazard policy options developed in a variety of jurisdictions external to Canada, and to assess their applicability to CMHC. The execution of this study involved a two part analysis comprised of the following components:

- A review of the published literature pertaining to environmental hazard issues and policies.
- A case study analysis involving interviews with housing policy representatives in seven international jurisdictions, including: the United Kingdom, the United States, the State of California, the Federal Republic of Germany, the Netherlands, Sweden and Denmark.

¹ Residential environmental hazards do not include the consequences of an occupants' behaviour with regard to consumption patterns and normal waste disposal practices. In addition, the topic of residential environmental hazards does not include urban and site planning issues.

In conducting this study, the focus of the analysis was confined to policy options developed with respect to environmental hazards associated with the site of a residence or its physical structure.² The main findings from the two components of our analysis are summarized below.

I. Residential Environmental Hazard Issues

Within the published literature, descriptions of the present and emerging environmental hazards of concern in the residential sector are quite limited. However, on the basis of the information presented, the hazards which appear to be of primary concern to policy makers essentially represent a sub-set of the hazards under investigation in the commercial, industrial and occupational indoor environments, and include:

- Formaldehyde Concentrations
- Radon Infiltration
- Volatile Organic Compound Concentrations
- Asbestos Concentrations
- Lead Based Paints
- Respirable Particles
- Soil Contaminants and Soil-Gas Infiltration
- Mould Spores

The results of the interview component of the analysis confirmed that these hazards represent the principal issues of current or emerging concern in the residential sector. The interview results further indicated that, while each of the environmental hazards presented are legitimate issues of concern to policy makers, differences exist in terms of the priorities assigned to these hazards in the various jurisdictions. However, the consensus opinion appears to be that the hazards assigned the highest priorities for assessment and management include radon, formaldehyde, asbestos and lead.

II. Public Policies to Manage Environmental Hazards

Public Policy Options

While certain countries have maintained residential environmental hazard issues as an active research topic for a number of years, for the majority of the jurisdictions reviewed as part of our analysis, the emergence of residential environmental hazards as a subject of active policy development and implementation is a very recent event (this is especially true for most of the European countries). As a consequence, it was not surprising to find that the results of the literature review and the interview analysis were not particularly enlightening in terms of defining the range of policy approaches available to address residential environmental hazard issues. In fact, the suite of policy options, identified in our analysis as being applicable to the

² Policy options designed to address the hazards associated with appliances and household products, which are not part of the physical structure of the residence and can be removed, were not addressed. Similarly, hazards that arise directly as a result of the personal habits of homeowners and residential occupants (such as smoking, etc.), and the applicable policy options, were not addressed.

residential sector, are not materially different from the measures that governments have traditionally relied upon to address environmental hazard issues in the non-residential sector. The particular regulatory and non-regulatory policy options suggested include:

Regulatory Public Policy Tools

Air Quality Standards
Emission/Product Standards
Application Standards
Prohibitive Bans
Building Code Restrictions
Warnings

Non-Regulatory Public Policy Tools

Health Guidelines
Information/Education Programs

The apparent lack of innovation in either regulatory or non-regulatory management measures, indicated by our analysis, may simply reflect the recent emergence of residential environmental hazard issues as an active policy area in most countries. However, the lack of innovation in policy measures has implications in terms of the likelihood that governments can effectively address the hazard issues of concern in the residential sector. Specifically, while each of the aforementioned policy tools exhibit strengths and weaknesses, our analysis suggests that these tools, taken individually or collectively, are unlikely to offer a unique or comprehensive solution to the problems that residential environmental hazards present (this is especially true of the regulatory measures) for the following reasons:

- The majority of the identified policy measures can only effectively address residential environmental hazard issues arising in the future.
- In non-residential environments, public exposures to environmental hazards are not seen as voluntary acts. Thus, given its responsibility to protect public health, governments can (and do) impose regulations and enforce restrictions in the non-residential sectors to address environmental hazards. With respect to the residential sector, however, exposures are not seen as an involuntary act. Furthermore, many of the environmental hazards present in existing residential structures stem from, or are exacerbated by, the behaviour of residential occupants. Due to the nature of the exposure relationship in the private, residential sector, many governments are questioning whether they have a legitimate right to directly regulate the behaviour of homeowners within the confines of their residences. The resolution of this issue may indicate that policy tools which can adequately address environmental hazards in the non-residential sector may not be permissible in the residential environment (e.g., due to possible infringements of rights, resistance by homeowners to any action taken, inability to prescribe behaviour, etc).
- The effectiveness of many of the available tools is dependent, to a certain degree, on the recognition by residential occupants of the nature and severity of the risks associated with the hazards to which the various measures apply.

- Irrespective of whether policy makers would be willing to actively, and overtly, intervene in the residential sector, given the nature of the sector, effective compliance monitoring and enforcement of many of the traditional regulatory measures (such as air quality standards) is a practical impossibility.

Public Policy Responses in Other Jurisdictions

The results of our analysis demonstrated that the level of activity exhibited by each of the jurisdictions reviewed with respect to the development and implementation of public policies pertaining specifically to residential environmental hazards is quite limited. In the majority of the countries reviewed, policy activity with respect to residential environmental hazards has largely been limited to: research with respect to the measurement of the risks posed by environmental hazards; research with respect to the development of protocols for measuring pollutant concentrations in the residential environment; and the production and dissemination of information with respect to the nature of particular hazards and the methods available to reduce pollutant concentrations and minimize exposure risks.

For certain hazards which have represented long-standing concerns to policy makers (e.g., formaldehyde, asbestos, VOCs, radon, lead), broadly similar policy measures have been implemented in each of the jurisdiction to address the associated risks. In the main, these responses have involved:

- the development of exposure guidelines (generally developed on the basis of information garnered in the non-residential sector);
- the implementation of prohibitive bans and product standards (e.g., formaldehyde emission standards for plywood and particle board, bans or restrictions on the use of asbestos in construction and building materials, bans or restrictions on the use of urea-formaldehyde foam insulation, etc.);
- the implementation of building code restrictions (e.g., minimum ventilation requirements, the installation of soil-gas retarder membranes to limit the infiltration of radon and other soil gases, etc.); and
- the distribution of information pamphlets.

The reasons for the apparent immaturity of policy development and implementation activities targeted specifically on hazard issues as they present themselves in the residential sector vary by country. However, the results of the case study interview analysis suggest that the following factors appear to represent the primary impediments to the development and implementation of residential environmental hazard policy, and apply, to greater or lesser degrees, to each of the jurisdictions reviewed:

- A general lack of awareness, on the part of both policy makers and the public, as to the nature of residential environmental hazards and the risks they pose. This factor is especially important in Europe where, until quite recently, there was very little public pressure or impetus to investigate residential environmental hazard issues, or to develop policies to mitigate the associated health risks.
- The absence of accurate and defensible guidelines for pollutant exposures in the residential sector has impeded policy development. In each of the European countries, and to a lesser extent in the United States, these guidelines are seen as a basic requirement for the development of defensible and publicly acceptable policy measures for addressing environmental hazard issues in the residential sector. The development of these guidelines is being delayed, however, due to the fact that many of the existing measurement protocols are unable to provide accurate, robust and defensible exposure measures.
- Active policy development and implementation in the various jurisdictions is hindered by a lack of resolution of the issue as to whether governments have the legal right to intervene in the residential sector, and/or whether they ought to intervene.
- The final impediment relates to issues of enforceability and cost-effectiveness. While it is possible to conceive of a variety of policy measures to address environmental hazards, given the nature of the residential sector, many of these measures may have to be ruled out simply because they cannot be enforced in a practical and cost-effective manner -- this is especially true of the more traditional management options.

The interview component of this study demonstrated that the resolution of the majority of these issues is a necessary precursor to the development of effective public policy responses to residential environmental hazard issues. Furthermore, the inability to resolve many of these issues (and particularly the development of measurement protocols and exposure guidelines) has curtailed policy development and implementation activities in a number of countries. Until these issues are resolved, and governments (predominantly in Europe) become confident that they have established the bases for the development and implementation of policy measures which would be acceptable and defensible in the eyes of politicians, the courts and the public, policy activity with respect to residential environmental hazards will continue to be characterized by research and the dissemination of information.

III. Protective Policies

Protective policies are designed to limit an organization's liability for environmental damages and its exposure to litigation. Protective policies are of particular interest to lending institutions and mortgage guarantors, such as CMHC, due to the legal and financial risks associated with exposure to environmental liability.

The results of the literature review indicated that a small number of policies/practices have been developed to minimize the legal and financial risks associated with exposure to environmental liability. The specific protective policy tools identified in the literature include:

- Borrower Warranties
- Borrower Credit Assessments
- Site Assessment
- Red-lining Industries and Locations
- Disclosure Policies

In terms of the application of these policies, the results of the interview analysis indicated that the United States and the European countries differed dramatically in terms of both the importance attached to the issue of environmental liability, and the priority assigned to the development of protective policies. In the United States, specific assignments of liability for environmental hazards have been enshrined in a variety of statutes, such as the *Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)* of 1980. As a consequence, a variety of lending institutions and government agencies have adopted policies to shield themselves against liability. The most common forms of protective policy encountered in the United States, and the one adopted by the Department of Housing and Urban Development, the Federal National Mortgage Association (Fannie Mae) and the Federal Home Loan Mortgage Corporation (Freddie Mac), include the red-lining of particular building sites and the requirement for environmental site assessments as a condition of mortgage approval and/or guarantee.

In contrast to the situation in the United States, the European countries view protective policies as either unnecessary, or a very remote priority for development. In addition, while liability for residential environmental hazards is a realistic concern in the United States, most European countries do not anticipate that it will emerge as a policy issue.

IV. Implications for CMHC

The broad objective of this study was to determine whether a review of the public and protective policies developed and implemented to address environmental hazard issues, in a variety of jurisdictions external to Canada, would provide new and unique alternative for CMHC to explore, or particular insights for CMHC to consider. In terms of public policies, the literature review and the interview analysis demonstrated that very little new information can be garnered from the international community with respect to existing/emerging environmental hazard issues of concern, or the types of public policy measures available to address environmental hazards in the residential sector. What the analysis did uncover is that there are a number of issues which will have a bearing on the development and implementation of an effective strategy for addressing residential environmental hazards (e.g., the development of effective exposure

guidelines, issues surrounding compliance monitoring and enforceability, the inadequacy of traditional measures in addressing environmental hazard issues, etc.).

With respect to protective policies, again the analysis was not very revealing. A small number of protective measures were identified in the analysis. However, none of the tools provided a particularly novel approach to limiting and/or shifting liability. Rather, for the most part, the protective measures identified in the analysis simply represented formal expressions of common sense solutions to limiting legal risks. Nevertheless, CMHC could usefully adopt the requirement for site assessments. However, the question then becomes one of who would finance the assessment, especially given CMHC's mandate to provide affordable accommodations to Canadians. Finally, none of the measures presented in the analysis are capable of adequately addressing the liability issues associated with properties already acquired by CMHC. Thus, even if site assessment requirements are adopted, environmental liability will continue to represent a risk to the Corporation given its existing property holdings and the claims it maintains on other properties as a result of its role as a mortgage guarantor.

RÉSUMÉ

INTRODUCTION

Jusqu'à récemment, les préoccupations relatives à la contamination des sols étaient réservées à certains «points chauds» et les efforts d'assainissement, aux sites où des déversements de produits chimiques ou radioactifs avaient eu lieu. Par suite des possibilités accrues de mesure et d'analyse, par contre, tous les terrains pouvant être contaminés sont maintenant source de préoccupation. Cela a eu pour conséquence de faire de la contamination des terrains en milieu urbain une question d'ordre public.

Au même moment, la restructuration économique a entraîné la fermeture de nombreuses industries et l'abandon de milliers d'hectares de terrains ayant eu une vocation industrielle. Alors que ces terrains représentent un avoir économique considérable et pourraient jouer un rôle important dans la revitalisation des villes canadiennes, leur réutilisation est menacée par la contamination. En vertu des normes et des procédés actuels, le réaménagement est interdit tant qu'aucune preuve n'indique que le sol n'est pas contaminé. Le coût de la décontamination annule souvent la valeur commerciale d'un terrain contaminé.

ASPECTS DIVERS

La contamination touche directement le secteur de l'habitation étant donné ses effets économiques, sociaux et environnementaux. Parce que le logement représente une utilisation viable des sites d'anciens établissements industriels, le secteur de l'habitation pourrait tenir un rôle clé dans la réutilisation de régions potentiellement contaminées. Les normes relatives à la décontamination entravent cependant la nature, la quantité et l'abordabilité des logements pouvant être construits dans les grandes villes.

. Aspects économiques

Les coûts liés à la décontamination influent sur l'abordabilité et l'accessibilité des logements. Les sites d'anciens établissements industriels des centres-villes, ressource économique considérable et facteur important dans la réorientation de la croissance des terres agricoles situées en bordure vers des centres urbains revitalisés, risquent d'être marginalisés par les façons de procéder actuelles en matière de détermination et d'assainissement des terrains contaminés.

En tant que grand propriétaire de sites contaminés, le gouvernement a des droits acquis dans la décontamination et le réaménagement des sites d'anciens établissements industriels. Les terrains des centres-villes présentent des avantages économiques par rapport aux terrains des régions rurales et leur réaménagement permettrait aux organismes de service publics et privés de construire des logements plus abordables. Ces terrains sont déjà viabilisés et il est souvent politiquement acceptable de les aménager selon des densités d'occupation plus élevées et de façon plus durables que les régions périphériques.

. Aspects sociaux

Nous vivons une période de longues restrictions financières où de moins en moins de subventions seront offertes à un nombre croissant de logements sociaux. La société comptera de plus en plus sur le secteur privé pour fournir du logement aux ménages à revenu faible ou moyen. La solution repose en partie sur la maximisation des occasions de réaliser des logements abordables.

Bien que les sites d'anciens établissements industriels favorisent le réaménagement urbain, les coûts de la décontamination et l'attitude qu'elle suscite ont des effets directs sur les objectifs de logement des centres-villes. Le système actuel, qui, en réalité, gèle de vastes étendues de terrains inutilisés, souvent indéfiniment, contribue à l'érosion de collectivités par la perte d'occasions économiques, l'intrusion physique, la peur, l'inquiétude et la frustration, et freine la densification des centres-villes en limitant les possibilités d'offrir des logements abordables et de créer des emplois.

De plus, la question de la contamination des terrains est mal comprise par le grand public et la terminologie utilisée dans le débat peut causer une peur injustifiée. Le fait de fournir aux occupants et aux propriétaires de logements existants l'information nécessaire à la détermination de la présence de produits contaminants sur leurs propres terrains et à la prise des mesures requises améliorera la santé et la sécurité du public.

. Aspects environnementaux

La croissance des banlieues à faible densité et à vocation unique a eu un effet dévastateur sur l'environnement. Les terres arables consommées par ce genre d'aménagement et les effets secondaires de l'étalement urbain, comme la pollution extrême causée par l'utilisation fréquente de l'automobile, sont des préoccupations sérieuses. Dans la recherche d'un nouveau modèle urbain, les sites d'anciens établissements industriels pourraient jouer un rôle important. En éliminant des terrains potentiellement contaminés du marché, par contre, les lignes de conduite actuelles en matière d'environnement contribuent à l'étalement urbain plutôt que d'y remédier.

. Manquement aux responsabilités ou gestion des risques

La plupart des mesures adoptées par les organismes gouvernementaux à l'égard des terrains contaminés visent à éviter toute responsabilité. Les organismes de réglementation sont protégés par des normes très traditionnelles et rigoureuses. Les établissements financiers sont protégés par des exigences prévoyant des évaluations de la qualité du sol et la décontamination. Les intérêts des futurs propriétaires-occupants et des locataires ne sont pas représentés et les mesures actuelles ne tiennent pas compte de l'intérêt du public en général.

La responsabilité s'applique aux intérêts privés; le risque, aux intérêts publics. L'exigence très rigoureuse visant le nettoyage avant tout réaménagement a pour effet d'empêcher ce réaménagement. Les risques demeurent et les intérêts du public ne sont pas servis. Si les normes en matière de décontamination étaient liées aux risques réels, on se préoccuperait moins d'éviter les responsabilités et davantage de gérer le

risque. Des mesures tenant compte de tous les risques doivent remplacer les mesures actuellement en vigueur et celles en cours d'élaboration.

. Le rôle des organismes publics

Un certain nombre d'organismes publics aux niveaux national, provincial et local ont déjà pris des mesures dans le dossier des terrains contaminés et leurs activités ont un effet sur l'habitation. Jusqu'à maintenant, malheureusement, leurs efforts ont été morcelés, non coordonnés et non structurés. Il y a eu peu de collaboration ou d'échange entre les différents groupes. Bien qu'ils se concentrent généralement sur les mêmes points, soit la détermination de la responsabilité à l'égard des sites contaminés et l'établissement de normes de décontamination, ces deux aspects sont traités par toutes les parties comme des éléments sans lien entre eux. De plus, la préoccupation quant aux responsabilités et à l'établissement de normes a mené à la négligence d'une autre question importante et connexe : l'évaluation du risque. Là où l'on a reconnu la nécessité d'évaluer les risques, peu d'efforts ont été consacrés à l'équilibre entre les intérêts économiques, sociaux et environnementaux.

CONCLUSION

Des logements seront requis dans les centres-villes du Canada. Ce besoin pourrait être comblé facilement et de manière abordable si ce n'étaient des normes qui rendent le réaménagement peu attrayant et même non abordable. Aussi longtemps que la simple présence de contaminants sera considérée comme un risque inacceptable et que l'on ne tentera pas d'équilibrer les coûts et les avantages de la décontamination et du réaménagement par l'entremise d'une évaluation pratique du risque, les dommages environnementaux, économiques et sociaux qu'entraînent les méthodes actuelles se poursuivront.

Le maintien de cette approche morcelée et axée sur un seul intérêt compromettra tous buts établis en faveur de l'environnement, de l'économie et de la société.

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1.0 Introduction

Since the mid to late 1960s, considerable research and governmental regulatory effort has been devoted to: (i) the identification and measurement of pollutants suspected of posing risks to human health; (ii) assessing the significance of the health risks consequent on exposure to the identified pollutants; and (iii) where the risks to human health are deemed significant, the promulgation of laws directed at the abatement, control and avoidance of these pollutants. The majority of the research and regulatory emphasis has historically been directed toward ameliorating the health risks posed by exposure to pollutants in outdoor environments. However, over the past ten years, the effort devoted to obtaining a cleaner outdoor environment has led to an increasing awareness and concern for the potential health risks associated with the presence of environmental hazards in confined areas, such as in industrial and occupational environs and, of particular interest in this study, with environmental hazards in residential indoor environments.

Residential environmental hazards are taken to include any contaminant¹ that is situated on, contained in, or is produced as a result of the residential housing structure, site, system or associated infrastructure.² The human health risks posed by exposure to certain residential environmental hazards (e.g., radon, asbestos, formaldehyde, etc.) are fairly well known. However, while still in its infancy, recent research has indicated that there remains a wide range of additional residential environmental hazards (e.g., volatile organic compounds, lead-based paints, carbon monoxide, etc.) which may reach concentration in residential environments which are sufficient to pose a risk to human health. Given Canada Mortgage and Housing Corporation's (CMHC) role as administrator of the *National Housing Act*, the risks associated with residential environmental hazards, as identified through recent research, could have an important impact on the Corporation and its ability to facilitate the attainment of the goals of the *National Housing Act*. Furthermore, the presence of environmental hazards on properties owned, administered or insured by CMHC could result in significant financial risks to the Corporation in terms of remediation expenses, property devaluation, legal costs, etc. In recognition of these facts, CMHC is in the process of developing policy measures to address residential environmental hazard issues.

¹ Contaminants can be broadly defined as any solid, liquid, gas, odour, heat, sound, vibration, radiation or combination thereof which may cause an adverse effect to human health (or the environment).

² Residential environmental hazards do not include the consequences of an occupants' behaviour with regard to consumption patterns (e.g., the use of chemically hazardous household cleaners, energy use, etc.) and normal waste disposal practices (e.g., recycling, water use, etc.). In addition, the topic of residential environmental hazards does not include urban and site planning issues.

1.1 Purpose of this Report

As part of CMHC's policy development process, the ARA Consulting Group Inc. has been asked to review the policy options developed in other countries to address residential environmental hazards, to assess their applicability to CMHC, and to determine whether the "lessons learned" by other jurisdictions in the development of policy could provide guidance to CMHC. This report provides the results of our review. The information presented was collected through both a review of the published literature on residential environmental hazards, and through interviews with housing policy representatives in a variety of international jurisdictions. In conducting this review, our focus was on the residential hazards associated with the site of a residence or its physical structure. Policy options designed to address the hazards associated with appliances and household products, which are not part of the physical structure of the residence and can be easily removed, are not addressed in this study. Similarly, environmental hazards associated with personal habits and behaviours (such as smoking, etc.), and the policy options developed in response to these hazards are not addressed.

1.2 Structure of the Report

The results of the literature review and interview process are presented in the following manner. We begin, in Section 2.0, with a discussion of the events which have led to the development of residential environmental hazards as a health and policy issue, and review the manner in which residential environmental hazards may impact on CMHC's ability to discharge its mandated responsibilities. This section is meant to provide both an understanding of the potential significance of residential environmental hazards, as well as a context for the discussion of the policies, identified in the literature and through the interview process, which have been implemented (or are being considered) to address residential environmental hazard issues. Section 3.0 address the methodology adopted in this study to assess the policies developed in other jurisdictions. The methodology originally presented in the proposal for this study differs somewhat from that actually applied in the conduct of this review, and the reasons for this are presented in this section. Section 4.0 provides the results of the literature review and address the policy tools that are available to governments and that have been applied in various jurisdictions. In this section, both public policy issues (i.e., those directly concerned with mitigating human health risks) and legal/protective policies (i.e., those concerned with minimizing the potential for assuming liability for remediating environmental damage) are discussed. Section 5.0 reviews the public and protective policies adopted in seven international jurisdictions to address residential environmental hazard issues. The jurisdictions include: the United States (federal), the United Kingdom; Germany; Sweden; Denmark; the Netherlands; and the State of California. This section begins with an overall review of the nature and extent of policies adopted in these jurisdictions, and is followed by a discussion of the nature and extent of policy activity in each of the individual jurisdictions. Section 6.0 provides a summary of our findings and an assessment of the extent to which the policy tools developed in other jurisdictions are applicable to the concerns faced by CMHC.

2.0 Background

Residential Environmental Hazards as a Public Health and a Policy Issue

In this section we discuss the events which have led to the development and recognition of residential environmental hazards as a health and policy issue. Following this, the manner in which residential environmental hazards may impact on CMHC's ability to discharge its mandated responsibilities is discussed.

2.1 Residential Environmental Hazards as a Health and Policy Issue

The links between potential health risks, indoor environmental hazards generally, and residential hazards specifically, have developed over a considerable period of time. While it would be possible to trace the epidemiological nature of these linkages back over a similar period, a convenient starting point for an analysis of the problem posed by indoor environmental hazards can be set in the mid to late 1940s. Since the Second World War, a number of discrete events can be identified which have exacerbated the risks posed by environmental hazards, and have culminated in the policy issue that many governments presently face.

2.1.1 Development of Residential Environmental Hazards as a Public Health Issue

The seed for many of the problems associated with residential environmental hazards was first sown during the Second World War. Through the war years, and continuing on thereafter, our understanding of the nature and possible applications of synthetic chemistry had taken tremendous leaps forward. Through much of the postwar era, synthetic materials developed as part of the war effort were commercialized, and the use of synthetic building materials, furnishings and decorating materials became quite commonplace. In applying these products, little attention was paid to the nature of, and potential health effects associated with, the emission of fugitive chemicals and respirable particles from these materials. However, recent research on indoor environments indicates that many of the construction materials, household appliances, household cleaning products and decorating supplies, derived from synthetic materials, have proven among the most significant sources of indoor pollutants. Some of the more common household pollutants released from these sources include formaldehyde (used in insulation, as adhesives for plywood and particle board, carpet and carpet glue, etc.); volatile organic compounds (from carpets, paints, wood preservatives, etc.); combustion by-products from the operation of cooking and heating appliances (such as CO, CO₂, NO₂, SO₂, etc.); and a variety of particulates and organic compounds released from household cleaning products, synthetic materials, etc. While the adverse health impacts associated with short and/or long-term exposure to these pollutants, especially within a confined area, can be severe, in the two decades following the Second World War the risks were ameliorated to a degree due to the existence of sufficient ventilation (buildings and homes had operable windows, many were drafty, etc.).

However, the beneficial impact of direct ventilation to outdoor environments was extensively reduced due to events in the 1970s.

The next major event contributing to the current concern over indoor environmental hazards is associated with the energy crisis of the early 1970s. Increases in energy costs during the 1970s (and the early 1980s) prompted significant building modifications in an effort to conserve energy. Many of the modifications involved increased insulation, with both traditional and synthetic materials (such as urea-formaldehyde foam insulation), and the installation of air conditioning/heating systems with significantly reduced air-exchange rates. In addition, new buildings were designed as air-tight "envelopes" with few operable windows, and with heating/cooling systems based on recycled air. For example, in an effort to conserve energy during this period, the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) slashed ventilation rates by a factor of three.³

While many of these developments originated in the commercial, industrial and institutional sectors, a number of the tactics employed to increase the energy-efficiency of the building envelope were incorporated within building codes. Consequently, many of the energy efficiency measures initially developed for, and adopted in, other sectors filtered down to the residential sector and led to an increased effort to seal and insulate residential housing. While many of these ideas and modification did indeed improve energy efficiency, they also served to increase both the number of pollutant sources (through the application of synthetic technology), and their concentrations (by reducing the rate at which they are expelled from indoor environments). The latter consequence is of particular importance in that recent research has suggested that the significantly reduced air exchange rates present in many homes and buildings has meant that many pollutants, which hitherto were not identified as a health risk (given the higher historical air exchange rates), now can attain toxic concentrations.

The potential risks from indoor environmental hazards were further elevated by a third event: increased urbanization and the expansion of suburbs into areas which were once landfill sites and/or the industrial belts of cities. The lands on which many homes are sited have been found to have been contaminated by previous industrial occupants and many of the associated pollutants have found their way into the indoor environment (such as landfill gases). In addition, the presence of soil contamination (such as radon and radon daughters) has broadened the range of pollutants that can represent an indoor hazard.

The fourth event to augment the health risks associated with indoor environmental hazards is associated with the boom in information and computer technology and the development of the "home office". Many of the products traditionally associated with occupational indoor environments, and many of the activities which have traditionally been conducted on commercial locations, have been brought into the home and have been installed and operated, in many cases,

³ The buildings constructed to these standards have caused many indoor air pollution problems and ASHRAE has twice since then revised its ventilation standards, which are now similar to the pre-1973 levels (Environment Committee (1991) pg. xxiv.)

without benefit of adequate ventilation. The addition of the pollutants associated with these products/activities, in combination with reduced air exchange rate, has served to exacerbate the residential environmental hazard problem.⁴

2.1.2 Development of Residential Environmental Hazards as a Policy Issue

Development of policy with respect to environmental hazards in the residential sector was essentially led by recognition of the risks posed by environmental hazards in the commercial and industrial sectors. The risks posed by certain environmental hazards in the industrial sector (such as exposure to asbestos, formaldehyde, etc.) have been recognized for quite some time, and many countries have developed occupational health and safety regulations to protect workers in high risk occupations. It would seem that, in developing these regulations, it may have been implicitly assumed that the risks posed by indoor air quality was not necessarily pervasive; rather, the risks were a function of the nature of the industrial activity undertaken in the indoor environ. However, a number of events over the last two decades have brought to light the fact that environmental hazards may poses health risks in any enclosed environment.

Over the past fifteen to twenty years, policy measures have been implemented to mitigate the risks associated with particular pollutants for which the health effects are widely known (such as asbestos, formaldehyde and radon). However, the development of policies directed at addressing indoor pollution generally, as opposed to specific pollutants, began to receive increasing emphasis with the identification of what has come to be known as "sick-building syndrome" in the occupational/commercial sectors. The development of this "syndrome" led to the recognition that the safety of indoor environments is a function of not only the presence of certain defined pollutants (such as those identified above), but are also a function of the interrelationship between reduced ventilation rates, variable thermal conditions, and the combination of various fugitive chemicals and respirable particles from the materials used in the building structure.

The next major impetus to the development of indoor environmental hazard policy came about as the result of a variety of studies which have indicated that urban residents spend more than 90% of their time indoors, with that time divided between the workplace, their principal residence, commercial and public buildings and various modes of transportation. In addition, time-budget surveys have indicated that the majority of urban residents spend more than 16 hours per day at home.⁵ As a consequence of the amount of time individuals spend indoors, it was recognized that even low concentrations of indoor pollutants can make substantial contributions to time weighted exposures.

⁴ The development of the "home office", and its implications in terms of elevating exposures to residential pollutants, is an issue that may be of increasing importance as many jurisdictions look at the feasibility of "telecommuting" and other work at home policies as possible management measures for outdoor air pollutants (e.g., the Greater Vancouver Regional District's Air Quality Management Plan).

⁵ John D. Spengler and Ken Sexton (1983), pg. 9.

Technical advances in our ability to detect ever lower levels of pollutants has also influenced the development of indoor environmental hazard policy. Previously developed threshold levels for a variety of pollutants have been found to be no longer adequate: in essence, every technological advance serves to redefine "safe". Furthermore, advances in medical research over the past two decades have led to the demonstration of significant correlations between health problems and long-term exposure to low levels of indoor pollutants, which had hitherto been deemed as "safe".

In summary, the combination of a large number of pollution emitting materials (many of which are part of an industrial, commercial or residential structure); the increased propensity to seal the indoor environment for the purpose of energy conservation; the fact that society is spending more time within occupational and residential indoor environments; and the increasing technological capability to identify pollutants, their concentrations and their impacts on human health has led to an increase, in a number of countries, in an awareness of the health risks associated with pollutant exposures in enclosed environments. As the level of awareness of these risks increased, and the extent of the indoor environs to which these risks apply were broadened, numerous government agencies began to focus their research and policy attention towards the issue of indoor pollution, the identification of pollutant sources (e.g., the site of the structure, ground-soil characteristics, structural components, etc.), and the identification of management measures. While the resolution of these issues would seem to fall within the purview of the variety of government departments that are more commonly associated with public health issues (the Department of Health and Welfare, etc.), the risks posed by indoor environmental hazards have implications for a much broader array of public and private concerns, such as CMHC. The nature of the environmental hazard issues that CMHC potentially faces are discussed below.

2.2 Canada Mortgage and Housing Perspectives

Residential environmental hazard issues are a direct concern of CMHC for a number of reasons. First, as the federal government's housing agency and administrator of the *National Housing Act*, CMHC has the authority to undertake investigations "... into housing conditions and the adequacy of existing housing accommodations in Canada". In addition, the Corporation has the authority to "... cause steps to be taken for the distribution of information leading to the construction and provision of more adequate and improved housing accommodation".⁶ Hence, given its authority in these areas, CMHC has the mandate to assess, monitor and develop measures to address the health risks posed by residential environmental hazards.

As part of its efforts to fulfill its mandate, CMHC has undertaken numerous research activities to address residential environmental hazard problems. A partial list of these activities include:

- determining ways of reducing pollutant sources in homes;
- finding ways of minimizing the spillage of combustion gases into the indoor environment;

⁶ National Housing Act, Section 9.

- developing techniques to minimize the risk of pollutant infiltration from toxic lands;
- determining methods of protecting homes from radon gas;
- identifying cost-effective solutions for environmentally sensitive occupants;
- developing construction and retrofit techniques for the control of moulds; and
- developing more effective ventilation systems.

These activities, among others, have contributed to the fulfilment of CMHC's responsibility to generate and distribute information pertinent to the construction and provision of more adequate and improved housing accommodation. However, the issue of environmental hazards is also relevant to other aspects of the Corporation's activities.

Specifically, residential environmental hazards are a concern of CMHC's as a consequence of its roles as a landlord, administrator of social housing and federally assisted housing programs, developer, and an insurer of mortgages. As a landlord, administrator or developer, CMHC could be held liable for the environmental hazards present on the lands it owns, administers and/or controls and, therefore, it can be held financially responsible for removing the hazards and remediating the site.

Residential environmental hazards are also a concern of CMHC's as a consequence of its role as an insurer of mortgages. If a homeowner defaults on an insured loan, ownership of the dwelling reverts to the financial institution which issued the mortgage and, in many instances, to CMHC itself. In these instances, if they are deemed to be contaminated then CMHC could incur financial losses associated with the remediation of the site, the devaluation of the property, legal expenses, etc. Given the number of loans underwritten by CMHC (the total value of *National Housing Act* mortgage loans outstanding is in the order of \$64 billion)⁷ the problems posed by residential environmental hazards could impose a significant financial burden on the Corporation.

⁷ CMHC (1993), *Canadian Housing Statistics*.

3.0 Study Methodology

As indicated in Section 2.0, the issues relating to environmental hazards generally, and residential hazards specifically, are broadly based and may affect the activities of an organization such as CMHC in a variety of ways. Therefore, part of the challenge of this study was to define a methodological approach which would allow the study team to quickly and efficiently: (i) define the scope of the study; (ii) focus on the major issues and policy concerns for CMHC; (iii) ensure that the "right" information is collected from the published literature and from housing representatives in other countries; and (iv) assess the extent to which the policies developed, and lessons learned, in other jurisdictions can be applied within the Canadian context.

The approach adopted in this study involved a two-stage literature review and a set of detailed interviews with housing policy representatives in a variety of international jurisdictions (the specifics of each of these two aspects of our approach are discussed in detail below). While this approach is rather straightforward, its utilization in the achievement of the objectives enumerated above was complicated by a variety of factors. Specifically, in developing the study methodology, our initial indications from other jurisdictions was that residential environmental hazard policies are relatively fragmented and have been applied in a piece-meal fashion. This appeared to be partly the result of the preliminary nature of society's understanding of the issues involved, and partly the result of the traditional focus of environmental policy on large, single-source (industrial) polluters rather than residential and indoor issues. Thus, in order to produce a synthesis of experience of various countries that highlights the issues and possibilities for CMHC, the research undertaken in this study had to be guided by a common framework. This common framework was created through the development of two paradigms, which are discussed below.

3.1 The Literature Review Process

Phase 1 Literature Review

The literature review which formed the basis of our research for this study was divided into two phases. During the first phase of the literature review process, published documentation addressing the nature of the environmental hazard issues involved, and the types of policies which have been adopted, or could be applied, to these issues was collected. This phase of the literature review was highly directed. Specifically, instead of a general key-word search, documentation was identified and collected on the basis of:

- references in specific relevant articles identified by the study team; and/or
- references from CMHC staff and environmental non-governmental groups; and/or
- documentation from contacts in other countries.

The literature review covered as many countries as possible as well as general literature on residential environmental hazard policy.

The information gathered during the first phase review was utilized to fulfil two objectives. First, on the basis of the literature collected, candidate jurisdictions for the case study interview analysis were selected (the specific jurisdictions are discussed in Section 3.2 below). The case study countries were selected on the basis of the number of references made in the literature with respect to a particular jurisdiction, as well as specific criteria noted in the Terms of Reference; namely:

- a capitalist economy;
- a democratic political system;
- considerable governmental intervention in housing; and
- significant activity with regard to residential environmental hazards.

The second objective of the first phase review was to utilize the information gathered during the literature review, in conjunction with the study team's expertise in environmental policy, housing, construction and public health, to frame two study paradigms deemed beneficial as a guide to the research/interview process. The paradigms included a residential environmental hazard paradigm, and a policy paradigm (both of which are discussed below).

The Residential Environmental Hazard Paradigm

The Terms of Reference for this study characterized residential environmental hazards as consisting of:

Any solid, liquid, gas, odour, heat, sound, vibration, radiation, or combination of any of these that is situated on, contained in, or is produced as a result of the residential housing structure, system, or associated infrastructures.

This definition is very broad and it did not provide sufficient guidance in terms of defining the types of policies of relevance to CMHC. Utilizing this definition of residential environmental hazards could result in the collection of information on policies with little relevance to CMHC while holding out the possibility that pertinent policy information would receive only a cursory treatment. The first phase literature review indicated that there are at least six pathways by which residential environmental hazards may be characterized. These pathways include:

- 1) *Land Contamination*: including indoor air pollution from soil gases, radon, etc..
- 2) *Design Features*: including concerns related to residential insulation, ventilation, etc.
- 3) *Building and Housing Materials*: both construction and "soft" materials are included in this category and include gases and odours from carpets, lead from lead-based paints, formaldehyde from wood products, etc.

- 4) *In-House Activities*: relate to the operation of household appliances (e.g., emissions from energy combustion activities) and to emissions relating to personal behaviour (e.g., particulates from tobacco smoke, etc.).
- 5) *Off-Site Hazards*: involve hazards that are generated by residential structures/activities but have environmental impacts off-site (away from the housing structure), such as water run-off during construction, contamination of water supply through pipe deterioration or disposition of construction and other household wastes.
- 6) *External Environmental Hazards*: relate to hazards that are generated outside of the housing structure (e.g., proximity of building next to sources of pollutants) but affect the health of housing occupants, such as lead, NO_x, VOC and CO air pollutants, etc.

Based on this paradigm, the study more narrowly defined the term residential environmental hazards *in the context of CMHC's interests*. Specifically, the hazards of concern were reduced to those stemming from: (i) structural design features; (ii) building and housing materials; and (iii) soil contamination.

The Residential Environmental Hazard Policy Paradigm

Having more concisely defined the environmental hazard issues of concerns, a second paradigm was developed to help focus the second-stage, or more detailed, literature review and the country specific interview activities. The intent of the policy paradigm was to focus on the points and mechanisms by which policy can affect the environmental hazards deemed relevant to this study. The policy mechanisms considered included the following:

Public Policy Tools

Air Quality Standards
Emission/Product Standards
Application Standards
Prohibitive Bans
Building Codes
Warnings
Health Guidelines
Information/Education Programs

Protective Policy Tools

Borrower Warranties
Borrower Credit Assessments
Site Assessments
Red-Lining Industries and Locations
Disclosure Policies

The specific policy/issue mappings were to be based on the general literature review as well as the study team's expertise in environmental policy, housing, construction and public health. However, as will be further discussed in Section 3.4, the published literature provided little guidance to the study team which mitigated against the development of a formal policy paradigm. Consequently, while the policy paradigm was to aid in focusing the second phase literature review and provide a framework for possible policy options that may arise in different countries, both the execution of the second-stage literature review and the country specific interview activities relied more on the experience of the study team.

Phase 2 Literature Review

While the intent of the phase 1 literature review was to provide a broad overview of environmental hazard policy activity, and form a basis for the selection of case study jurisdictions, the phase 2 literature review was much more focused. Specifically, the second phase review focused on the specific policies in the case study jurisdictions, and involved the collection of policy documentation, background information and government reports from the individual case study jurisdictions. The collection of this information allowed the study team to better prepare for, and focus, the case study interview process.

3.2 Country Studies

The Terms of Reference for this project indicated that CMHC's primary objectives were to obtain "a broad understanding of the level of international government policy activity" as well as "an appreciation of these policies and their impact through an in-depth analysis of policy development in specific countries". To meet the first objective of this study, a broad overview of activity in other jurisdictions was gleaned from both the first phase literature review as well as the more focused second phase literature review (as discussed above). While the literature review process was able to provide a certain level of understanding of the nature of policy activity in other jurisdictions, fulfilling the second objective of this study required a more in-depth analysis of country specific policy experience: this was gained from a case study interview analysis.

As discussed above, the case study countries were selected on the basis of the information gathered during the literature review, as well as a specific criteria noted in the Terms of Reference. A total of seven case study jurisdictions were selected by the study team, in consultation with the client. The specific jurisdictions include: (i) the United States (federally); (ii) the United Kingdom; (iii) Germany; (iv) Denmark; (v) Sweden; (vi) the Netherlands; and (vii) the State of California. A limited number of case studies was selected because covering too many countries may have compromised the depth of understanding of the intricacies and mosaics of residential environmental hazard policies in each of the countries.

3.2.1 Interview Process

Once the case study countries had been selected, and all secondary literature sources had been reasonably surveyed, the next step in the analysis was the execution of the case study interview analyses. The following outlines the interview process.

Interview Guide

The interview process began with the preparation of a questionnaire guide. The initial guides were developed in a multi-disciplinary setting, involving members of the study team with expertise in environmental policy, housing, construction and public health, and were structured, as much as possible, around the environmental hazard and policy paradigms. The multi-

disciplinary approach was selected to ensure that the questionnaires were not biased towards any one perspective and would be able to speak to each type of individual interviewed.

Once an initial interview guide had been developed, it was then "pre-tested" with a variety of policy representatives in the United States. The purpose of the pre-test was to gather sufficient information to enable the study team to "fine tune" the interview guides. Unfortunately, as will be discussed further in Section 3.4 below, the results of the pre-test suggested that the application of a formal and structured interview guide in this analysis was not possible. Discussions with policy representatives in the United States indicated that, with respect to residential environmental hazards, there is no cohesive policy structure nor designated policy body addressing residential environmental hazard policies. Given the results of this pre-test, the study team opted for a much less formal, and more open ended interview guide containing the following categories of questions:

- name, position and organization of interviewee;
- involvement with indoor air pollution generally, and residential environmental hazard policy specifically (development, implementation, enforcement, compliance);
- scope of residential environmental hazards considered in policies (based on the focus defined by the environmental hazard paradigm);
- nature of the residential environmental hazard policies (borrowing from policy paradigm);
- institutional arrangements for policy development, implementation and enforcement (including legal authority);
- history of policies;
- impact of policies; and
- implications for government intervention in housing.

Interview Activity

The country specific interviews were conducted largely by telephone; however, where time, language, or availability mitigated against telephone contact, a series of fax-interviews was conducted. One of the challenges of this study was to identify the "right" people to interview. Thus, in conducting the interviews, a two-stage process was followed. First, an initial set of interview candidates was identified through contacts of the study team, CMHC, and industry associations. This initial set of interview candidates were then contacted by telephone and briefly interviewed. During this process, the interviewee was asked to comment briefly on the nature and extent of residential environmental hazard policy in their jurisdiction; to indicate which governmental departments or agencies were responsible for policy development; and to

supply additional contact names within these departments/agencies. These additional contact names were then telephoned, briefly interviewed, and asked for additional contacts. During this process of initial interviews, we found that the circle of individuals responsible for residential environmental hazard development closed quite rapidly (i.e., particular individuals were repeatedly cited). Hence, a set of what were deemed the most "appropriate" interview candidates was, in most cases, quickly identified.

Once the set of most appropriate interviewees had been determined, the study team embarked on a more in-depth interview process (again by telephone and, where necessary, by fax). The interviews lasted, on average, about one-half to three-quarters of an hour. During this period, the interviewees were asked a variety of questions (along the lines indicated above); to supply any available policy documentation; and, if appropriate, to suggest additional contacts.

3.3 Analysis

The interview results and policy documentation provided by the interviewees was synthesized with the information gathered through the literature review and evaluated in terms of the following topic areas:

- considerations in the development of policy;
- historical evolution of policies;
- principles and scope of policies (e.g., polluter pay, regulatory versus non-regulatory approaches, preventive versus remedial);
- institutional arrangements;
- description of policies:
 - preventive/precautionary
 - detection
 - remedial;
- legal liability issues;
- effectiveness;
- impacts on construction, design, lending, etc. activities, market vs. social housing
- application to Canada; and
- implications for/application to CMHC.

As indicated by the above list of categories, a comprehensive analysis would go beyond a strict description of policies to explore what makes some policies/policy approaches more effective than others and to highlight lessons Canada can learn from experience in other jurisdictions. These lessons may constitute specific barriers or facilitators (such as institutional arrangements) or may identify successful programs/approaches that could be "transplanted" to Canada.

3.4 Divergence from the Proposed Approach

The methodology described above is essentially that which we had initially described in our proposal for this study. However, while this methodological structure was followed in the conduct of this study, we encountered a number of difficulties in fully implementing the proposed methodology. The main problem stemmed from the belief held by the study team that residential environmental hazard issues had gained a significant level of awareness (both from a public and a policy perspective) in most of the industrialized, democratic countries, and that residential environmental hazard policies, while fragmented, had at least reached a reasonable level of development (i.e., coordinating policy bodies had been defined, research in support of policy was well underway, etc.).

As the discussions in Sections 4.0 and 5.0 will indicate, both the level of awareness of the issue, and the degree of policy development, had been significantly overestimated in the development of the study methodology. What we found in our research was that, with the exception of certain pollutants (radon, asbestos, formaldehyde), and certain policy issues which cut across the residential, commercial and industrial sectors (e.g., legal/liability issues arising from the application of the U.S *Comprehensive Environmental Response, Compensation and Liability Act*), policy development with respect to residential environmental hazards specifically is very much in its infancy. Both the literature review and the interview process indicated that in the majority of international jurisdictions, the bulk of research/policy attention is focused on indoor air pollution and indoor air quality initiatives in the commercial, occupational and industrial sectors (e.g., sick building syndrome, etc.). A shift in focus toward the residential sector specifically is only now beginning, albeit slowly.

This finding largely served to explain the general lack of policy information in the published literature. In addition, this finding mitigated against the development of both a formal policy/issue mapping (i.e., the residential environmental hazard policy paradigm) and a formal interview guide. Both the phase 2 literature review and our initial interview guides were to be structured around the issue and policy paradigms which would provide a framework for the identification of existing and emerging environmental hazard issues and policy specific questions. However, the level of policy development was generally found to be insufficient to allow for the development of such a formal framework. As a consequence, the study team had to rely on its own expertise in the execution of the more focused research components of this study.

4.0 Policy Responses to Residential Environmental Hazards: The Results of the Literature Review

The recognition of indoor environmental hazards as both a public health and a policy issue has largely evolved over the last ten years. Nevertheless, within this span of time, concerns over the health effects associated with indoor environmental hazards have prompted the development and implementation of a variety of government policy measures in a number of jurisdictions. For example, policy measures have been implemented in many of the industrialized democracies to minimize the health risks associated with indoor exposure to pollutants such as asbestos, formaldehyde and radon. The measures taken have included prohibiting the use of products which contain these pollutants, and the establishment of building codes and safe construction and installation practices which serve to contain emissions, reduce pollutant infiltration, or reduce ambient concentrations. Similarly, many countries (as well as the World Health Organization and the European Commission) have established, or are in the process of establishing, air quality standards for certain pollutants (e.g., CO, CO₂, SO₂, NO₂, VOCs, environmental tobacco smoke, etc.) present in industrial and occupational indoor environments.

The literature addressing the issue of indoor pollution and indoor air quality in the commercial, industrial and occupational sectors is quite voluminous; however, its primary focus is on evaluating the health consequences associated with exposure to various pollutants within indoor, non-residential environments. In addition, a sufficient body of literature exists which addresses itself to the types of regulatory and non-regulatory activities available to reduce indoor environmental hazards within the commercial, industrial and occupational sectors. However, within the published literature, discussions of the policy options that have actually been adopted to address environmental hazards, in the residential sector specifically, are rather scant. While descriptions of the application of individual policy options in this sector are not common in the literature, discussions of the issues which influence the development of residential environmental hazard policy, and assessments of the types of policy options that might be applied, are more common. Hence, the balance of this section will reflect the focus provided in the literature.

Specifically, Section 4.1 will review the issues, identified in the literature, which have a bearing on the development of environmental hazard policy in the residential sector. This review will provide the reader with a better understanding of the state of policy development with respect to the residential sector as characterized in the balance of this section and in Section 5.0. Sections 4.2 and 4.3 will concentrate on an evaluation of the types of regulatory and non-regulatory public policy measures available to governments to address the problem of residential environmental hazards. In addition, the strengths and weaknesses of these measures will be identified. While the focus in these two sections will be on preventative/remedial public policy tools, Section 4.4 will address the range of legal and protective policy responses to residential environmental hazard issues (e.g., liability for site remediation).

4.1 Issues in the Development of a Public Policy Response

Our review of the literature indicates that the implementation of policy measures directed towards the minimization of residential environmental hazards *specifically* has been slow to emerge, and the policy measures that have been developed to date have generally been implemented in a rather piece-meal fashion. The limited application of policy measures to-date is partially the result of a slow evolution in the level of awareness, from a public, scientific and policy perspective, concerning residential environmental hazard issues. As noted in Section 2.0, efforts to control environmental hazards have traditionally focused on the industrial and occupational work environments and the outdoor ambient environment. In developing policy in these settings, there appears to have been an assumption that "... exposures from which people should be protected occur primarily in industrial and outdoor settings. This implies that the air quality in other environments, such as inside buildings or vehicles, is acceptable from a public health perspective."⁸ However, as the level of awareness concerning the potential health effects of exposure to pollutants in industrial and occupational environments developed over the past decade (such as the increasing awareness of "sick building syndrome"), policy attention began to focus on indoor pollution in the non-residential sector generally. Research and policy activity in the non-residential sector served to further raise the level of understanding and awareness of the health risks posed by exposure to pollutants within indoor environments generally and, as this occurred, both public and policy attention began to focus on the potential environmental hazards present in residential indoor environs.

In essence, the paradigm suggested in the literature is that both public awareness and policy attention has developed along a roughly linear pattern: from industrial indoor pollution, to outdoor ambient air pollution, to indoor pollution in the occupational and commercial sectors, to environmental hazards in the residential sector. As will be noted in Section 5.0, public awareness and policy attention in many jurisdictions -- especially outside of North America -- is only now shifting from indoor pollution issues in the industrial, commercial and occupational sectors toward environmental hazard issues in the residential sector. This relatively recent shift in focus may go some way to explaining the lack of published documentation concerning the nature and extent of policy activity with respect to residential environmental hazards.

However, awareness is not the only impetus to, nor determinant of, policy developments. Rather, the development of effective residential environmental hazard policy measures hinges on an adequate consideration, and resolution, of a number of additional factors, including: (i) the difficulties associated with conducting defensible risk assessments (i.e., the difficulties involved in assessing pollution characteristics and dose-response relationships within an enclosed area which is subject to the influence of a combination of a variety of pollutant sources, structural design characteristics, and the behaviour of residential occupants); (ii) the immaturity of research in defining measurement procedures which can account for such a broad array of variables; (iii) philosophical issues concerning risk management (i.e., does the government have the right to intrude on individual and private property rights); and (iv) issues concerning the

⁸ Sexton, K. (1985), pg. 106.

selection of appropriate, defensible and enforceable risk management measures. Each of these factors will be considered in turn below.

While awareness of a potential environmental hazard may serve as an impetus to policy action, it generally provides an insufficient basis for a policy response. To be acceptable and defensible in the eyes of the public, the courts and the political arena, policy actions taken to reduce the health risks associated with environmental hazards should (ideally) be predicated on a factual and defensible link between an identified hazard and the adverse health consequences associated with exposure.⁹ The development of this link (i.e., the conduct of a risk assessment) typically involves some or all of the following steps:¹⁰ (i) hazard identification -- determination of whether exposure to a specific substance is casually linked to observed health effects; (ii) dose-response assessment -- determination of the quantitative relationship between exposure or dose and a particular health response; (iii) exposure assessment -- determination of the extent to which humans are exposed to particular pollutants occurring in real world situations; and (iv) risk characterization -- use of data from the preceding steps to quantify the magnitude and associated uncertainty of relevant public health risks. While a risk assessment is a necessary precursor to the development of policy measures, the completion of the steps involved in assessing environmental hazards in the residential sector is complicated by a variety of factors.

Specifically, the difficulties involved in assessing the characteristics of a particular residential environmental hazard revolve around the question of how does one causally link health effects to a particular environmental hazard, and ascertain safe exposure limits, within a setting in which: (i) a variety of synthetic construction and decorating materials are present and may interact with and/or intensify the severity of the risk posed by any one pollutant; (ii) unvented heating and cooking appliances may be present which may interact with and/or intensify the severity of the risk posed by any one pollutant; (iii) the severity of the risk posed by a particular hazard will be affected by the design characteristics of the residential structure (such as the degree of ventilation); and (iv) the severity of the risk posed by a particular hazard will vary according to the level of awareness that residential occupants have concerning the hazard, and their particular behavioural characteristics with respect to the hazard. As indicated in the literature (and confirmed in the case study interview analysis), with the exception of particularly hazardous pollutants (such as asbestos, radon and formaldehyde), it is not clear how scientifically and politically defensible links can be established between health risks and environmental hazards in a sector characterized by such a diverse set of both constructive and destructive influences.

This brings us to the second issue of import to policy development; namely, while the problems associated with assessing the risks posed by a particular environmental hazard have generally

⁹ It should be noted that, while a policy response should be predicated on a factual and defensible understanding of the health risks associated with exposure to particular hazards, policy measures have been implemented in the absence of this understanding. For example, a policy response with respect to a particular hazard may be initiated as a preventative/defensive strategy while the actual risks posed by the hazard are assessed. Similarly, policy measures may be implemented on the basis of public pressure concerning a perceived risk.

¹⁰ The following is taken from Sexton (1985).

been recognized, research with respect to the definition of defensible measurement procedures, capable of controlling for such a broad array of variables, is still relatively immature. In addition, such research is often hindered by a paucity of data on the distributions of pollutant sources, building characteristics, daily activity patterns, indoor concentration characteristics, etc. As will be noted in Section 5.0, within many jurisdictions it would appear that efforts directed towards both the resolution of data gaps and the definition of defensible assessment procedures serves to characterize the state of the majority of current policy activity concerning residential environmental hazards.

While the development of policy with respect to a number of environmental hazards is hampered by a lack of data and of effective assessment procedures, with respect to certain hazards which cut across the occupational, industrial and residential sectors (moulds, formaldehyde, asbestos, radon and radon daughters, certain carcinogens such as polychlorinated biphenyls, etc.) causal links to significant health effects have been established (although these links are generally based on assessments made in non-residential settings). With respect to these hazards then, the question is not as much one of risk assessment but risk management: what regulatory and/or non-regulatory measures should be entertained? In answering this question, the government must resolve two issues.

The first issue involves the fact that government, in defining its risk management measures, must attempt to balance its obligations to protect public health with its obligations to protect the rights of the individual, their rights to privacy and their private property rights. For example, suppose exposure to radon in a particular residential area is deemed unsafe. The government can take action to ensure that new homes built in the area are safe by requiring the installation of protective membranes (such as soil gas retarder and sub-slab membranes) and adequate ventilation controls. However, with respect to existing homes, does government have the right to violate a homeowners property and privacy rights in order to ensure that they test for radon concentrations and take any necessary remediation measures?¹¹ Similarly, while building codes may specify certain ventilation requirements to reduce pollutant concentration, and thus residential exposures, after installation the homeowner may elect to seal a number of vents in order to improve energy efficiency (i.e., to save money). Does government have the right to require a homeowner to maintain his residence in accordance with building code requirements? Questions such as these are not trivial, and the position taken by a government with respect to issues such as public health protection versus individual rights, voluntary versus involuntary risks, etc., will have significant bearing on both the decision as to whether a regulatory or non-regulatory approach will be adopted to combat residential environmental hazards, as well as the selection of specific policy measures.¹²

¹¹ Furthermore, even if the government does assume this right, it is likely that homeowners will actively resist and attempts by government to conduct hazard assessments as it may lead to a devaluation of the homeowner's property.

¹² As will be noted in Section 5.0, a number of jurisdictions have determined that individual rights are paramount and have elected to adopt non-regulatory measures – such as the establishment of guidelines and educational programs – to avoid transgressing on individual and private property rights.

The second issue for the government to consider in the development of residential environmental hazard policy involves the selection of specific risk management measures -- be they regulatory or non-regulatory in nature. The decision here is not simply one of determining whether or not to take policy action. Rather, the decision involves the determination of whether the specific measures being considered are defensible (on the basis of a factual risk assessment), acceptable (in the eyes of the public, the courts and politicians) and enforceable.

In many instance, selection of an appropriate measure may appear to be clear cut. For example, if a particular chemical or synthetic material poses a significant health hazard, then it may be deemed necessary to ban the material/product. However, in adopting this measure, both industry and the public may protest the complete banning of a popular product, and/or it may not be technically feasible to either eliminate or reduce the proportion of a pollutant in a product. Considerations such as these must be taken into account when selecting specific policy measures.

As opposed to the previous example, in many instances the selection of an appropriate measure may be quite difficult. For example, in terms of the hypothetical situation presented earlier, the government may in fact elect to adopt a policy which requires a homeowner to maintain his residence in accordance with specified building codes; however, the question then becomes one of how does the government enforce such a policy and ensure compliance.

In summary, the process of developing and implementing measures to reduce the risks posed by residential environmental hazards must take into account a variety of issues. As a first step in policy development the characteristics of a hazard, and its link to human health, must be accurately and defensibly determined. However, the completion of this step is not without its problems. In addition to assessing the risk posed by an environmental hazard, the government must also determine if it is appropriate to interfere with the rights of homeowners, even if the intention is to protect their health. Finally, even if the risk assessment and philosophical questions are resolved, the problem of defining an appropriate, defensible and enforceable policy response within a sector characterized by a multitude of different building structures and widely varying homeowner behavioural characteristics, remains.

Each of these issues has an important influence on the policy development process. With these considerations in hand, however, we now turn to a discussion of the range of both regulatory and non-regulatory measures identified in the literature as available to governments to address the issue of residential environmental hazards.

4.2 Regulatory Strategies for Public Policy

The regulatory tools identified in the literature as available to government and applicable to addressing the issue of residential environmental hazards (in theory at least), include: (i) air

quality standards; (ii) building codes; (iii) emission standards; (iv) application standards; (v) prohibitive bans; and (vi) warnings.¹³

4.2.1 Air Quality Standards

The development and implementation of policy measures to address environmental hazards must be based on a working understanding of the "objective" or "base-line" level of exposure that is required to protect public health. The "base-line" for most regulatory activity addressing ambient air pollution issues is provided through the development of air quality standards. These standards are based on the assumption that there is some minimum, threshold dose below which no adverse health effects should occur; hence, the construction of an air quality standard requires the identification of this threshold limit and its expression in numerical terms. With this value in hand, an air contaminant standard can be set, and it is usually specified at a level which is low enough to protect public health with an adequate margin of safety.

While most of the existing air quality standards relate to outdoor and occupational environments, air quality standards will also provide the necessary basis for the development of policies which address residential environmental hazards, at least in theory. However, while these standards are theoretically useful, in practice there are numerous problems associated with their application in the residential sector. To begin, as discussed in Section 4.1, the development and implementation of standards associated with air pollutant exposure (or for that matter, exposure to any toxic substance), involves a slow and arduous risk assessment process. The period of time necessary to move through the process from hazard identification, to risk assessment, to the promulgation of a standard can be considerable.

The second problem with the use of standards is that, regardless of whether they apply to ambient air, the air in occupational environments or the air within residential environments, they tend to be based not only on scientific judgement, but on political and economic considerations as well. For instance, the process of developing standards with respect to formaldehyde and asbestos (especially in the United States) was subject to considerable political pressure from lobbyists for asbestos mines, asbestos products manufactures, and plywood and particle board manufacturers. In many cases this lobbying pressure led to the defeat of a standard or a

¹³ It should be noted that these tools represent the principal regulatory strategies applicable to residential hazard issues, and that additional regulatory measures could be specifically noted as applicable to hazard issues. One such regulatory strategy would involve the development of ground-soil contaminant standards. Such standards did not receive attention in the literature (and are not discussed here) largely due to the fact that they are generally imbedded in site assessment standards, zoning restrictions and red-line protective policies. Furthermore, except in instances where certain sites are red-lined because of excessive levels of contaminants (i.e., the site is a toxic waste site, exhibits high radon or soil gas emissions, has soil contaminated with petroleum products, etc.), the definition of what the most appropriate ground-soil contaminant standards might be will vary with the type of structure placed on a given site, the building codes in force, the pollutant infiltration mitigation measures used in construction, the behaviour of occupants, etc.

significant modification in the defined exposure limit.¹⁴ Consequently, the promulgated standard may not, in fact, be adequate for the protection of human health, and it may not provide an acceptable and defensible basis for the development of policy measures.¹⁵

Finally, even if these problems are overcome, the application of air quality standards in the residential sector, as a measure for reducing the health risks associated with environmental hazards, is largely a practical impossibility. In order for the standard to have any force and effect, compliance monitoring is necessary. While it is possible to assess the extent to which a particular residential unit meets the standard at the point of sale, on-going monitoring to ensure compliance and to safeguard the occupants would be intrusive (and especially in countries such as the United States, it would likely violate a variety of constitutional guarantees) and would require an enormous amount of resources.

While the practical difficulties associated with applying air quality standards in residential environments renders them ineffective as a direct regulatory tool, they can be quite useful as a tool for educating household occupants as to the types of substances that can pose a risk to human health, and the concentrations levels at which the risks are most acute. In addition, the acceptance of other regulatory and/or non-regulatory measures, and the extent to which they lead to effective protection from an environmental hazard, will depend on the public's awareness of the risks associated with a given hazard: air quality standards can help to foster this awareness.

4.2.2 Emission/Product Standards

As noted earlier, variations in the design of residential structures, the materials used in their construction, and the behavioural characteristics of household occupants may render direct, sector specific policy actions taken to control in-home pollutant concentrations ineffective. For instance, while it is possible to require that new homes be built to certain ventilation standards, the government has little control over homeowners who, after purchasing the house, elect to block-up the vents to save on heating/cooling costs. Similarly, while proper ventilation may be seen as a solution to the hazards posed when volatile organic compounds, formaldehyde, etc. are emitted from household construction, decorating and cleaning materials, the government may not have the means to force homeowners to increase household ventilation rates in order to ameliorate the risks associated with these hazards.

However, while the government may not be able to directly control pollutant concentrations arising from products and materials once they are present in the home, it can indirectly affect pollutant concentrations by adopting emission standards for specific products before they can be

¹⁴ For example, the Department of Housing and Urban Development in the United States accepted a standard for formaldehyde of 0.40 parts per million for mobile homes, even though health data suggested this standard was too high, primarily due to the fact that the wood products industry was not capable of producing particle board and plywood which emitted lower levels of formaldehyde.

¹⁵ Further problems can arise in that standards carry with them an implicit sense of safety which can produce a false sense of security if they are poorly defined.

used in the home. These standards which are, in effect, product standards, place limits on the allowable emissions of toxic substances from particular products; hence, they provide an indirect means of achieving indoor pollution control objectives. Emission standards have proven to be a useful approach for controlling environmental hazards in both the residential and non-residential sectors, and are a popular tactic in Germany, the Scandinavian countries, a number of other Western European countries and the United States. In these countries, product standards have been applied to plywood, panelling and particle board to control formaldehyde, and to paints, varnishes, adhesives, etc., in an effort to control the emission of volatile organic compounds (VOCs).

Product standards are fairly simple to apply and enforce since the burden of compliance is placed directly on product manufacturers: the manufacturer must provide proof of compliance prior to placing the product on the market. However, like air quality standards, their formulation can be subject to considerable political and economic influences. Specifically, due to technical and/or cost consideration, considerable lobbying effort may be exerted by product manufacturers to moderate the emission standards being considered. A further difficulty associated with the application of product standards to address residential environmental hazards (as with many of the regulatory tools available to address residential environmental hazards) is that they can only serve to reduce future exposures to toxic substances. They are not able to reduce existing exposure levels in residential environments unless older, higher emission materials are identified and replaced (during renovations, upgrades or retrofits) with newer products.

4.2.3 Application Standards

Many appliances and building, insulation, and pest control products have the potential to emit toxic substances which can lead to significant contaminate concentrations within indoor environments. However, these products can be rendered relatively safe (theoretically) if they are applied/installed in a particular manner. In order to ensure that products are used in a way which minimizes the possibility of contamination, standards of performance and certification have been applied to individuals and businesses who apply/install such products on a commercial basis (such as the application of insulation, the installation of protective membranes to guard against radon infiltration, etc.).¹⁶

For example, in the United Kingdom, urea-formaldehyde foam has been used as an insulating product in many residential and commercial applications. However, unlike Canada and the United States, the United Kingdom does not view urea-formaldehyde foam as an inherently dangerous product that should be banned; rather, the associated health problems are viewed as a consequence of misapplication of the product. Hence, application standards and codes of practice have been developed which specify not only the formulation of the foam, but also the procedures to be followed to ensure safe installation. Similar standards have been developed in

¹⁶ Product labels which stipulate the procedures to follow to ensure the safe use on many products used by individuals within the home (e.g., pesticides and herbicides, cleaning products, paints and varnishes, etc.) are discussed in Section 4.2.6 below.

the United States to reduce potential health problems associated with the misapplication of pest control products.

With respect to the commercial application/installation of products, these standards are relatively easy to apply and enforce. However, they also suffer from the weakness of only being able to address the emissions from products installed after the promulgation of the standard. In addition, as indicated in the case of urea-formaldehyde foam insulation, one has to begin with the assumption that proper application/installation will render a particular product safe: this assumption is not necessarily that easy to prove and is often the subject of considerable controversy.

4.2.4 Prohibitive Bans

Another popular tactic to follow in an effort to meet specific pollution standards, and to limit future exposures, is to place prohibitive bans on specific products which are known (or suspected) to be heavy emitters of toxic substances. Examples of the application of this regulatory tool abound and include bans on friable asbestos materials in construction, bans on urea-formaldehyde foam insulation, bans on kerosene heaters, and restrictions on the use of methylene chloride in paint strippers.

Like product standards, prohibitive bans are relatively easy to apply, and are even easier to administer since compliance with numerical emission limits does not need to be assessed. However, there are also a number of potential problems associated with product prohibitions. For instance, as with air quality standards, attempts to implement prohibitive bans on certain products can lead to significant political lobbying pressure from the manufacturers and/or users of the products. For instance, the ban on urea-formaldehyde foam insulation in the United States, implemented by the Consumer Product Safety Commission, was eventually voided after the U.S. formaldehyde industry appealed the ban in the courts (in short, if the application of a ban has the potential to generate significant economic repercussions, in terms of lost jobs, etc., it may be difficult for the ban to survive the political implementation process). In addition to the political ramifications of a ban, it may not be technically feasible to either eliminate or reduce the proportion of a pollutant in a product, and/or the pollutant may be an essential component for which no substitute is available. In cases such as these, the health risks posed by the product will have to be more carefully weighed against the cost associated with finding substitutes for a pollutant used in a product, or the cost of doing without the product altogether.

4.2.5 Building Codes

As indicated in Section 2.0, when the background to the problem of environmental hazards was discussed, much of the concern over residential and occupational environmental hazards stems from the fact that air exchange rates in many homes and buildings have been significantly reduced over the last two decades in an effort to improve energy efficiency. Recognizing the trade-offs that exist between energy efficiency and public health risks, a number of governments have developed ventilation guidelines, and many have also elected to incorporate ventilation standards within building codes in an effort to reduce the environmental hazards associated with

reduced air exchange rates. Most of the guidelines with respect to ventilation have remained just that -- guidelines -- and consequently they do not have the force of law. Of the guidelines which have been incorporated in building codes, most have related only to mechanically ventilated buildings.

However, in Sweden, Denmark, Finland, Norway and the Netherlands, and the United Kingdom, minimum ventilation and air exchange rate guidelines have been incorporated within residential building codes in order to reduce residential environmental risks. The application of ventilation codes/guidelines has also become quite common in Western Europe, and can be an effective tool in addressing environmental hazards. However, unless these codes and guidelines are applied in concert with other options (such as reductions in indoor sources, increased education and awareness, etc.), they may be challenged by the public because the increased air exchange rates that these ventilation requirements entail may hamper the achievement of household energy efficiency goals. In addition, unless the codes can be applied retroactively then, once again, this policy tool can only guard against future problems.

4.2.6 Warnings

Probably the weakest regulatory tool available is the requirement that manufacturers place warning labels on products which are known to be, or potentially are, hazardous. These warnings generally specify the nature of the hazard and the conditions under which the product can be safely used. The requirement for warning labels on products which are used by individuals within their own homes is a relatively easy regulation to apply and, in terms of the manufacturers of the products, easy to enforce. As a tool to protect public health, however, such warning are impossible to enforce at the level of the individual homeowner/occupant. Furthermore, unless the gravity of the risk posed by a particular product is fully appreciated by the homeowner using the product, instructions pertaining to the safe use of the product may be treated lightly or completely ignored. Again, awareness of the hazard becomes a key determinant of the effectiveness of measures taken to ameliorate the associated risks. In the absence of an adequate appreciation of the risks posed by a hazard, the use of warning labels, or other types of product advisories, as a tool for reducing indoor contamination and exposure from substances such as formaldehyde and VOCs, will generally prove to be ineffective. In fact, it is more likely that such requirements have done more to reduce a product manufacturer's legal liabilities than they have reduced public health risks.

4.3 Non-Regulatory Strategies

Each of the regulatory tools described above suffers, to a greater or lesser degree, from problems of technical and/or political definition (such as in the case of air quality standards, prohibitive bans and products standards); problems of ensuring adequate enforcement within the residential sector; or some degree of reliance on the recognition by residential occupants of the nature and severity of the risks associated with the hazard to which the measure applies. Partially as a result of these problems, a number of governments have implemented non-regulatory measures, either alone or in concert with regulatory measures, in an effort to increase the level of awareness and understanding of the significance of environmental hazards. In

addition, a number of governments have come to rely on non-regulatory measures as a result of the view that: (i) much of the risks associated with residential environmental hazards stem from the behaviour of residential occupants; (ii) government may not have a legitimate right to directly regulate the behaviour of homeowners within the confines of their residences (except in exceptional circumstances); and (iii) that individual behaviour patterns can be changed, and risks reduced, if homeowners are adequately educated about the potential for environmental hazards within their dwellings. In this regard, the non-regulatory measures that are most common include health guidelines and the provision of information/education.

4.3.1 Health Guidelines

Health guidelines for indoor environments can be developed and issued by government agencies or by professional groups who represent particular health issues. These guidelines are akin to air quality standards and are developed to meet the same objectives: achieving and maintaining acceptable air quality. Unlike standards, health guidelines with respect to indoor pollution have no legal force; however, while they do not have the force of law, they do offer a number of advantages over regulatory standards.¹⁷ Specifically, the process of developing and publishing guidelines is more rapid, and less complicated, than that associated with standards. In addition, guidelines are (in theory) less susceptible to the political and economic compromises associated with the implementation of standards. Furthermore, given the lack of political interference, guidelines tend to be based largely on a scientific consensus and, therefore, are more likely to reflect true health risk.

Despite the fact that health guidelines do not have the force of law, they can carry considerable weight in individual decisions in that they carry the sense that the scientific community (or the government agency or other public body which developed the guideline) believes that levels of exposure above the guidelines are unsafe. Hence, many individuals may take remedial steps, or at least consider them, if they believe that the pollutant exposure guidelines are being exceeded in their homes.

The most common residential environment health guidelines are those that have been promulgated for radon (and radon daughters) in Europe, Canada and the United States. Health guidelines have also been published for formaldehyde, fibrous materials, lead, polycyclic aromatic hydrocarbons, and various biological agents. In addition, associated with each of these guidelines, the agency/department issuing the guidelines commonly produces a companion reference which lists practices and procedures for limiting or reducing exposure to these substances.

¹⁷ The absence of a legal standing has both disadvantages and advantages. On the one hand, an individual cannot be forced to comply with the guidelines. On the other hand, the lack of legal force guards against the risk of liability in the event the guideline is contravened.

4.3.2 Information/Education

A low-cost approach for addressing residential environmental risks is to develop and operate public information and education programs. Such programs are already in effect in a number of countries and provide information on proper building/installation practices, ventilation guidelines, health risks associated with various building materials, and the identification and mitigation of radon problems. The main problem with this approach is that the burden of identifying and mitigating residential environmental hazards falls on homeowners and tenants. However, while it is possible to provide the information necessary to make these individuals aware of the nature of the problems, how they can be identified, and the range of solutions available, it is the responsibility of the homeowner/tenant to access the information and act on any problems they find.

4.4 Legal and Protective Policy Responses to Residential Environmental Hazard Issues

In most of the industrialized democracies, individuals who have been personally injured, or have suffered property damage and/or diminished property value, may seek legal redress through the courts. The actions that can be taken cover a broad spectrum. For instance, in addition to the long standing ability of an individual to sue a manufacturer for a defective product or for damages suffered from its use, in the case of building materials (which are part of the structure of the house and cannot be removed without considerable expense and inconvenience), the homeowner is also able to seek redress from the seller of the home, the architect, the developer or the contractor/builder for damages suffered. Most of the legal action taken in these cases has been based on either negligence, strict liability in tort, misrepresentation or fraud, or breach of expressed or implied warranty.

Over the past ten to fifteen years, a number of countries have modified existing legislation and/or developed new policies which have explicitly laid out the extent to which a particular individual or organization is liable for health or property damages arising from the presence of environmental hazards. The legislation which defines liability in these instances was initially developed to address industrial and commercial pollution, and is generally based on the principle that the "polluter-pays".¹⁸ Some noted examples of environmental liability legislation includes the U.S. *Comprehensive Environmental Response, Compensation, and Liability Act* (also known as CERCLA or Superfund) and the Japanese *Compensation Law*.

The published literature on the nature of existing environmental liability legislation, and/or the types of legal and protective policies that can be adopted to protect against such liability, is not particularly broad. In addition, the majority of the literature addressing these subject areas is concerned with developments in the United States and, specifically, the continued evolution of the Superfund legislation. With respect to the documentation reviewed concerning Superfund,

¹⁸ However, recent developments in both the United States and in Canada has led to a very broad definition of polluters and potential liability now extends beyond the rational concept of polluter pays to that of "deep pocket pays" (Ford [1992a], pg. 7.).

it was interesting to note that to-date, secured creditors have been granted an exemption from liability under Superfund (as will be further discussed in Section 5.0, the issue of lender liability in the United States is a contentious one).¹⁹ However, irrespective of this exemption, the issue of environmental liability has dramatically affected the behaviour of many American banks. For example, in 1990 the American Bankers Association conducted a survey of community banks (which comprise 94% of its membership) on environmental issues.²⁰ The results of the survey were quite striking and included the following:

- 62.5% rejected loan applications because of the possibility of environmental liability;
- 88.1% had changed lending practices to avoid liability;
- 45.8% had discontinued loans to businesses because of environmental concerns;
- 13.5% had incurred cleanup costs on property held as collateral; and
- 16.7% had abandoned property rather than taking title in order to avoid liability.²¹

While the majority of these loan applications did not involve transactions in the residential sector, and especially at the level of single dwelling mortgage applications, the implications for lending practices in this sector are clear.

In terms of the practices of lenders, there are four principal means by which banking institutions (and/or entities which guarantee mortgages, such as CMHC and Fannie Mae in the United States) can be affected by environmental liability. First, a borrower may be required to comply with an order to remove a hazard which is present on his property. In order to comply with the order, the borrower may have to incur expenses of a magnitude which prevent him from meeting his mortgage obligations, and this will have a financial affect on the lender. Second, if the real estate taken as collateral for the loan is contaminated or subject to an administrative order for remediation, then its value may be severely diminished. Third, the lender or mortgage guarantor may assume direct liability for remediating a property if it can be shown that the lender could have exercised some form of control which would have prevented the borrower from contaminating the site. Similarly, the lender or mortgage guarantor may assume direct liability if the borrower defaults on a loan and the title to the contaminated real estate, which was held as collateral, reverts to the lender or to the mortgage guarantor. In either of these cases, the financial consequences for the organization which issued and/or guaranteed the loan can be quite severe since the liability and, therefore, the responsibility for remediation, will bear no

¹⁹ Legislation in Canada, and particularly the Government of Ontario's *Environmental Protection Act (1990)*, does not grant such an exemption (Ford [1992a]).

²⁰ The Canadian Bankers Association published a similar report entitled *The Effect of Environmental Liability in Canada on Borrowers, Lenders and Investors* in November, 1991.

²¹ Ford (1992b), pg. 7.

relationship to the amount of the loan or the value of the security taken. The final pathway in which environmental liability can affect a lender stems from the fact that the priority of secured lenders may be superseded by a statutory lien, or "environmental lien". These liens have the same priority as a municipal tax lien and stipulate that remediation of the contaminated site must occur before the property is disposed of in any way.

Given the fact that a number of laws have been redefined to more explicitly state liability in cases of residential environmental hazards, a number of organizations, such as lenders, mortgage guarantors, realtors, developers, etc., have sought to adopt protective policies and practices in an attempt to limit their liability and exposure to litigation. These policies/practices can be based on explicit legal analysis, or they may simply reflect the application of common sense protective measures. Unfortunately, very few examples of these policies and practices appear in the literature. However, some examples include the following:

- *Borrower Warranties*: the individual or organization which borrows funds to acquire property warrants that, to the best of his knowledge, the property is free of contamination; is not causing or subject to environmental damage; and that the property will be maintained in a contamination free state. These warranties serve the purpose of placing the legal liability for damage on the borrower and not on the lender or mortgage guarantor.
- *Site Assessment*: an assessment is done to ensure that the property is not redeveloped industrial land, or that previous owners did not make, store or use toxic contaminants on the site. This assessment can involve document/land title searches and/or physical, on site inspections. The intent of a site assessment is to gather as much information as possible on the property so as to assess the potential environmental risk before accepting a claim on the property as either a borrower or lender.
- *Red-lining Industries and Locations*: high environmental risk locations (previous industrial lands, service station locations, chemical plant locations, etc.) are not considered eligible unless extensive assessments are conducted to ensure that ground-soil standards of sufficient stringency to ensure environmental safety are met.

In addition to these practices, many real estate agencies are now required to make full disclosure of certain environmental risks associated with a residence (such as the presence of urea-formaldehyde foam insulation), and many lending institutions routinely perform brief risk assessments, both of the property and of the borrower's ability to absorb any clean-up charges. Each of these practices serves to limit and/or shift liability and, in essence, are formal expressions of common sense solutions to limiting legal risks: collect as much information as you can *before* assuming responsibility.

While each of these procedures will provide some protection from litigation, the nature of the legal system itself demonstrates a number of characteristics, some of which might work to favour the plaintiff, and some which may work to favour the defendant. Specifically, the litigation of a liability case is very expensive, and the outcomes can be quite unpredictable,

particularly if the case actually goes to trial. As a consequence, a decision on whether to pursue a liability case will generally take into consideration the relative financial positions of the litigants. In addition, in most cases the burdens of proof are different for plaintiffs and defendants: the former usually must prove causation, while the latter need only generate a reasonable doubt in the minds of the jury. Furthermore, in many cases the injured parties may not be able to afford either the costs of litigation, nor the costs of cleaning up the environmental problem in the residence. As a consequence, the only course of action may be to walk away from the property.

4.5 Summary

The public policy options identified in the literature, and discussed above, each have their own particular merits and weaknesses. However, regardless of whether the options stem from a regulatory or a non-regulatory approach, to be defensible and acceptable in the eyes of the public and the political process, ideally they must be based on accurate risk assessments.²² The problem here, however, is that accurate and robust risk assessment procedures are lacking and research with respect to their development is still in its infancy. The second common weakness associated with most of the identified policy measures is that, in general, they can only effectively address residential environmental hazard issues arising in the future: the setting of product standards, bans or building codes will not normally effect existing structures. Measures aimed at providing protection from environmental hazards arising from decisions made in the past generally involve non-regulatory measures aimed at educating homeowners and raising their awareness of the potential health risks associated with exposures to residential environmental hazards. Regulatory measures which are designed to address hazards arising from past decisions are very difficult to develop and implement unless policy makers are willing to actively, and overtly, intervene in the residential sector. However, even if the issue of private rights is put aside, the problem of developing cost-effective and enforceable policy measures remains.

With the exception of non-regulatory, educational measures, the policy tools most commonly employed to protect against decisions made in the past involve liability laws and protective policies. The protective measures that are available generally involve common sense techniques for limiting liability. Their effectiveness, however, depends on the severity and breadth of the liability laws in place in a particular jurisdiction.

²² As noted, this condition is not always satisfied which can lead to problems in terms of on-going policy implementation, as evident with respect to the issue of radon in the United States (see Section 5.3 below).

5.0 Policy Responses to Residential Environmental Hazards: The Results of the Country Studies

This section provides the results of the case study interview analysis with respect to the public and protective policies adopted in seven international jurisdictions to address residential environmental hazard issues. The jurisdictions include: the United Kingdom; the United States (federal); the State of California; Sweden; Denmark; the Federal Republic of Germany; and the Netherlands. In our interim report,²³ we had indicated that a total of six jurisdictions would be reviewed. However, given the more advanced development of environmental hazard issues in the United States, and the interrelationships which exist between state and federal agencies in the development and implementation of policy measures with respect to these issues, we elected to include a review of the measures taken to address environmental hazards in the State of California.

This section of the report begins with an overall review of the nature and extent of the public and protective policies adopted in the aforementioned jurisdictions. This is followed by a discussion of the nature and extent of policy activity in each of the individual jurisdictions. In reviewing this material, one caveat must be kept in mind. While we are confident that the individuals that were interviewed in each jurisdiction were well qualified to address the issues involved, given budget and time constraints we were not able to conduct a comprehensive survey of every department, ministry or agency which may play a role in the development of residential environmental hazard policy. Thus, the assumption has to be made that the information presented by the representatives of the various organizations contacted in each jurisdiction provides an accurate assessment of the state of policy activity in each country. While the possibility exists that some aspects of policy activity were not captured in our review, we are confident that what is presented below provides an accurate representation of the policy thrust in each jurisdiction.

5.1 Overall Summary

The results of the case study interview analysis revealed that, with respect to the research and policy development activities undertaken to address residential environmental hazard issues, each of the seven international jurisdictions exhibited broadly similar characteristics. In particular, the analysis revealed that, in each of the case study jurisdictions, policy attention with respect to indoor pollution issues has evolved along a roughly linear path which, as indicated in Section 4.1, has involved a progressive shift in the focus of policy from industrial indoor pollution issues, to outdoor ambient air pollution issues, to indoor pollution issues in the occupational and commercial sectors and, lastly, to environmental hazard issues in the residential sector. The similarities demonstrated with respect to the evolution of policy development activities in each

²³ *Residential Environmental Hazard Policies in Other Countries: Results from the Literature Review*, January 21, 1993.

of the study countries also appears to extend to the particular pollutants of concern. Specifically, in each country the primary hazards of concern for policy include: asbestos, formaldehyde, radon and other soil/landfill gases, volatile organic compounds, and a variety of chemical substances commonly found in construction and decorating materials and other household products.

In terms of the development and implementation of policy measures, again there are a number of common features amongst the various countries; including:

- In each of the jurisdictions reviewed, few policies have been implemented that have been *directly* concerned with residential environmental hazards. Rather, the policies that have been developed and implemented largely address broader indoor pollution issues that cut across both the residential and non-residential sectors.
- In developing policy with respect to the residential sector, each jurisdiction appears to continue to grapple with the question of whether it would be appropriate to overtly intervene in the residential sector given the personal and property rights issues involved, and the difficulties associated with differentiating between voluntary and involuntary risks in certain situations.
- Partially as a consequence of the lack of a direct focus on the residential sector, and the question of whether the government has the right to directly intervene in this sector, the third similarity exhibited is that each jurisdiction has generally relied on the development and implementation of informational guidelines (for pollutants such as formaldehyde, lead, radon, etc.), product standards and prohibitions (with respect to lead, asbestos and formaldehyde), and building code restrictions (e.g., such as ventilation requirements and the installation of soil gas retarder membranes) in order to address residential hazard issues.
- With respect to the present state of policy development, a similar feature exhibited by each country (although to a lesser degree in the United States than elsewhere), involves a recognition of the need to establish accurate and defensible guidelines for pollutant exposures in the residential sector as a basis for further policy development. These guidelines are seen as a basic requirement for the development of an effective strategy for addressing environmental hazard issues in the residential sector. However, while the need for guidelines is recognized, the scientific and technical issues surrounding the development of robust and defensible measurement protocols is impeding their development.
- Finally, as was reflected in the literature review, in each jurisdiction residential environmental hazards issues are generally equated with residential indoor air pollution/air quality issues. However, the treatment of residential indoor air pollution as being synonymous with residential environmental hazards issues is more a matter of nomenclature than substance. Irrespective of the title employed, we found that in practice the pollutants of concern are essentially the same; the pollutant sources of

concern are common (i.e., emissions from products brought into the residential structure, from construction and decorating materials, from the ground-soil and sub-surface rock, etc.); and the policy focus is largely the same (i.e., determining the concentrations that pollutants from disparate sources reach in the enclosed residential environment, the risks the pollutant concentrations pose, and the management measures available to mitigate the risks). Thus, the predilection exhibited by each of the jurisdictions reviewed for the term "indoor air pollution" appears to evolve from the fact that it is the identification of the pollutants present in the indoor residential environments, the measurement of the concentrations that pollutants (emitted from disparate sources) reach in the indoor environment, and the assessment of the risks they pose to occupants that serve as the jumping-off point for the development and implementation of mitigation measures (both regulatory and non-regulatory) and protective policies.

While the interview analysis revealed that the various countries exhibited a number of common characteristics in terms of the approaches adopted to address residential environmental hazard issues, the analysis also indicated two significant differences. First, one can distinguish between the European countries and North America on the basis of the level of awareness of the environmental hazard issues facing the residential sector. While the Netherlands and Denmark represent somewhat of an exception amongst the European countries reviewed, policy activity with respect to more general indoor air pollution issues in the occupational, commercial and institutional sectors is a relatively recent event, and the shift in policy focus toward the residential sector has only been apparent in the past few years. In addition, the level of awareness of residential hazard issues, exhibited by the general population in most European countries, is also very immature. In contrast, in the United States, research and policy activity with respect to indoor air pollution generally has occurred since the late 1970s. Furthermore, while few regulatory measures have been implemented to address hazard issues in the residential sector specifically, numerous guidelines, informational pamphlets and educational programs have been provided to the public by a wide variety of government departments at both the state and federal levels.

The second key difference amongst the countries reviewed in this analysis involves the development of protective policies; i.e., those policies that serve to limit exposure to liability for any damages associated with environmental hazards. Again, the European countries and the United States distinguish themselves with respect to this issue. In the United States, environmental liability issues have been prominent for a considerable period of time, and their significance is represented, among other statutes, by the *Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)* of 1980. While legislation such as CERCLA is not specifically aimed at the residential sector, the potential exists that lenders and mortgage insuring agencies may be held liable for damages associated with environmental hazards. As a consequence, a variety of lending institutions and government agencies are considering, or have adopted, policies to shield themselves against liability, with the most common forms of policy involving the red-lining of locations and requirements for environmental site assessments. In contrast to the situation in the United States, the European countries view protective policies as either unnecessary, or a very remote priority for

development. In addition, while liability for residential environmental hazards is a realistic concern in the United States, most European countries do not anticipate that it will emerge as a policy issue.

5.2 Residential Environmental Hazard Policy in the United Kingdom

Prior to about five years ago, the issues which surround residential environmental hazards, and indoor air quality generally, had been largely neglected in the United Kingdom, both in policy terms and in terms of public perceptions. The main reasons for this neglect appears to have stemmed from both a lack of information and awareness as to the nature of the health issues associated with exposure to pollutants in indoor environments, and a perception that the health effects which relate to exposure tend to be chronic, long-term and not directly and immediately life-threatening.²⁴

In recent years, however, issues of concern with respect to environmental hazards within the non-residential sector have become more prominent, and legislative activities have been undertaken to address these concerns in the non-residential sector.²⁵ However, despite the increase in awareness and legislative activity with respect to a variety of environmental hazard issues, few effective guidelines, codes of practice or other forms of guidance have been implemented with respect to indoor air pollution in the commercial, industrial and occupational environments.²⁶ In fact, a recent inquiry into indoor air pollution in the United Kingdom received numerous submissions stating that, without further guidance, existing legislation was too vague and could only be effectively used to cover the most grossly unsatisfactory conditions. Thus, with respect to the non-residential sector, the level of awareness, investigatory activities and policy development largely remains in its infancy.

Given the immaturity of policy activity in the non-residential sector, it is not surprising that in the United Kingdom, awareness of, and policy activity with respect to, residential environmental hazards issues has lagged that found in North America by upwards of ten years.²⁷ In fact, it is only in the past two to three years that awareness of the issues involved has developed to any significant extent. The government of the United Kingdom (and specifically the Department of

²⁴ Environment Committee (1991), pg. ix.

²⁵ The guiding legislation is the *Health and Safety at Work Act (1974)*, and the *Offices, Shops and Railway Premises Act (1963)*. The main onus for ensuring adequate air quality for commercial buildings rests with the employer and is enforced by environmental health officers from the Institution of Environmental Health Officers (IEHO); however, the Health and Safety Executive (HSE) has responsibility for providing the appropriate guidance.

²⁶ Environment Committee (1991) pg. x.

²⁷ Personal Communication with Dr. J.W. Llewellyn, Building Research Establishment, United Kingdom, April 22, 1993. Dr. Llewellyn also indicated that his characterization of the situation in the United Kingdom would equally apply to the majority of European countries.

the Environment) has played a role in fostering this awareness through a variety of activities. For instance, it has distributed numerous information pamphlets relating to specific indoor air pollutants (e.g., radon, lead-based paints, formaldehyde, etc.), and in 1992, the government published a more comprehensive information pamphlet titled *Good Air Quality in Your Home*. In addition to the government's efforts, as awareness has increased developers have begun to demand more environmentally friendly products and building materials; hence, the government (as well as private concerns) has undertaken a variety of research and development activities in this area. Furthermore, there has been a movement toward the development of codes and standards for structural design, ventilation requirements, and building materials. However, it should be noted that the majority of the design codes and standards that have been put in place have been developed to control air flow for energy conservation reasons and to control dampness. Concern over residential environmental hazard issues was not the driving force behind the implementation of these measures; however, their implementation has served to reduce the risks associated with a variety of these hazards.

In addition to the government's efforts to educate and inform the public, the increase in the awareness of, and policy attention directed toward, environmental hazard issues within the residential sector, witnessed in the United Kingdom over the last two to three years, was given further impetus as a result of the initiation of the House of Commons Select Committee on the Environment Inquiry into Indoor Pollution, conducted during the 1990-91 parliamentary session (this was the first time that the Environment Committee had conducted an inquiry in this area).²⁸ The report produced by the Environment Committee, and the subsequent Command Paper produced by the Government of the United Kingdom in response to the Committee's report, predominantly addressed indoor pollution issues in the non-residential sector; however, indoor air quality concerns in the residential sector were also addressed and recommendations concerning this sector were provided.²⁹

The results of the inquiry with respect to the residential sector, however, were not particularly extensive nor path-breaking. In summary, the results of the inquiry stated that: (i) individuals should not be exposed to "undo risks" from indoor pollutants; (ii) health based risk assessments for certain "priority pollutants" (namely, formaldehyde, asbestos, radon, VOCs, CO, CO₂, NO_x, etc.) should be conducted to determine "reasonable" exposure limits; (iii) these exposure limits would not pose a mandatory requirement (i.e., they would have no legal force); and (iv) in the residential sector, any guidelines, etc., would only serve to provide advice and direction on how to reduce exposure levels.

²⁸ Within the United Kingdom, environmental hazards are addressed in term of "indoor pollution" and/or "indoor air quality".

²⁹ The specific reports include: *House of Commons Environment Committee Sixth Report: Indoor Pollution*, The House of Commons Environment Committee, Vol. 1-3, June, 1991; *The Government's Response to the Sixth Report from the House of Commons Select Committee on the Environment: Indoor Pollution*, Department of the Environment, September, 1991.

In response to the findings of the inquiry, government policy with respect to residential environmental hazards, as indicated in the Command Paper, is to be based on the following two principles: (i) provide advice on what are appropriate exposure levels (create awareness); and (ii) provide guidance on how to reduce exposures. In essence, then, the philosophy of the government of the United Kingdom is to adopt policies that are voluntary and non-regulatory in nature, as opposed to policy measures which carry a legal force.³⁰

5.2.1 Residential Environmental Hazard Issues

Within the United Kingdom, the residential hazard issues of concern to policy makers include the following:

- 1) *Condensation and Dampness*: which promotes the growth of a variety of bacteria, mould spores and mites which can generate health hazards to household residents (e.g., allergic illnesses). Condensation and dampness problems are generally addressed through the provision of adequate means of ventilation within dwellings which restricts both the accumulation of moisture, as well as other airborne pollutants originating within the building which could pose a hazard to the health of residents.
- 2) *Contaminated Sites*: which pose a danger to residential health and safety through infiltration into the indoor environment of gaseous contaminants such as radon, methane and carbon dioxide. There is practical guidance to address these issues in approved documents produced by the Department of the Environment, and further detailed guidance is provided in two Building Research Establishment guides in support of the requirement for protection against radon and landfill gas (these issues are discussed further below).
- 3) *Formaldehyde Gas*: concerns with respect to this pollutant stems from its use as a bonding agent (e.g., for pressed wood products, etc.), and from the use of urea formaldehyde foam for cavity wall insulation. As will be discussed below, protection against the health hazards posed by urea formaldehyde foam insulation is achieved by reference to British Standards governing the types of wall cavities that can be filled with this form of insulation, and the manner in which it is installed.
- 4) *Asbestos*: the main concern with this pollutant stems from its use as an insulating material; its use as a component in decorating materials (such as textured plasters); and because airborne asbestos particles originating from manufacturing plants can infiltrate nearby residential dwellings. Protection against the health hazards posed by asbestos is achieved by controlling the use of the product, through mandatory

³⁰ Although there are exceptions, the government maintains a predilection for policies which do not stipulate a legal/regulatory response; this may go a long way toward explaining the lack of protective policies in the United Kingdom, as presented in Section 5.2.3 below (if there are no legal requirements, this serves to reduce exposure to environmental liability as there are no regulations to violate).

requirements prohibiting the spraying of asbestos, and voluntary measures designed to induce manufacturers to use substitute materials where appropriate.

- 5) *Lead*: the environmental hazard posed by lead stems largely from its use in paints. While most modern paints manufactured in the United Kingdom in the last 30 years contain little or no lead, old gloss paint found mainly on metal work and in pre-war buildings contain significant quantities of lead as a pigment. Measures taken to control the hazards posed by lead in paints involves recommendation as to the precautions to be taken against exposure to dusts and fumes when stripping old, crumbling or flaking paint. In addition, the government recommends that old paintwork in good condition should be painted over with modern low/no-lead paints.
- 6) *Solvent Vapours*: are associated with many household and DIY (do-it-yourself) products. Government action with respect to the hazards posed by solvents has involved the publication of guidelines for the proper use of these products.³¹

Each of these pollutants can present a health risk to residential occupants and, therefore, represent an issue which warrants policy attention. While measures have been taken with respect to each of these hazards, the priority pollutants of current concern to policy makers include carbon monoxide (from combustion appliances), tobacco smoke, and radon.³²

5.2.2 Regulatory Responsibilities and Public Policy Measures

A number of public policy measures have been implemented to address the residential environmental hazard issues discussed above. In this section we provide a brief description of the departments/agencies with the legislative authority to develop and implement policy with respect to these issues, as well as a description of the types of public policy measures adopted to address residential environmental hazard issues in the United Kingdom.

Regulatory Responsibilities

Within the United Kingdom, the development of public policy measures to address residential environmental hazard issues is the purview of the following organizations:

³¹ A further residential hazard issue of concern in the United Kingdom relates to the adequate discharge of *combustion products*, from heat producing appliances, to the outside air. This issue is addressed in the United Kingdom through the provision of adequate combustion air and flue arrangements. While a relevant and important residential environmental hazard issue, it falls outside the terms of reference for this study and will not be further addressed. An additional area of concern in terms of indoor pollution generally is environmental tobacco smoke. Since indoor pollution stemming from personal behaviour is excluded from the terms of reference for this study, this issue will also not be discussed further.

³² Department of the Environment (1992a), pg. 4.

- 1) *The Department of Environment*: exercises the lead policy role on issues concerning controls on the design and construction of new buildings (to control dampness, radon infiltration, etc.), and conditions in existing homes and other buildings which are not workplaces. Policy development with respect to these issues involve the following divisions within the Department: (i) the Toxic Substances Division; and (ii) the Building Regulations Division.
- 2) *The Building Research Establishment*: plays an important role in policy development as it acts as the principal research organization for the Department of Environment.
- 3) *The Department of Health*: has an overriding responsibility to promote and protect public health and provides advice to all departments on the health implications of policies. With respect to residential environmental hazards, the Department of Health's role is to provide risk assessments when required.
- 4) *The British Standards Institution*: promotes standards for a wide range of construction products, materials, fittings and equipment such as ventilation systems. They also produce various good design codes, codes of practice and quality assurance schemes.

In addition to these departments/agencies, other organizations may, from time-to-time, have an input in the policy development process (e.g., the National Radiological Protection Board).

Public Policy Measures

While the Departments of Environment and Health, as well as the Building Research Establishment and a variety of other agencies, each have a role to play in policy development, as indicated in Section 5.2.1, their activities are generally guided by a philosophy in which the responsibility for managing the risk of indoor air pollution in the residential sector is shared between the government and the public. Specifically:

"... the Government takes responsibility for ensuring that all dwellings are built with adequate ventilation, will take action to ban particularly hazardous materials over which the public has little control, eg blue asbestos and certain wood preservatives and will give advice on issues posing lesser risks, eg lead in old paint. The public also have their part to play, eg by maintaining adequate ventilation or use of approved products in accordance with manufacturer's instructions. There is a limit to the controls which it would be appropriate to be exercised by Government in such cases."³³

Given this philosophy, much of the policy activity in the United Kingdom with respect to indoor air quality has generally been concerned with the provision of information and advice, as opposed to the implementation of regulatory measures. As will be noted below, policy measures taken with respect to the hazards posed by radon, urea formaldehyde foam insulation and

³³ Environment Committee (1991) Minutes of Evidence, Vol. 2, pg. 4.

asbestos represent, to a degree, an exception to this philosophy (however, even with respect to these pollutants, there is significant latitude for individual decision-making on the part of homeowners with respect to testing and the implementation of remediation measures). With this description of the philosophy guiding policy development in the United Kingdom as a back-drop, the policy measures that have been adopted to address residential environmental hazard issues are discussed below.

Guidelines

The present state of residential environmental hazard issue investigation/policy development, particularly within the Toxic Substances Division of the Department of the Environment, is one of focusing on the development of pollutant exposure guidelines for the residential sector (the development of such exposure limits for an extended list of pollutants was recommended in the Environment Committee's 6th Report). Essentially, the Division is involved in the risk assessment and monitoring stage of policy development.

In terms of its assessment activities, the Division's primary objective at present is to determine whether it would be *feasible* to develop guidelines for residential exposure limits. The determination of feasibility revolves around defining scientifically accurate, defensible and robust assessment procedures for estimating exposure values for indoor air pollutants within residential environments. The position of the Toxic Substances Division is that, before the government can contemplate the development of effective indoor air quality guidelines, one needs to accurately specify how the exposure values are arrived at, the different circumstances and characteristics taken into account in their calculation, and the implications of any resulting guidelines for various groups in society (such as builders, lenders, homeowners, etc.). Research with respect to the development of such guidelines is very much in its infancy; however, according to the Department of Environment's White Paper, *This Common Inheritance -- The Second Year Report* (which details the Department's commitments on indoor air quality issues and actions taken to-date), the Department of the Environment hopes to establish the feasibility of developing these guidelines by the end of 1993. The essential problem lies in the definition of robust, accurate and defensible measurement procedures that can account for the complex influences present in the residential sector.

In terms of its monitoring activities, the Toxic Substances Division has conducted a number of surveys with respect to pollutant levels in British homes. Partly as a result of the findings from these surveys/data gathering activities, the Department has published a variety of booklets which provide *advice* to British homeowners on how to reduce exposure/concentrations for certain pollutants.³⁴

³⁴ Some of the more pollutant specific guides include: *Radon in Houses* and the *Householder's Guide to Radon*; *Asbestos in Housing* and *Asbestos Materials in Buildings*; *Insulating Your Home*; *Lead in Paint*; *Keep Your Home Free of Damp and Mould*; and *Urea-formaldehyde-foam cavity wall insulation: reducing formaldehyde vapour in dwellings*. Each of these guides explains the nature of the pollutant, its sources and steps that householders can take to reduce exposures.

Building Codes and Control Measures

New buildings in the United Kingdom are subject to building code restrictions (under the *Building Acts of 1984* and the *1990 Amendments*) in order to protect health and safety and to conserve energy. In addition to building code requirements governing new homes, under the *Local Government and Housing Act (1989)*, local authorities have a statutory duty to take action on any existing dwelling which is deemed to be unfit with respect to the fitness standards stipulated in the building code, and can require compulsory renovation, closure or demolition. It should be noted that, while the issues addressed by building codes are clearly within the realm of residential environmental hazards, the majority of the building regulations that are currently in force were not designed to deal with indoor pollution as a specific subject; rather, most of the building regulations that relate to environmental hazard issues in the residential sector have been designed to address dampness and energy conservation issues. The building code requirements which can, however, be viewed as measures designed more specifically to combat residential environmental hazards relate to the following pollutants: (i) urea-formaldehyde foam insulation (UFFI); and (ii) radon.

Urea-Formaldehyde Foam Insulation

Urea-formaldehyde foam insulation (UFFI) is not banned in the United Kingdom; rather, it is subject to installation controls specified under the *Building Regulation (1985)* and the *British Standard Code of Practice for Thermal Insulation of Cavity Walls*. The code specifies that UFFI can only be installed in double leaf walls and cannot be installed in timber frame walls. In addition, the code also specifies the foaming mix formula required for different installations. The provisions of the building regulations and the standard code of practice, with respect to UFFI, are mandatory.

Radon

The National Radiological Protection Board, which has the statutory responsibility of advising government on the protection of communities from radon hazards, formally advised in January, 1987, that radon concentrations in homes should be limited. Since that time, public policy initiatives have been developed to address radon hazards; however, the measures adopted differ by new and existing homes.

With respect to existing homes, the government has defined a voluntary survey scheme based on an advisory "Action Level" for radon exposures of 200 becquerels per cubic metre. In certain high level radon areas, or "affected areas" (such as Cornwall, Devon and to a lesser degree, Somerset, Northamptonshire and Derbyshire), the government will perform free radon measurement surveys at the request of homeowners (in other areas the homeowners must not only request the service but pay for it as well). If the ambient level of radon is found to exceed the Action Level, the government will advise the homeowner of the results and advise the

homeowner as to what measures can be taken to reduce exposures: mitigation activities are not mandatory and are undertaken at the discretion of the homeowner.³⁵

For new homes (especially in higher risk parts of the country), the *Building Regulations* require builders to take all precautions that are reasonably practicable to avoid danger to health caused by substances found on or in the ground to be covered by a new structure (this includes radon, methane and other landfill gases). The principal precautionary measures include either the installation of appropriate ventilation, and/or the installation of a membrane enveloping the foundation of the structure (the installation of soil gas retarder or sub-slab membranes in an "affected area" is mandatory).³⁶

Standards for Construction Products

The Department of the Environment is currently working toward the establishment of emission standards for construction products. In addition, under the *Construction Products Directive*, activity is being directed toward the establishment of harmonized European standards for construction products. In developing these standards a number of requirements must be met. One group of essential requirements relates to hygiene, health and the environment and, in turn, to specific dangers which must be avoided if a product is to gain approval as a construction material. These dangers include: the giving-off of toxic gas; the presence of dangerous particles or gases in the air; and the emission of radiation. Standards for construction and decorating products relating to a small number of pollutants are currently maintained. For example, while asbestos as a sprayed-on insulating material is prohibited, both mandatory and voluntary standards relating to the reduction of this material in other construction and decorating products are in place.

As part of its collaborative efforts under the *Construction Products Directive*, the government anticipates that it will begin work on standard setting for a priority list of products near the end of 1993. However, as with indoor exposure guidelines, an essential first step in developing these emission standards is the establishment of a standard test method for measuring chemical emanations. The Building Research Establishment is playing a leading role in the European collaborative program with respect to the development of both the measurement protocols and the resulting standards.

³⁵ Evidence presented to the Environment Committee suggests that few householders in fact take action to radon-proof their homes (the costs can vary from £500 to £5,000 per residence). Furthermore, due to the fact that radon test results are protected by confidentiality laws, there appears to be nothing to prevent homeowners from selling a house with a high radon level without notifying the incoming purchaser.

³⁶ There is compulsory restriction of radon levels in all non-residential buildings under health and safety regulations and exposure to radon in places of work is restricted by the *Ionising Radiation Regulations 1985*.

Educational Programs: Eco-Labeling

The Department of the Environment, in conjunction with the Building Research Establishment, is working on an eco-labelling scheme (similar to the Canadian Environmental Choice labelling program) for building products, household products and appliances. The labelling criteria takes into account indoor pollution emission characteristics. Similarly, the Department of the Environment and the Building Research Establishment have developed a number of publications listing the health effects of certain products and indoor pollutants, as well as guidance on how to reduce indoor exposures.

5.2.3 Protective Policies

For the most part, the Government of the United Kingdom, domestic lending institutions, etc., have not developed explicit policies to protect against environmental liability.³⁷ However, the Building Research Establishment has developed the "Building Research Establishment Environmental Assessment Method (BREEAM)". This method is primarily designed for commercial, institutional and multi-dwelling buildings; however, a residential version of BREEAM does exist. The BREEAM is a voluntary, self-financing assessment tool that assigns points to new/existing buildings on the basis of their "environmental friendliness". The Building Research Establishment conducts the survey and assesses scores against a variety of environmental criteria and operating practices. A certificate is then awarded which specifies the environmental rating attained by the building.

About 25% of new office buildings have been surveyed (largely as a public relations move, however, since points are given for energy efficiency, real cost savings can be gained). Within the residential sector, take-up has been almost non-existent and there is very little incentive to do so. While the BREEAM was not intended as a protective device, and it is not currently used as such, it could be used as a screening tool if liability for residential environmental hazards becomes an issue in the United Kingdom.

The lack of protective policies in the United Kingdom reflects the development of indoor pollution issues in this jurisdiction. As opposed to North America, where there are many more modern "sealed" buildings constructed and furnished with synthetic materials, and more stringent and wide ranging environmental liability regulations (e.g., the United States *Comprehensive Environmental Response, Compensation and Liability Act (1980)*), the problems posed by indoor air pollution in both the non-residential and residential environments in the United Kingdom are a more recent, and less acute, phenomenon. For instance, as noted earlier, because of the need to save energy in the 1970s the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) slashed ventilation rates by a factor of three. The buildings constructed

³⁷ However, certain lending institutions have adopted informal site assessment procedures for instances where the conditions of the loan warrant it (i.e., the land being mortgaged or taken as security is known to be in a high risk area).

to these standards have caused many indoor air pollution problems and ASHRAE has twice since then revised its ventilation standards (which are now similar to the pre-1973 levels).

According to the Chartered Institution of Building Services Engineers (CIBSE) and the Health and Safety Executive (HSE), the United Kingdom was able to avoid the early and rapid development of indoor pollution problems since ventilation standards were never reduced and, in fact, have been increased for certain situations (such as smoking areas).³⁸ The early development and recognition of environmental hazard issues in the United States, the presence of defined liability laws, the more litigious nature of the United States, and the instances of successful litigation of environmental hazard cases, has necessitated the development of protective policies in that country. While it is recognized that litigation with respect to environmental hazards may occur in the United Kingdom as awareness of the associated health effects grows, it is considered unlikely that such litigious activity will occur in the United Kingdom, and especially with respect to the residential sector.³⁹ As a consequence, the development of protective policies has been, and remains, a remote priority. Furthermore, the HSE has indicated that since there are no standards or guidelines, with respect to residential environmental hazards, to which reference can be made in the courts, there is often little ground on which to develop a liability case. Consequently, given the difficulties in defining and litigating liability cases with respect to residential environmental hazards, there is little incentive to focus on the development of protective policies.

5.2.4 Summary

The Department of Environment maintains the primary legislative responsibility for residential environmental hazards and is assisted in discharging its responsibilities by the Building Research Establishment (which performs much of the research required by the Department of the Environment), the Department of Health (which has input when health risk assessment is required), and a number of other agencies.

Given the philosophy of the government, and particularly that of the Department of Environment, policy with respect to indoor air pollution is largely concerned with the provision of information and advice to homeowners on the measures available to reduce residential environmental hazards, as opposed to the implementation of mandatory regulations. In this light, the Department of the Environment is currently looking at the nature of the problem of indoor air pollution in the residential sector and at the feasibility of establishing guidelines for residential exposure. However, research in this area is in its infancy and development is slow.

With respect to protective policy measures, their development has not been seen as a priority in the United Kingdom; hence, no formal policies exist at present.

³⁸ Environment Committee (1991) pg. xxiv.

³⁹ Personal Communication with Dr. J.W. Llewellyn, Building Research Establishment, United Kingdom, April 22, 1993.

5.3 Residential Environmental Hazard Policy in the United States

Of the jurisdictions reviewed as part of this study, the United States has the longest history with respect to environmental hazard issues, both from a public policy and a protective policy perspective. Since the 1970s, environmental hazard issues in the non-residential sector have been a focus of local, state and federal policy activity. In this section of the report, however, only policy activities at the federal level are considered (an example of the policies adopted at the state level will be presented in Section 5.4, where the environmental hazard policies adopted in the State of California are reviewed).

At the federal level, activities with respect to indoor pollution are coordinated through the Interagency Committee on Indoor Air Quality (CIAQ). A total of 16 federal agencies participate in the CIAQ, and the majority of the activity of the Committee is focused on environmental hazard issues within the non-residential sector. While the CIAQ coordinates activity with respect to environmental hazards, none of the federal departments/agencies which participate on the Committee has direct or explicit legislative authority over indoor pollution issues.⁴⁰ However, as a result of pressure from Congress, the Environmental Protection Agency (EPA) has increasingly taken a leadership role in this area, despite the fact that the EPA has little legislative authority with respect to indoor pollution.⁴¹ With the exception of the hazards posed by radon and, to a lesser extent, formaldehyde and asbestos, the lack of a defined structure of legislative authority has led the CIAQ and its participating agencies to adopt an approach with respect to indoor pollution issues which has consisted primarily of research with respect to the development of guidelines, standards and mitigation measures; the development and implementation of educational programs; and the development of a variety of other non-regulatory measures. These activities have been undertaken by a small number of federal agencies.

While legislative authority with respect to non-residential environmental hazards is not well defined at the federal level, it is practically non-existent with respect to environmental hazards in the residential sector. Again, with the exception of the hazards posed by radon, formaldehyde, asbestos and lead-based paints, legislative activity with respect to the residential sector has consisted primarily of research and educational activities. The lack of policy activity with respect to this sector partially stems from the fact that no agency has claimed, nor has been specifically assigned, responsibility for indoor pollution in the residential sector (although, on a defacto basis, this responsibility seems to be shared by the EPA and the Department of Housing and Urban Development), and partially as a result of a hesitancy, on the part of the last two federal administrations, to intervene in this sector due to concerns over personal rights and freedoms, private property issues, etc.

⁴⁰ One exception involves the Occupational Safety and Health Administration (OSHA) which has authority over workplace air quality.

⁴¹ The EPA's legislative authority is largely confined to outdoor air pollution and hazardous waste sites.

5.3.1 Residential Environmental Hazard Issues

Within the United States, the environmental hazards of concern in the residential sector are essentially a subset of those that have emerged in the non-residential sector. The hazards that are of particular concern include the following:

- 1) *Contaminated Sites*: pose a danger to residential health and safety through the infiltration of gaseous contaminants such as radon, methane, carbon dioxide and other land-fill gases. Concern with respect to contaminated sites has developed partially as a consequence of that fact that as American cities have grown and expanded, a number of residential districts have been constructed on old landfill sites, industrial waste dumps, industrial lands, etc. The environmental hazard issues associated with land-fill gases, or other hazardous materials (such as radon) that can emanate from these sites, are largely addressed through both voluntary measures (guidelines and information leaflets) and building code restriction stipulating ventilation requirements and the installation of soil gas retarder and sub-slab protective membranes.
- 2) *Formaldehyde*: represents an environmental hazard in the residential sector as a consequence of its use in bonding agents for particle boards, plywood, etc., and from its use in insulation (e.g., urea formaldehyde foam insulation). Environmental hazard concerns with respect to this pollutant have been addressed through prohibitions on the use of urea formaldehyde foam insulation, emission standards with respect to the use of formaldehyde in other products, and guidelines and information leaflets which describe the means available to homeowners to reduce formaldehyde concentrations.
- 3) *Asbestos*: hazards associated with asbestos stem largely from its use as an insulating material, and as an input in the formulation of other construction/decorating materials. Protection against the health hazards posed by asbestos is achieved by controlling the use of the product through mandatory requirements prohibiting the use of asbestos, and through statutory measures designed to induce manufacturers to use substitute materials.
- 4) *Lead and Lead-Based Paints*: the risks associated with lead have largely been addressed through the provision of guidelines and information leaflets describing the procedures available to reduce exposures stemming from chipping paint and paint removal.⁴²

⁴² A further residential hazard issue of concern in the United States relates to the adequate discharge of *combustion products*, from heat producing appliances, to the outside air. This issue is addressed in the United States through building code provisions with respect to adequate combustion air and flue arrangements. The issues surrounding appliances, heating systems, etc., fall outside the terms of reference for this study and will not be further addressed. An additional area of concern in terms of indoor pollution generally involves environmental tobacco smoke. Since indoor pollution stemming from personal behaviour is excluded from the terms of reference for this study, this issue will also not be further discussed.

In addition to the hazards enumerated above, a variety of pesticides, wood preservatives and airborne pollutants (CO, NO_x, VOCs, etc.) are also of concern in the residential sector.⁴³ Policy activity with respect to these additional pollutants has generally revolved around the development of defensible exposure guidelines which can be used as a basis for the development of future regulatory and/or non-regulatory policy measures.

5.3.2 Regulatory Responsibilities and Public Policy Measures

As indicated earlier, the development of public policy measures to address environmental hazard issues within the United States is not the purview of any one single department, agency, nor level of government. Similarly, no government program, department or coordinating body has been assigned the legislative authority necessary to address environmental hazards in the residential sector. While a variety of local, state and federal departments/agencies play a role in the definition of environmental hazard policy, the following only provides a description of both the responsibilities of the federal agencies that are most closely associated with the residential sector, and the policy measures that these agencies have implemented to reduce the health risks associated with residential environmental hazards.⁴⁴

The Environmental Protection Agency (EPA)

The EPA's regulatory authority, as defined under the *Clean Air Act*, is largely limited to outdoor air issues; however, it does have the authority to conduct research and gather data relating to indoor pollution. In addition, under certain statutes and, in particular, the *Toxic Substances Control Act*, the EPA is authorized to identify and control the manufacture, processing, commercial distribution, use and disposal of chemical substances that have the potential to pose an unreasonable risk to human health or the environment.⁴⁵ In addition, the EPA has also been granted the authority, under a variety of other statutes, to develop regulations in the following areas: (i) waste management and disposal practices, including the prevention and/or reduction of toxic gas migration into buildings from landfills, etc.; (ii) drinking water, including concentrations of VOCs and radon which may be emitted from water into the indoor

⁴³ Over 300 airborne pollutant standards have been promulgated with respect to the non-residential environment. While only a subset of these pollutants are relevant to the residential sector, it is not clear at this time which pollutants will be deemed as "priority pollutants" in the residential sector.

⁴⁴ A number of federal government departments and agencies maintain policies with respect to indoor pollution; however, as a consequence of the fact that their legislative authorities focus on the non-residential sector, the following departments and agencies will not be addressed in this section: (i) the Occupational Safety and Health Administration (OSHA), which maintains a variety of air quality standards with respect to the non-residential environment; (ii) the Department of Health and Human Services (DHHS), which develops recommended exposure limits for workplace environments; (iii) the National Institute for Occupational Safety and Health (NIOSH), which conducts research on occupational health and safety hazards and recommends workplace standards; (iv) the Food and Drug Administration; (v) the National Institutes of Health; and (vi) the Department of Transportation.

⁴⁵ State of California Air Resources Board (1989), pg. 19.

environment as a consequence of domestic or commercial water use; and (iii) indoor concentrations of radon in buildings affected by uranium mill tailings. In addition, under the *Superfund Amendments and Reauthorization Act (1986)*, the EPA has been assigned the responsibility to assess radon problems nationwide and to develop appropriate and effective radon mitigation techniques.⁴⁶

While the majority of its activity has been directed toward the non-residential environment, under its current authority the EPA has taken a variety of steps with respect to indoor air pollution which have indirectly, or directly, affected environmental hazard issues within the residential sector. Some of these measures include:

- prohibition of the use of asbestos in specified building materials;
- identification of a guideline mitigation level for indoor radon exposures of four picocuries per litre;
- the prohibition of most applications of the structural wood preservatives pentachlorophenol and creosote;
- the restriction of certain products containing formaldehyde (such as urea formaldehyde foam insulation) and the imposition of emission standards for other formaldehyde containing products (e.g., plywood, particleboard, etc.);
- restrictions and prohibitions on the use of chlorinated solvents;
- restrictions and prohibitions on the manufacture and use of lead-based paints; and
- restrictions and prohibitions on the use of a variety of insecticides, fungicides and rodenticides.

In addition to these measures, the EPA has conducted significant non-regulatory activities relating to indoor pollution including public education programs, the development of pollutant specific fact sheets and information documents, and several guides on limiting radon, formaldehyde and asbestos exposures.

Consumer Product Safety Commission (CPSC)

The CPSC is an independent, federal regulatory agency with broad jurisdiction over consumer products (which are defined as any article which is produced or distributed for sale to, or used by, consumers in or around the home, schools, recreational areas or other non-occupational

⁴⁶ Under the *Indoor Radon Abatement Bill*, the EPA was also given additional authority to develop mitigation measures, as well as the resources necessary to provide grants to individual states to finance assessment and mitigation measures.

environments).⁴⁷ The CPSC's responsibility is to identify, reduce and eliminate unreasonable risks to human health associated with these products. In regulating these products, the CPSC must consider not only the health and safety risks associated with a particular products, but also the public's need for the product and the economic implications of regulating the product.

In terms of the policy measures implemented by the CPSC, it does maintain a preference for voluntary product standards rather than product bans and mandatory standards.⁴⁸ For instance, the CPSC has implemented a number of non-regulatory measures which emphasize applied research and public information dissemination. In addition, the CPSC is in the process of assessing the health risks associated with methylene chloride (found in a number of consumer products); airborne biological contaminants; and exposure to lead during paint removal. However, despite its non-regulatory preference, the CPSC's activities with respect to indoor pollutants have included product bans or labelling requirements with respect to asbestos, vinyl chloride, and combustion pollutants.

The Department of Energy (DOE)

The DOE has the responsibility for promoting energy conservation, developing voluntary energy conservation standards for buildings, mandatory standards for appliances, and the conduct of research on the environmental hazards associated with energy-related pollutants. Although the DOE does not have any specific regulatory authority with respect to indoor pollutants, it has played a significant role in terms of conducting research on indoor pollution issues.

Over its history, the DOE has funded and administered several energy conservation programs which have had an affect on indoor pollution. For example, since the mid-1970s the DOE has implemented various weatherization and conservation programs for new and existing structures which have involved the installation of urea-formaldehyde insulation and/or a reduction in ventilation.⁴⁹ However, since 1977, DOE has also conducted research on the infiltration of pollutants, ventilation requirements, the health effects of indoor pollution, and the health effects associated with radon. With respect to indoor pollutants, the DOE has also conducted research into mitigation measures; it has provided guidelines and handbooks on residential building design, combustion sources and building system characteristics; it has provided information pamphlets with respect to reducing energy related pollutant exposures; and it conducts environmental impact assessments for its various programs.

⁴⁷ Certain products, such as tobacco, cosmetics, pesticides, food, drugs, etc., are exempted from CPSC authority.

⁴⁸ This preference is based on the fact that voluntary standards take less time to develop and implement, they are less likely to be challenged within the legal system, and public protection is afforded in a much shorter timeframe.

⁴⁹ Some of the programs involved include the *Residential Conservation Service*, the *Weatherization Assistance Program*, the *Institutional Conservation Program*, and the *Energy Extension Program*.

The Bonneville Power Administration (BPA)

Over its history, the BPA has aggressively pursued energy conservation opportunities, and it has funded indoor pollution research and public information programs as well. More specifically, while the BPA is concerned with energy conservation issues, it is also concerned with ensuring that their conservation programs do not lead to reductions in ventilation rates that can engender indoor pollution problems. Specific measures adopted by BPA with respect to indoor pollution issues include:

- For existing homes which are weatherized, BPA has subsidized (since 1984) proven radon mitigation measures in residences with radon levels in excess of five picocuries per litre.
- For new residential buildings, BPA has required (since 1986) low formaldehyde emitting building products; radon monitoring using monitors supplied free of charge; preparation for radon source control measures; whole-house, continuously operating mechanical ventilation; and the distribution of indoor pollution information.

The Department of Housing and Urban Development (HUD)

HUD has a similar mandate to that of CMHC: a decent home and suitable living area environment for every American family.⁵⁰ More specifically, the basic mission of HUD is to provide adequate housing, promote community and economic development in urban areas, and eliminate discrimination in housing markets. Given its responsibilities, HUD has several mandated responsibilities with respect to environmental hazards in the residential sector. These include: (i) promulgation and enforcement of the *Manufactured Housing Construction and Safety Standards* (single-family mobilehomes), which currently include formaldehyde emission standards and ventilation requirements; (ii) development of indoor radon policy measures (in association with the EPA); (iii) incorporation of future EPA radon guidelines, standards, information and mitigation measures into HUD housing programs; (iv) research on the assessment and mitigation of radon and other indoor pollution problems in new construction (again, in conjunction with the EPA); and (v) development of mitigation measures with respect to lead-based paints.

With respect to formaldehyde, under the *Community Development Act (1974)*, HUD has the authority to establish appropriate manufactured home construction and safety standards. In 1984, HUD established formaldehyde emission standards for the plywood and particleboard used in mobilehomes of 0.2 parts per million (ppm) to maintain indoor air concentrations of formaldehyde in manufactured homes below 4.0 ppm. HUD also required the provision of ventilation options, including a mechanical system, a passive system or a combination of the

⁵⁰ State of California Air Resources Board (1989), pg. 29.

two.⁵¹ In addition, HUD requires buyers of manufactured and mobile homes to be provided with a health hazard notification and written information on the capacity and installation of ventilation systems.

With respect to radon, since the 1970s, and with respect to certain regions in the United States, HUD has required radon testing and/or mitigation measures for HUD assisted housing, and the rejection of mortgage insurance applications if mitigation measures are not undertaken. In 1986, HUD received an explicit mandate through Title IV of the *Superfund Authorization and Renewal Act (SARA)* to conduct research and develop mitigation measures, with respect to radon, in conjunction with the EPA. Amendments to the *McKinney Homeless Assistance Act (1988)* further required HUD to develop and recommend policy with respect to radon in HUD programs; enter into a Memorandum of Understanding with the EPA with respect to radon research and the development of mitigation measures; and utilize any guidelines, standards, or mitigation measures developed in the future by EPA in carrying out HUD housing programs.⁵²

In addition to its responsibilities for radon, under the *Lead-Based Paint Poisoning Prevention Act (1971)*, and subsequent legislation, HUD is required to study, demonstrate, and establish procedures for eliminating hazards due to lead-based paint in its mortgage insurance and other housing assistance programs, as well as to conduct a demonstration program and develop health and safety guidelines for the removal of lead-based paints.

5.3.3 Protective Policies

In the United States the issue of environmental liability has about as long a history as the public health issues surrounding environmental hazards. The significance of the liability issue is represented, among other statutes, by the *Comprehensive Environmental Response, Compensation and Liability Act (1980)*, (also known as Superfund or CERCLA). While legislation such as Superfund is not specifically aimed at the residential sector, the liability of lenders generally,

⁵¹ A mechanical system relates to a fresh air inlet installed with the heating system; a passive system refers to operable doors and windows.

⁵² In terms of the development of policy with respect to radon, at present there exists a number of conflicts between the EPA and HUD, in terms of the direction to be taken with respect to radon. The focus of the conflict is over what is an appropriate exposure level and what are the appropriate measurement techniques. EPA is using the ambient air standard of 4 picocuries per litre (equivalent to about 7.4 becquerels per cubic metre), and the policy that is currently proposed by the EPA is to retrofit residential structures if radon levels are above this action level (at a cost of about \$US5,000 to \$US7,000 per house) through ventilation changes in new and existing structures, and the installation of soil gas retarder or sub-slab protective membranes in new structures. HUD argues that the action level is too low (Europe for instance uses a standard of 200 becquerels per cubic metre); that the measurement techniques used by the EPA are not appropriate in that they only provide short-term exposure readings which are often taken at inappropriate locations in the residential structure; and that more R&D is required (the EPA has, in fact, been criticized on the basis that its radon policy is unnecessarily stringent: see the U.K. Environment Committee Report [1991]). The EPA argues that HUD should stop insisting on further R&D and get on with the implementation of mitigation measures. Given the disagreements that exist, their resolution is, at present, the focus of much of HUD's activity with respect to radon.

and of particular importance to this study, mortgage insuring federal housing agencies (such as HUD, the Federal National Mortgage Association and the Federal Home Loan Mortgage Corporation), has recently emerged as a major legal issue.⁵³ For example, recent court decisions have required the federal government, as a landlord, to correct or eliminate problems of habitability relating to environmental hazards. In addition, HUD has been brought to court to defend itself against charges that it permitted exposure to asbestos in HUD-owned public housing projects. Litigation of a similar manner relating to radon, formaldehyde and other indoor pollutants may also emerge in the future.

In response to concerns over environmental liability issues, two private sector financial institutions -- the Federal National Mortgage Association (Fannie Mae) and the Federal Home Loan Mortgage Corporation (Freddie Mac) -- have adopted procedures for managing the environmental liability risk presented by residential environmental hazards. Specifically, these organizations require that lenders conduct an environmental assessment of a site (utilizing a two phase procedure, to be discussed below) as a condition for guaranteeing a loan or mortgage. HUD is in the process of adopting a similar procedure and will utilize the two phase environmental assessment methodology currently being developed by the American Society for Testing and Materials (ASTM).⁵⁴

The assessment process utilized by Fannie Mae and Freddie Mac is quite similar to that being developed by ASTM. Hence, for efficiency, only the ASTM procedure will be described here. In essence, the two phase ASTM process can be summarized as follows:

⁵³ The Superfund legislation contains an exemption from liability for secured creditors; hence, in most cases, lenders and mortgage guarantors have not been held liable as responsible persons in liability cases. The issue of lender liability is, however, a very contentious one. For instance the court's interpretation of the meaning of the security interest exemption, in a recent decision of *U.S. v. Fleet Factors Corp.* (1990) (901 F.2d 1550) (*Fleet Factors*), has led to considerable concern in the business and lending communities. In *Fleet Factors*, the Eleventh Circuit Court of Appeal held that "occasional and discrete financial decisions relating to the protection of its security" would be permissible and would preserve the secured creditor's exemption. However, "... a secured creditor will be held liable if its involvement with the management of a facility is sufficiently broad to support the inference that it could affect hazardous waste disposal decisions if it so chose" (*Federal Register*, April 29, 1992 [57FR18344]). As a consequence of the *Fleet Factors* decision, the EPA published an administrative rule to clarify the meaning of the security interest exemption and the range of activities that may be undertaken by a private or public lending institution, or another entity holding a security interest, without voiding the exemption. Despite the EPA's rule, however, a number of lending institutions have, as a matter of prudence, adopted procedures which would allow them to demonstrate due diligence.

⁵⁴ HUD was in the process of developing its own environmental assessment procedure. However, before completing its development work, HUD learned that ASTM was developing a similar assessment methodology. Methods and procedures developed by ASTM are generally considered as the industry standard; hence, HUD discontinued its own development work and has elected to adopt the ASTM environmental assessment process (which is due for release in June, 1993).

- The Phase 1 assessment, or the "Transaction Screen" involves up to about a two week investigation of the records (e.g., land titles, etc.) relating to a particular site. The objective of the Phase 1 assessment is to determine, on the basis of what has happened on the site in the past, whether the *possibility* exists that a hazard is present on the site. If such a possibility cannot be ruled out, then a Phase 2 assessment is conducted.
- The Phase 2 assessment involves a physical assessment of the site by licensed engineers and/or environmental consultants possessing the necessary expertise.

The purpose of the two-phase site assessment is to provide a lender or mortgage guarantor with an understanding of the potential environmental liability associated with the site being considered for a mortgage, or being taken as security for a loan, *prior* to taking any claim to the site. Aside from providing protection against liability for known environmental hazards before taking claim to a site, if for some reason an environmental hazard is discovered on the site at a latter date, then the assessment process developed by ASTM, as well as those currently being used by Fannie Mae and Freddie Mac, still provides protection in that it can be used as a basis for the "innocent purchasers" defense under Superfund.

5.3.4 Summary

While the issues surrounding environmental hazards have been recognized and addressed, to a degree, for some time in the United States, recognition of the issues surrounding environmental hazards in the residential sector, and the development and implementation of policies which address these issues, are comparatively recent events. As indicated above, no specific government agency has the mandate to address residential environmental hazard issues. Rather, a variety of departments maintain some regulatory authority, with respect to certain issues, and these departments have implemented a number of individual policies to address residential environmental hazards. The majority of these policies have been introduced in a rather piecemeal fashion. In addition, of the policies that have been implemented, most have stopped short of governing the behaviour of the homeowner or occupant. A more concerted policy effort with respect to residential environmental hazards, on the part of all levels of government, will require a clear delineation of regulatory responsibilities; a better understanding of the relationship between human health risks and environmental hazards; and an understanding of the affect that building design characteristics and the behavioural patterns of occupants will have on that relationship.

In order to understand these relationships, and provide a basis for policy development, governments must establish some objective measure of the nature of the problem: i.e., risk assessments are required. Thus, despite the measures indicated above, much of the United States federal government's activity, with respect to residential environmental hazard issues, is currently focused on the definition of indoor air exposure limits as a prerequisite to the definition of guidelines. As is the case in most other jurisdictions reviewed in this study, the development of these guidelines is seen as a first step in the development of defensible, and more wide-ranging, policies. However, there is significant controversy with respect to the development of

these guidelines (e.g., the conflicts between HUD and the EPA over radon). The problem is a technical one in that it is difficult to scientifically define accurate, robust, non-controversial exposure limits that can then be used to support federal regulatory activity. The need for such limits cuts both ways in that if you can not arrive at an objective, non-controversial measure for exposure, it is difficult to define enforceable policy, and it is extremely difficult to define liability for environmental damage.

With respect to protective policies, many of the public and private lending institutions now require environmental assessments as a condition for loan approval. The processes used by Freddie Mac and Fannie Mae, and the process being developed by ASTM (and which will be used by HUD), provide for adequate protection in the event of an environmental liability suit, both by providing protection before a claim to a site is made, and by providing the means for a defence after the fact. However, despite the current use of site assessments, organizations such as HUD, Fannie Mae, Freddie Mac, etc., are still open to legal action with respect to properties acquired/insured before the implementation of site assessments. Protection against liability in these instances will depend on the case by case evolution of liability law with respect to who could be held liable for an environmental hazard, over and above the current owner of a property (e.g., builders, developers, previous owners, etc.).

5.4 Residential Environmental Hazard Policy in the State of California

As appears to be the case at the level of the United States federal government, the results of our analysis suggests that the state of policy activity relating to residential environmental hazards in California is also very much in its infancy. Until quite recently, the policy focus with respect to environmental hazard issues was almost entirely directed toward the industrial, commercial and occupational environments (a pattern which is consistent with our findings in the other jurisdictions reviewed in this study). However, over the past few years, this focus has begun to broaden to address environmental issues relevant to the residential environment. For example, research studies have been undertaken to investigate the degree to which radon infiltrates Californian homes, as well as the health effects of formaldehyde concentrations in residential environments.

Overall, the reasons for the lack of information and activity pertaining specifically to the residential environment are two-fold. First, research undertaken to-date has yet to identify adequate systems to measure "acceptable levels" of specific pollutants found inside individual homes. Secondly, without the development of appropriate standards based upon these measurements, the development, implementation, monitoring and enforcement of control standards becomes a practical impossibility. Another complication in controlling residential indoor air quality lies in the behavioural habits of homeowners and occupants. Again, it is much more difficult to monitor and control the exposure of hazardous pollutants within the residential environment when factors such as tobacco smoke, household cleaning product emissions, etc., are added to the equation.

Despite these hindrances to policy development and implementation, some measures have been adopted, and are currently in force, in the non-residential environment that are equally applicable

to the hazards which exist in the home environment. For example, specific guidelines have been developed that regulate the use of insulations, aerosol sprays, solvents and pesticides. The control strategies behind these guidelines are aimed at the permanent removal, substitution, or modification of toxic substances. For example, in 1982, the California Energy Commission banned the sale and installation of urea formaldehyde foam insulation (UFFI). In addition, in 1986, the Occupational Safety and Health Standards Board approved the *Minimum Building Ventilation Standard* which requires the proper operation and maintenance of ventilation systems. It should be noted that ventilation systems are the most frequently employed control technique since they have been proven to be most successful in lowering the indoor concentrations of a variety of toxins. However, while measures such as those prescribed in the *Minimum Building Ventilation Standard* provide useful mitigation tools, in most cases, compliance stipulations are not adequately addressed.

5.4.1 Residential Environmental Hazard Issues

The environmental hazard issues that are of concern in the State of California reflect those faced by the United States as a whole and include:

- 1) *Formaldehyde*: from urea formaldehyde, which can be found in foam insulations, particle boards, plywood and some glues, is currently being restricted through specific industry standards within the State of California.
- 2) *Contaminated Sites*: pose a danger to residential health and safety through the infiltration of gaseous contaminants such as radon, methane and carbon dioxide. These environmental hazards are largely addressed through both voluntary measures (guidelines and information leaflets) and building code restrictions stipulating ventilation requirements and the installation of protective membranes.
- 3) *Asbestos*: hazards associated with asbestos stem largely from its use as an insulating material and as an input in the formation of a variety of construction/decorating materials. Protection against the health hazards posed by asbestos is achieved by controlling the use of the product through mandatory requirements prohibiting the use of asbestos, and through statutory measures designed to induce manufacturers to use substitute materials.
- 4) *Lead and Lead-Based Paints*: concerns with respect to this pollutant have largely been addressed through the provision of guidelines and information leaflets describing the procedures available to reduce exposures stemming from old, chipped paint and from paint dust generated during renovations and paint stripping.

5.4.2 Regulatory Responsibilities and Public Policy Measures

California has not yet developed an extensive plan to address indoor air quality issues. Reflecting the situation at the federal level, no one state agency has been granted the necessary legislative authority to address indoor air quality issues. Nevertheless, several organizations and

agencies have, in the past several years, focused their efforts in this direction with the primary aim of developing specific policies and guidelines to limit public exposure to environmental hazards. Exhibits 5.1 through 5.3 below outline the specific responsibilities of individual California State organizations with respect to indoor air quality. The following is a brief summary of the activities of these state organizations and agencies who directly effect the development of such policies.

The Department of Health Services/California Indoor Air Quality Interagency Working Group

Since 1982, the mandate of the Department of Health Services (DHS) has been to "coordinate efforts to assess, protect, and enhance indoor environmental quality" and to "conduct and promote the coordination of research, investigations, experiments, demonstrations, surveys, and studies relating to the causes, effects, extent, prevention, and control of indoor pollution."⁵⁵ Under this mandate, DHS's purview includes residential dwellings, schools, offices and public buildings but excludes industrial working buildings. However, explicit regulatory authority over indoor air quality was excluded from this mandate.

Overall, the efforts of DHS have been aimed at both research and education. In fact, their mandate specifically requires them to "conduct a toxic research and information program," and further, "to be devoted to the development of standard methods for measuring indoor air quality, the determination of the source of contaminants, and the making of recommendations for laws or regulations, where appropriate."⁵⁶

This being the case, DHS has conducted a number of research studies over time which have measured the effects of specific toxins found within the indoor environment. For example, formaldehyde and NO₂ concentrations were measured in California mobile homes, as were radon concentrations in California residences, and asbestos concentrations in public buildings.

In addition, DHS chairs the California Indoor Air Quality Interagency Working Group (IWG) which consists of representatives from federal, state, local agencies and private organizations. The group meets several times each year to discuss indoor air quality issues. Despite the fact that they do not possess any legislative authority, the group provides a forum where concerns and possible solutions are examined.

⁵⁵ State of California Air Resources Board (1989), pg. 36.

⁵⁶ State of California Air Resources Board (1989), pg. 36.

Exhibit 5.1: State and Local* Agency IAQ Authority — Indoor Pollutant Sources

Source/ Authority	Cigarettes	Building Material and Furnishings	Combustion Appliances	Pesticides	Cosmetics, Drugs Med. Devices	Other Consumer Products	Water and Soil
Research and Assessment	DES (1) ARB (2)	DES (1) DCA (2) CEC (2) HCD (2)	DES (2) CEC (2) DCA (2) HCD (1)	DES (1) CDFA (2) SPCB (2)	DES (2) DCA/BOC (2)	DES (2) DCA (2)	DES (2) CEC (2) HCD (2)
Public Education	DES (1)	DES (2) DCA/BHFTI (2) CEC (2) HCD (2) LOCAL (2)	CEC (2) DCA (2) HCD (2) DES (1)	CDFA (1) SPCB (2)	DCA/BOC (2) DES (2)	DCA (2) LOCAL (2) DES (2)	DES (1) CEC (1) HCD (1) LOCAL (2)
Regulatory Authority	LOCAL (1)	DES (2) DCA/BHFTI (2) CEC (2) HCD (2) LOCAL (2)	CDFC (2) HCD (2) LOCAL (2) DES (2)	CDFA (1) SPCB (2)	DCA/BOC (2) DES (2) ARB (2)	DES (2) ARB (2) DCA (2) LOCAL (2)	DES (1) CEC (2) HCD (2) LOCAL (1)
Compliance Authority	LOCAL (1)	DCA/BHFTI (2) CEC (2) LOCAL (2)	CEC (2) HCD (2) LOCAL (2) DES (2)	CDFA (1) SPCB (2) LOCAL (2)	DCA/BOC (2) DES (2) ARB (2)	DES (2) ARB (2) ARB (2)	DES (2) LOCAL (1) CEC (2) HCD (2)

(1) Direct or complete authority

(2) Limited or indirect authority

* "Local" may include city and county governing bodies; city and county agencies such as health departments; air pollution control districts; and County Agricultural Commissioners.

Source: State of California Air Resources Board (1989), *Reducing Exposures to Indoor Air Pollutants in California: Existing Authorities and Recommended Action*.

Exhibit 5.2: State and Local* Agency IAQ Authority -- Type of Enclosed Space

Enclosed Space/ Authority	Residences	Workplaces	Public Buildings	Transportation Conveyances
Research and Assessment	DES (1) ARB (2) CEC (2)	CAL-OSHA (2) DES (2)	DES (1) ARB (2) CEC (2) HCD (2)	DES (1) ARB (2)
Public Education	DES (2) ARB (2) CEC (2) HUD (2)	CAL-OSHA (1) DES (2)	DES (2) ARB (2) CEC (2) HCD (2)	DES (2) ARB (2) CPUC (2)
Regulatory Authority		CAL-OSHA (1)	CAL-OSHA (2) LOCAL (2)	CAL-OSHA (2) CPUC (2)
Compliance Authority		CAL-OSHA (1)	CAL-OSHA (2) LOCAL (2)	CAL-OSHA (2) CPUC (2)

(1) Direct or complete authority

(2) Limited or indirect authority

* "Local" may include city and county governing bodies; city and county agencies such as health departments; air pollution control districts; and County Agricultural Commissioners.

Source: State of California Air Resources Board (1989), *Reducing Exposures to Indoor Air Pollutants in California: Existing Authorities and Recommended Action*.

Exhibit 5.3: State and Local* Agency IAQ Authority -- Type of Enclosed Space

Control Authority	Residential		Non-Residential	
	Building and Ventilation Design and Construction	Building and Ventilation Operation and Maintenance	Building and Ventilation Design and Construction	Building and Ventilation Operation and Maintenance
Research and Assessment	DES (1) CEC (1)	DES (1) CEC (2) HCD (2)	DES (1) CEC (1) HCD (2) Cal-OSHA (2)	DES (1) CAL-OSHA (2) CEC (2)
Public Education	CEC (2) HCD (2) LOCAL (2)	HCD (2) DES (2)	CEC (2) HCD (2) Cal-OSHA (2) LOCAL (2)	CAL-OSHA (2) DES (2)
Regulatory Authority	CEC (2) HCD (2) LOCAL (1) Other state (2)	HCD (2)	CEC (2) HCD (2) Cal-OSHA (2) Other state (2) LOCAL (1)	Cal-OSHA (1) LOCAL (2) Other State (2)
Compliance Authority	CEC (2) HCD (2) Other state (2) LOCAL (1)	HCD(2)	CEC (2) HCD (2) Other state (2) LOCAL (1)	CAL-OSHA (2) LOCAL (2) Other state (2)

(1) Direct or complete authority

(2) Limited or indirect authority

* "Local" may include city and county governing bodies; city and county agencies such as health departments; air pollution control districts; and County Agricultural Commissioners.

Source: State of California Air Resources Board (1989), *Reducing Exposures to Indoor Air Pollutants in California: Existing Authorities and Recommended Action*.

The Air Resources Board (ARB)

The many responsibilities of the ARB includes coordinating the federal air quality program in California and setting state ambient air quality standards. They do not have direct regulatory authority over indoor air quality; however, they have been directed to assess both indoor and outdoor exposures to evaluate the level of human exposure to pollutants addressed through the *ARB Toxic Air Contamination Program (TACP)*. As part of this effort, in 1988 the ARB developed the *Indoor Air Quality/Personal Exposure Five-Year Study Plan* to produce indoor exposure assessments for the TACP. One such study conducted under the mandate of the Study Plan measured radon concentrations in approximately 440 California homes.

The ARB plays a further role with respect to residential environmental hazards. Specifically, since the ARB's primary focus is outdoor air quality, they have been given specific authority with regard to a variety of consumer products. Consequently, the ARB is in a position to regulate sources of indoor pollutants but only within the context of protecting outdoor air quality. Nevertheless, many of their regulations do, in fact, control pollutant emissions that directly effect indoor air quality. For example, the ARB has developed control measures to reduce the release of asbestos in the air.

Finally, ARB staff regularly participate in the California Indoor Air Quality Interagency Working Group.

The California Energy Commission (CEF)

Similar to the ARB, the CEF also lacks any real regulatory authority concerning indoor air quality; however, they are authorized to regulate urea formaldehyde foam insulation. In fact, the sale and installation of urea formaldehyde foam was effectively banned by the CEF in 1982. In addition, the CEF was the first government agency to both identify the effectiveness of ventilation in reducing indoor air pollutants and, in addition, the first to develop and disperse public information concerning indoor air quality.

The Department of Housing and Community Development (HCD)

HCD has no direct authority to regulate indoor air quality. However, they can reduce harmful emissions related to housing by enforcing the adoption of their building standards. For example, this entails regulating the use of combustion appliance venting, building materials, building ventilation, and residential hazardous materials.

Many of the HCD programs are federally funded through the Department of Housing and Urban Development (HUD); consequently, HCD is responsible for complying with all federal housing standards relating to public health and safety. These standards, for example, pertain to the use or mitigation of lead paint, asbestos and formaldehyde-containing materials.

Recently, federal standards were adopted by HUD which now require all newly manufactured homes and mobilehomes to provide: proof of compliance with standards for wood products

which limit formaldehyde emissions; an air exchange system; and finally, a health warning system for consumers. Needless to say, HCD has adopted these standards for all housing projects they finance.

The State Building Standards Commission (SBSC)

Inasmuch as the State Building Standards Commission does not develop standards of their own, they review and publish proposed building standards which have been developed by several other state agencies, including HCD and CEC. Since there are a number of agencies who are directly involved in the development of industry standards, the opportunity for conflict or duplication in standards is fairly high. Consequently, the primary focus of the SBSC is to ensure that this does not happen.

Proposition 65, The Safe Drinking Water and Toxic Enforcement Act

This Act, which was established in 1986, required the Governor of California to publish a list of chemicals that have been proven to be either carcinogenic or to cause reproductive toxicity. Further, the Act requires that "clear and reasonable" warnings are to be provided before any individual is exposed, in whatever manner, to the listed chemical. Two such chemicals are formaldehyde and asbestos. It should be noted that this warning applies to both indoor and outdoor exposures, and not only to exposures found in drinking water.

The American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)

ASHRAE has in the past developed a number of industry standards concerning indoor air quality: one of these is Standard 62 which relates to ventilation requirements. Standard 62 has undergone a number of revisions over the past two decades. However, its primary purpose remains the same; i.e., it governs ventilation rates for both smoking and non-smoking areas. Also included within this standard are additional air quality guidelines for several non-smoking related pollutants, including formaldehyde and radon. Many of the standards developed by ASHRAE have directly influenced the adoption of specific building standards by both federal and state agencies such as HUD, HCD, CEC and local governments.

The American Society for Testing and Materials (ASTM)

ASTM develops a number of standards which directly relate to indoor air quality. In fact, their most significant contribution to improved indoor air quality is the development of methods for sampling or measuring air concentrations of specific pollutants.

5.4.3 Protective Policies

To the extent that federal agencies, such as HUD, Fannie Mae and Freddie Mac, administer programs in and/or guarantee mortgages on properties in the State, then the protective policies developed by these agencies (and discussed in Section 5.3.3 above) apply in California. However, the state government and its agencies have not developed formal protective policies

with respect to residential environmental hazards, nor is the development of such policies seen as a priority issue at this time.

5.4.4 Summary

While the State of California has made tremendous strides in the past 10 years to protect the public from environmental hazards generally, state agencies admit they still have a long way to go. This is particularly true with respect to the residential sector in that issues relating to the residential environment appear to be a relatively new concern in terms of policy development. Nevertheless, as previously mentioned, many of the policies and guidelines that have been developed for the non-residential environment have, in many cases, been applied in the residential environment. However, as noted in the December, 1989 ARB report, "few specific actions have been taken that will actually reduce exposures to indoor pollutants."⁵⁷

The state agencies involved with indoor pollution admit that it is imperative that California develop a comprehensive plan (containing a strong public-information component) to combat residential environmental hazards. The ARB, in particular, strongly promotes this action. In fact, in the ARB (1989) report, they proposed a number of recommendations which specifically address indoor air quality. These include the following:

- a comprehensive plan which assures reductions of indoor air pollutant exposures in California should be developed;
- local health and environmental health departments should be provided with the resources necessary to conduct residential inspections when necessary in response to citizen requests for assistance in identifying and resolving residential indoor air quality problems;
- as sufficient data becomes available, the ARB staff should develop health-based indoor air quality guidelines for residential indoor environments; and
- the ARB should be given the responsibility to develop control measures to be used to mitigate indoor sources of residential exposures to designated air contaminants.

Due to a lack of resources, these and other recommendations have yet to be acted upon. However, they do represent a framework within which many of the residential environmental hazard issues currently facing the State of California can be addressed.

5.5 Residential Environmental Hazard Policy in Sweden

In the literature review component of this study, a sample of policy measures enacted by Sweden were cited, and partially on the basis of this information, Sweden was selected as a case study

⁵⁷ State of California Air Resources Board (1989), pg. 4.

jurisdiction. However, despite the considerable time and effort devoted by the Study Team with respect to the identification of potential public and protective policy measures, and the collection of policy specific documentation, very little information concerning the status of policy development with respect to residential environmental hazards in Sweden was forthcoming. As a consequence, the information presented in this section is rather sparse and relates largely to the specification of residential environmental hazard issues in Sweden, as identified in a recent nation-wide survey, and the Swedish government's activities with respect to radon. A discussion of other public and protective policies is not provided.

On the basis of the limited documentation received, discussions with contacts in Sweden, and the information provided in the literature review, it would appear that Sweden has been addressing indoor environmental issues in a similar fashion to that of the other European jurisdictions reviewed during the course of this study. Specifically, it would appear that the Swedish government had initially focused its energy on studying the non-residential indoor environment. Over the past ten years, however, research with respect to the potential health risks posed by pollutants such as radon and formaldehyde within the residential indoor climate has occurred. During this period, a number of studies have been undertaken to examine the exact degree to which toxic gases, chemicals and building materials have contributed to public health problems. In fact, in 1991, a nation-wide study of indoor climate in Swedish residential buildings was carried out involving 20,000 residents in more than 3,300 single and multi-family homes. This survey is only one of three research projects that are contained under the umbrella of the *Conservation of Electricity in Existing Buildings* research program. The purpose of this program is to improve energy efficiency and the indoor climate of Swedish buildings. The remaining two studies undertaken as part of this program include: *Technical Characteristics of the Swedish Housing Stock*; and *Energy Conservation Potentials in the Swedish Housing Stock*.

5.5.1 Residential Environmental Hazard Issues

The results of the climate survey brought to light specific issues that are currently the focus of Swedish policy-makers. Some of the findings of the survey, with respect to the hazard issues of concern in Sweden, include:

- a majority of the single-family homes and about half of the apartments and multi-family houses, have ventilation rates below the prescribed rate of 0.35 litres per second per square metre, which corresponds to 0.5 air changes per hour;
- the indoor temperature has increased over the past ten years and now averages 21°C in single-family houses and 22.2°C in multi-family houses;
- the indoor air is dry (less than 30% relative humidity) in about one third of the apartments and multi-family houses;
- the level of formaldehyde is low, in fact, it is well below recommended maximum values in all investigated houses;

- the radon level is higher than prescribed for existing houses (400 becquerels per cubic metre) in 70,000 to 120,000 single-family houses and in 20,000 to 80,000 apartments and multi-family houses; and
- between 600,000 and 900,000 persons reside in dwellings with an indoor climate which can affect health and well-being.

One of these findings is worth further discussion; that is, the study of radon infiltration into residential dwellings.

Radon

Since 1990, the Swedish limit for radon progeny concentrations in residential and non-residential dwellings (except for underground workers) has been set at 200 becquerels per cubic metre. However, Swedish authorities recommend that all buildings with radon concentrations exceeding 70 becquerels per cubic metre should have mitigation measures applied. In 1986, local authorities reported that out of 52,000 dwellings, the radon concentration exceeded 200 becquerels per cubic metre in 18,000 homes and, in 38,000 homes, the concentration exceeded 70 becquerels per cubic metre.

Although radon has been detected in tap water in Sweden, the greatest concern involves radon infiltration through ground-soil, and radon emissions from building materials. It has been found that regions in Sweden with higher concentrations of uranium in the ground are most likely to produce a greater potential increase in radon infiltration. Further, a light-weight concrete based on alum shale (used extensively in Sweden between 1929 and 1975) was found to contain an excessive amount of radon, in fact, up to 2.6 becquerels per kilogram.

In order to address the issues of concern with respect to radon, the Swedish government has granted responsibility to the following authorities for regulating radon infiltration into Swedish dwellings:

- *The Swedish Protection Institute*: has the overriding responsibility for following developments with respect to radon infiltration into dwellings, including the development of measurement techniques and the assessment of health risks.
- *The National Board of Health and Welfare*: issues limits and recommendations for existing buildings.
- *The National Board of Occupational Safety and Health*: sets the limits for mines and other underground working places.

In addition to these authorities, the government appointed a special Radon Commission (in 1979) whose responsibilities included advising on appropriate remedial actions against radon infiltration in existing and newly constructed Swedish dwellings. For existing buildings, the remedial actions developed included the following:

- improve ventilation systems (through the installation of mechanical systems with, preferably, an inlet and outlet system with heat recovery);
- seal visible cracks and holes in building footings;
- the installation of sub-slab suction (i.e., a pipe is drawn through the bottom slab of a building and up through the wall or roof to the outside air where a fan sucks soil air from under the building); and
- the installation of a radon well (i.e., a well is placed at a distance of 10 to 60 metres from the house and a powerful fan draws out the soil air from the well and reduces the air pressure surrounding the buildings footing).

The responsibility for ensuring the compliance to these measurements rests with the local authorities.

Remedial actions for new buildings involve many of the measures taken for existing buildings (i.e., the installation of appropriate ventilation systems, sub-slab suction processes and radon wells). However, when considering the siting of new residential structures, a "risk classification" is also required. This classification process includes: (i) an extensive study of geological maps relating to the housing site; (ii) measurements of radon concentration in the soil at the site; (iii) gamma spectroscopy measurements; (iv) indoor measurements in existing buildings in the surrounding area; (v) assessments of the permeability of the ground; and (vi) air-borne gamma measurements. Local building authorities will not issue building permits until they are satisfied that facilities will be built radon-safe.

5.5.2 Summary

As indicated earlier, despite the considerable efforts of the study team to obtain information which would allow for an accurate characterization of the nature and extent of policy activity with respect to residential environmental hazards in Sweden, such information was not forthcoming. The results of the literature review, and the assessment of the documentation that was provided (especially concerning radon), suggests that Sweden has adopted similar measures to those adopted in other jurisdictions to minimize the health risks posed by environmental hazards; e.g., the specification of ventilation requirements, the installation of sub-slab mitigation measures, etc. However, on the basis of available information, the Study Team is unable to comment further on the suite of alternative public (or protective) policy measures that Sweden may have adopted to address the concerns associated with residential environmental hazards.

5.6 Residential Environmental Hazard Policy in Denmark

Policy development with respect to indoor pollution in Denmark has largely followed the same evolutionary path encountered in the other jurisdictions reviewed as part of this study: the non-residential environment has been the primary focus for policy, with the bulk of activity involving research and the development of exposure guidelines. Many of the guidelines that have been

developed have led to restrictions in the use of hazardous materials that have, in the past, been used for the construction of both non-residential and residential structures. Thus, some of the policy measures implemented to combat environmental hazards in non-residential environments has served to reduce some of the health risks associated with in-home exposures.

However, with respect to the residential sector specifically, with the exception of certain regulations originally designed to address hazard issues in the non-residential sector (e.g., formaldehyde, asbestos, etc.), to-date the Danish government's initiatives with respect to residential environmental hazards have largely focused on research. In fact, the Danish National Building and Housing Agency closely follows international developments in this area (i.e., identifying environmental concerns which, in the past, have included hazardous chemicals and materials including asbestos, formaldehyde, radon, and nitric oxides) for the sole purpose of highlighting research needs in Denmark.

As part of Denmark's efforts to broaden its research and policy development activities to encompass hazards in the residential environment, a number of research studies are currently being developed that will investigate high risk issues unique to the residential indoor environment. For example, one such study proposes to indicate optimum methods of ventilating private homes. Another study, with a rather interesting slant, proposes to combine the efforts of three Danish government organizations -- the Building and Housing Register, the Health Service Register, and the Central Persons Register -- for the purpose of highlighting any possible connections between housing conditions and the morbidity and mortality of the general population. These and other research studies will eventually provide the groundwork from which future indoor climate standards, guidelines and policies can be developed.

5.6.1 Residential Environmental Hazard Issues

Following a review of Danish documentation on existing standards and guidelines regarding environmental hazards generally, and after interviewing key people in building and housing organizations within Denmark, it became evident that the major concerns and issues in terms of environmental risk management include the following:

- 1) *Formaldehyde*: this pollutant is found within building materials such as chip boards, plywood, some forms of glue, and insulation materials, and is an immediate cause for concern for the Danish government. A recently revised building code has formally addressed this concern by strictly regulating the use of materials containing this pollutant. For example, insulation made from urea formaldehyde can only be used to insulate the outside walls of a structure.
- 2) *Asbestos*: the revised building code addressed the health concerns posed by asbestos by prohibiting the use of asbestos in all indoor building materials.
- 3) *Fibre Glass*: this material is found in a variety of building materials and, as such, the building code restricts its use by insisting that all these materials be surfaced treated, encased or sealed. In addition, ceiling tiles must be treated on all sides.

- 4) *Contaminated Sites*: polluted soil, either from waste disposal sites or other industrial land uses, can have detrimental effects upon the quality of groundwater, outdoor air, surface soil around buildings and, ultimately, indoor air. This being the case, a number of remedial measures have been suggested which include the clean-up of polluted soil, the implementation of intercepting or ventilation drainage systems, and other such actions. However, the best course of action is not always clear since the remedial measure itself may actually result in undesirable environmental risks to those located nearby. Consequently, a number of Danish building associations feel there is real need for additional research to study the effects of the infiltration of radon, NO₂, and other soil pollutants into buildings. Further, they suggest that it is imperative that monitoring and control programs are developed to ensure an adequate risk management system.

5.6.2 *Regulatory Responsibilities and Public Policy Measures*

There are a number of key organizations within Denmark who directly influence the development of standards, guidelines and policies relating to environmental risk management. In fact, several years ago representatives from a number of these organizations formed a committee, known now as the Coordination and Collaboration Committee on Indoor Climate. The committee is comprised of representatives from the Ministry of Housing; the National Building and Housing Agency; the Danish National Institute of Occupational Health; The Danish Building Research Institute, Energy and Indoor Climate Division; the Laboratory of Heating and Air Conditioning; the Occupational Health Clinic; the Danish National Board of Health; the Faculty of Environmental and Occupational Health, University of Aarhus; and a Medical Health Officer from Copenhagen. The committee's mandate includes the following specific tasks:

"... to suggest fields in which research should be done in order to establish a proper and broader scientific basis for establishing building legislation requirements in areas such as hygienic limit values for dwellings (indoor climate standards), test methods, construction at polluted sites and building materials requirements (materials standards). Another task of the Committee is to assist in the coordination of technical and biological indoor climate research and so to consider ways of financing the proposed research. Finally, the Committee is to advise on the administrative utilization of research results."⁵⁸

The result of the combined efforts of the various agencies and departments on the Committee was the development of the *Framework Plan for 1991-93, Statement: Committee Work 1985-1990* (this document is an up-dated version of a similar framework plan created in 1985-87). The Framework addresses a number of issues that were recorded previously as priorities in the *Nordic Program of Action for a Better Indoor Climate, 1992-96*, prepared by the Nordic Indoor Climate Committee under the Nordic Committee on Building Regulations.

⁵⁸ The National Building and Housing Agency, Coordination and Collaboration Committee on Indoor Climate (1991), pg. 1.

The priorities addressed in the *Framework* range from project areas that are considered high risk, in terms of the health and welfare of the general public, to project areas that promote an active research environment within the field of indoor climate. In addition, the *Framework*, promotes the development of "mathematical models" capable of demonstrating the correlations between gas or particle emissions from different sources of pollutants, including building materials, cleaning products and tobacco smoke. According to the Committee, these models are to be developed and incorporated into the legislative process to facilitate the future development of healthy building materials and building designs. Furthermore, the *Framework* addresses the need for additional research investigating possible source controls employed within the indoor environment. For example, the recently revised Danish building code is quite specific about using ventilation as a way of reducing toxic pollutant concentrations in both non-residential and residential buildings. Again, the Danish building associations suggest there is a need for further investigations to identify the appropriate ventilation design for both public and private dwellings. According to the Committee, the design of a building's ventilation system, and the conditions under which it operates, are crucial to its pressure balance. Finally, the *Framework* stresses the importance of developing a comprehensive public information program. Many significant factors influence indoor pollution, some of which are not within legislative jurisdiction. These factors, of course, pertain to the public's understanding of the issues involved and the interrelationship between these issues and their personal habits. Consequently, the Committee feels that the only practical way to alter the behaviour of the public (in lieu of legislation), is to inform them as to the necessity of creating healthy climates inside their homes. To this end, the Committee recommends a program that includes televised public service announcements and advertisements as part of their strategy.

In order to gain a clearer understanding of the experience and knowledge brought to the Coordination and Collaboration Committee, the following is a brief summary of the activities (as they relate to the study of indoor pollution) of some of the larger organizations who either directly or indirectly participate in this committee.

The National Building and Housing Agency (NBHA)

Legislation with respect to indoor climate in housing and non-industrial workplaces is the province of the NBHA. The responsibilities of this agency pertain not only to new buildings and major renovations, but also to the rectification of climate problems found in existing buildings. In discharging its responsibilities, the NBHA performs two key tasks. First, the NBHA is responsible for the development of building regulations. In a recently released version of the building regulations, the NBHA devoted a special chapter to indoor climate issues. However, despite the attention given to the subject by this gesture, limited regulation with respect to indoor climate actually exists at this time. According to the NBHA, this limited amount of regulation is primarily due to the fact that, in many areas of indoor climate research, little information is available, and that which is available is insufficient as a basis for regulating the indoor environment.

The NBHA's second duty as a public authority is to communicate the need for environmental and health quality requirements to the producers of building materials, construction consultants,

contractors and, especially, to end users. The NBHA feel there is a definite need for improved communications between regulatory authorities and researchers; between technical researchers and biological researchers; and all those working in the indoor climate field (hence, their involvement since 1984, in the Coordination and Collaboration Committee on Indoor Climate).

The Danish National Institute of Occupational Health (NIOH)

The NIOH has performed indoor air quality research for more than 10 years in the fields of chemistry, aerosol and particle emissions, ventilation, and respiratory toxicology. Their activities have focused upon the development of methods for the measurement of particles, volatile and semivolatile organic compounds, the irritating potency of indoor pollutants, objective methods for measuring eye irritation, and fast methods to monitor ventilation effectiveness. Instruments to measure the chemical emission from building materials, as well as dust monitors, have also been developed and are currently being manufactured. The NIOH has conducted international courses on indoor air quality and have several highly qualified scientists on staff who deal primarily with indoor related research. In addition, the NIOH actively participates in several European working groups that study guidelines for measuring and evaluating indoor air quality.

The Institute of Environmental and Occupational Medicine (IEOM)

Among other activities, the IEOM investigates health effects caused by indoor air pollution and, especially, volatile organic compounds and airborne dust. Health effects of particular interest include the inflammation of membranes of the eyes and nose; and the neurotoxic and sensory effects experienced by normal and hypersensitive occupants of non-industrial buildings. The primary purpose of the IEOM's research is to develop methods for the quantification of these effects; to use such methods for risk evaluations and source characterization; and to develop methods for characterizing emissions of air pollutants from building and furnishing materials.

The Laboratory of Heating and Air Conditioning, Technical University of Denmark (LHAC)

The LHAC has had comprehensive experience in investigating the indoor environment and its impact on the public during more than 25 years of experimental work in this field. The LHAC has performed basic research on thermal comfort, draught and indoor air quality, and the results have been incorporated into indoor environmental standards and guidelines worldwide. The LHAC has excellent facilities and equipment for conducting research on the various aspects of indoor air quality including three advanced environmental chambers. In addition, they have carried out research which involved studying the indoor climate of more than 50 buildings.

5.6.3 Protective Policies

According to the information received from Denmark, no protective policies are in place with respect to the residential sector, nor is their development seen as an issue of any priority. Environmental liability does not appear to be an issue in Denmark; however, this may partly be a result of the level of awareness and policy activity with respect to residential environmental

hazard issues. In the future, as the levels of awareness of these issues increases, the development of protective policies may require attention from the government.

5.6.4 Summary

The review of policy activity with respect to residential environmental hazard issues indicates that, while a wide range of Danish organizations are currently involved in the investigation of these issues, the bulk of their activity centres on research efforts directed toward the development of an understanding of the human health risks associated with exposure to indoor pollutants. With respect to certain long-standing hazards, such as formaldehyde, asbestos, radon and other soil gases, formal mitigation measures have been developed and incorporated within Danish building codes and regulations. Aside from these pollutants, however, the Danish government has established that additional research with respect to the links between pollutant concentrations and health risks in the residential sector is required. The results of this work will form the basis for the development of more wide ranging policies, regulations and standards.

In terms of its research efforts, it is particularly interesting to note the commitment of Danish organizations to follow world-wide developments with respect to residential environmental hazard issues. This commitment should ensure a more integrated approach to environmental risk management within Denmark.

5.7 Residential Environmental Hazard Policy in the Federal Republic of Germany

The problem of air pollution within non-industrial indoor environments was first seriously addressed in the Federal Republic of Germany in the early 1970s. The motivation for focusing policy attention in this area involved concerns about an odour in Cologne's schools, which was subsequently revealed to be the result of increased formaldehyde concentrations, and also reports of adverse health effects associated with the use of pentachlorophenol (a wood protectant). As a consequence of these concerns, and additional investigations and analyses, the Federal Health Office introduced a regulation concerning acceptable indoor formaldehyde concentrations in 1977. In addition, by the end of the 1970s, the Federal Health Office had conducted a broad field study to determine the nature and extent of possible health problems associated with exposure to wood protectants.

Awareness of the issues surrounding indoor air pollution continued to develop in the 1980s. Specifically, in 1981 the Institute of Water, Soil and Air Hygiene (which is associated with the Federal Health Office) conducted the first scientific colloquium which addressed the problem of indoor air quality in the Federal Republic of Germany. Furthermore, in 1984, the Federal Health Office introduced a commission on *Innenraumluftthygiene* (Indoor Air Hygiene), whose objective was to differentiate between the sources and effects of poor indoor air quality and to set forth suggestions with respect to the steps to be taken to limit poor air quality. Since the commission began its investigations, certain substances have gained attention as dangerous pollutants, including: formaldehyde, asbestos, radon, pentachlorophenol, tetrachlorethane, perchlorethylene, and the products of tobacco combustion.

By the mid-1980s, the work of the Commission on Indoor Air Hygiene, and of the Federal Health Office generally, had established that, while indoor air pollution was a justifiable public policy issue, it had many causes and sources. In particular, indoor pollution was largely a result of new technologies and products developed during the previous decade; the necessity to conserve energy (which was done by sealing rooms and buildings to control air flow); new technologies in producing synthetic chemicals and materials; and the increase in the production and use of such chemical materials. The government also recognized that indoor air pollution was a result of personal behaviour such as smoking and the use of chemical cleaning agents. As a consequence of investigations in to the implications of each of these developments, the government recognized the sources of indoor air pollution as follows:

- tobacco smoke;
- radon;
- chemical substances in construction materials, furniture and fixtures;
- burning processes, especially open flames;
- the operation of technically or hygienically inadequate air conditioners or ventilators, and inadequate servicing of the same;
- the contamination of indoor air by the growth of microorganisms, bacteria, etc., especially through specific air conditioning/ventilation systems;
- household dust (especially when composed of foreign substances);
- products of human metabolism that linger because of lack of ventilation; and
- contaminated air from outdoors entering indoors, especially through emissions from the ground.⁵⁹

Finally, the motivation to consider policy options to control indoor air pollution was reinforced by a number of recent studies which showed that a number of air pollutants reached far greater concentrations in indoor, rather than outdoor, environments.⁶⁰

For the most part, the policy development activities undertaken with respect to these pollutants were focused on indoor air pollution issues in the workplace and other non-residential sector. However, in the last few years the focus has included the control of air pollution in German

⁵⁹ German Ministry of the Environment (1992), pg. 7.

⁶⁰ Umweltpolitik (1992), pg. 10.

households.⁶¹ Specifically, in May, 1987, the Rat von Sachverstaendigen fuer Umweltfragen (SRU) (Expert Environmental Advice) presented the document *Luftverunreinigungen in Innenraeumen* (Air Pollutants Indoors) in which the present state of knowledge (and the present lack of knowledge) concerning indoor air pollutants in both the residential and non-residential environments was explained. This document, like many European Community (EC) initiatives, made it clear that a comprehensive policy to reduce harmful substances in indoor environments was urgently needed. In response to the SRU report, in September, 1988, the federal government was mandated to intensively concern itself with the problem of indoor air pollution and to produce a report thereof. The federal government then appointed an inter-ministerial working group, Verbesserung der Luftqualitaet in Innenraeumen (Improving the Air Quality Indoors). This Working Group established that:

- the considerable amount of harmful substances found in indoor air falls into many departments of responsibility according to different indoor locations and uses; and
- an optimal solution to indoor air pollution requires the production of a draft report which takes into consideration the wide range of harmful substances that pollute indoor air -- this report should take into consideration collective and balanced judgement of the pertinent measures to be taken.⁶²

The following Ministers were commissioned to be part of the Working Group:

- Minister of Environment, Nature Protection, and Reactor Security;
- Minister of Youth, Family, Women, and Health;
- Minister of Space Organization, Methods of Construction, and Town Planning;
- Minister of Employment, and Social Organization; and
- Minister of Research, and Technology, and Economy.⁶³

The members of the Working Group were to research the sources of harmful substances and suggest concrete measures to improve indoor air quality. In addition, the members were to research and test possible improvements to poor indoor air quality through organizational changes as well as by educating and informing the public. Throughout, the government's concern with poor indoor air quality revolves around the health of the public. However, in

⁶¹ This focus has become more acute since German reunification and, in the near future, the government will take action to reduce the considerable amount of indoor air pollution in the new German states.

⁶² German Ministry of the Environment (1992), pg. 10.

⁶³ German Ministry of the Environment (1992), pg. 11.

developing policy with respect to these concerns in the residential sector, the government has, and continues to be, partially constrained by a perception that it may not have the right to intervene in the private lives of residential occupants. As a consequence, the policy measures being considered for the residential sector specifically will likely reflect a non-regulatory focus.

5.7.1 Residential Environmental Hazard Issues

As noted above, the Commission on Indoor Air Hygiene identified a variety of indoor air pollution sources and concerns. However, within the Federal Republic of Germany, the residential hazard issues of most concern to policy makers (and which fall within the Terms of Reference for this study) include the following:⁶⁴

- 1) *Construction Materials*: are composed of various substances and combinations of substances. These substances pose a health problem to residents because they can reach harmful concentrations when emitted into the air within closed household environments. The emissions from building materials which are of particular concern are classified as follows:
 - dust and fibres (especially from asbestos or artificial mineral fibres, wood dust, etc.);
 - chemical materials which are the basis of construction materials (e.g., pre-stressed plates, wall plates, ceiling construction materials, damming-up materials, sealants, floor coverings, and adhesives);
 - chemical materials, usually in small amounts, used on (or in) construction materials to bring about their unique qualities (e.g., preservatives, wood protectants, paints, varnishes, and glues); and
 - radiation from construction products containing radon emitting materials.
- 2) *Indoor Air Ventilation Systems*: since the 1950s, air ventilation systems have, in many cases, been individually and permanently installed into residences, and it is these systems which are of particular concern. These systems were installed according to the individual thermodynamic air-handling functions required; including: heating, cooling, humidifying, and de-humidifying. These functions differ in their ability to generate environmental hazards in that they may exchange indoor air with outdoor air, or they may simply recycle indoor air. Although filters are used to reduce the particles in the air, they do not reduce dangerous gases, and they can, in themselves, provide a breeding environment for micro-organisms, bacteria, mites, moulds, etc. Improper servicing (or a lack of servicing) of air ventilation systems can pose significant health risks for indoor environments, and many illnesses have been documented in Germany in which the cause of poor health is air contaminated with dangerous gases, bacteria, microorganisms, etc.

⁶⁴ These issues are also of concern in the non-residential sector.

- 3) *Radon*: emitted from soils and sub-surface formations in areas where granite is present and where uranium is stored. Radon is also found in some construction materials such as light-weight concretes based on alum shales.
- 4) *Outdoor Pollutant Infiltration*: poor outdoor air quality surrounding a residence (due to the homes proximity to busy streets, industrial plants, etc.) can result in poor indoor air quality as a result of pollutant migration through open windows and doors and through ventilation systems that exchange indoor and outdoor air. In addition, some airborne chemicals from neighbouring factories, storage sites or shipping vehicles, pass through walls and roofs and enter indoors. Residences built on former industrial sites, which are contaminated, may have polluted air sourced from underground emissions.

5.7.2 Regulatory Responsibilities and Public Policy Measures

Since the government's concern with indoor air quality is very recent, and especially so with respect to residential environs, there are few regulations in place; however, a number of regulatory proposals are in existence. In this section existing regulations, suggested regulations and regulatory goals are outlined with reference to the residential environmental hazard issues of concern in Germany.

Construction Materials

In 1988, the EC proposed to cancel a policy which allows the free trade of construction materials and their use in the Community by the summer of 1992. This was done in view of creating an all-encompassing system within the EC, which would embrace recognized EC and national specifications. In 1991, the German federal government outlined a law regarding the trade of construction materials. This law, which was in accordance with the recognized rules of technology in the technical building regulations and the many German industry norms, was designed to establish safety regulations and to reduce or avoid health hazards.

Under the construction materials law, new construction materials, and construction materials that had not yet gone through permitting procedures, must do so at the Institut fuer Bautechnik (Construction Technology Institute) in Berlin. The institute tests for a variety of environmental and human health aspects, and the results of these tests are then passed on to the Umweltbundesamt (Federal Office of the Environment) and the Bundesgesundheitsamt (Federal Office of Health). If the construction material passes the Construction Technology Institute's testing protocols, the material is certified for use. This certification essentially involves a review of the structural soundness of the materials and its resistance to fire. However, the scope of the federal demands on construction materials includes the protection of the environment and human health through the regulation of chemical substances. Consequently, depending on the nature of the construction material under consideration, certification may also require testing with respect to the harmful substances decree.

The harmful substances decree includes detailed regulations for formaldehyde and asbestos. This includes banning the production, circulation, and use of these substances in construction materials. For example, the circulation of certain materials, such as pressure plates, whose level of formaldehyde surpasses acceptable levels, is prohibited. Asbestos regulations are also quite strict regarding the production and use of this material. Thus, for certain asbestos materials, their production and use will no longer be allowed in the near future. The intention is to eventually prohibit asbestos in construction materials completely.

In addition to asbestos and formaldehyde, a number of other substances are tested for under the certification process. For example, pentachlorophenol in a number of construction materials, and especially as a wood and textile protectant and as a preservative, is prohibited. In addition, the production, circulation and use of perchlorethylene and a variety of volatile organic compounds is prohibited and, by the year 2000, transformers containing PCBs will be prohibited.

In terms of its future regulatory efforts in this area, the German government is working towards creating and improving regulations for construction materials in order to further minimize the dangers to health that toxic substance emission from these products, within the indoor environment, can engender. To this end, the government is preparing to undertake the following measures:

- create uniform criteria and systematic testing and assessment protocols to examine construction materials with regard to public health and environment hazard issues;
- test which existing regulations, regarding dangerous substances can be targeted with a view to reducing or prohibiting specific materials which are adverse to human health (the purpose here is to promote the substitution of safe materials for materials which contain dangerous substances);
- strengthen the publication of information regarding specific categories of construction materials and carry out professional construction seminars which make clear the connection between construction materials and indoor air quality; and
- order manufacturers and distributors of construction materials to make available all information regarding the toxicity of any dangerous contents.

Air Ventilation Systems

At present, there are no regulations for indoor air ventilation systems which are specifically designed to address indoor air quality issues. However, the German government is of the view that: (i) buildings should be designed so that reliance on air conditioning and ventilation systems is not necessary; and (ii) for existing ventilation systems, their functional and hygienic safety should be secure and regular servicing should be maintained. In order to reduce the environmental hazards associated with ventilation systems, the government is considering measures which will lead to:

- A consistent consideration of environment and health protection in the development of air conditioning and ventilation systems and service training procedures, including:
 - building systems that are "service-friendly";
 - descriptions and instructions regarding the type, range and frequency of necessary servicing; and
 - requiring qualified service personnel.
- Improvement in existing information, and a wider publication of information for construction workers, contractors, architects, etc., regarding the connection between air conditioning, ventilation systems and indoor air quality.

Radon

The German government has yet to impose legally binding regulations with regard to radon infiltration into indoors environments and its subsequent mitigation. In the opinion of the Radiation Protection Commission, if long-term radon concentrations in a residence reach or exceed 250 becquerels per cubic metre, mitigation measures should be implemented. This is especially important to ensure that maximum exposure levels of 15,000 becquerels per cubic metre per year is not exceeded (this maximum level should not be exceeded for more than a period of ten years).

Despite the lack of existing regulations, the German government does recognize the importance of minimizing its citizen's exposure to radon concentrations. As a result, the government recognizes that efforts should be increased to identify buildings with high concentrations of radon; to take steps to reduce these concentrations; and to implement mitigation measures and construction management procedures to ensure that radon concentrations are kept as low as possible in new buildings. To this end, the German government is considering the following:

- Embrace the EC's suggestions concerning radon mitigation which include:
 - Improve the criteria for measuring and comparing radon concentration in regions, locations, and certain building characteristics in comparison to those whose radon concentrations may be higher.
 - Commit a reference value of radon concentrations for existing buildings and a planning value of radon concentrations for construction procedures under the consideration of the recommendation of the German Radiation Protection Commission.
 - Educate construction authorities, as needed, about possible radon exposure levels and methods to avoid possible radon exposure.
- Undertake measures to inform the public about the risks of radon and the measures available to reduce radon concentrations, especially in areas where there are high concentrations of radon.

Outdoor Pollutant Infiltration

Protection from indoor air quality degradation resulting from pollutant infiltration from outdoor environments is a particular goal of the *Bundesimmissionsschutzgesetzes* (Federal Emissions Protection Law). The purpose of this law is to provide measures that will lead to the protection of neighbourhoods in areas of harmful emissions. The following decrees are part of this law:

- The central heating decree, which is aimed at reducing emissions of a variety of pollutants, such as sulphur dioxides, nitrogen oxides and dust.
- The decree for emission restrictions of air borne halogen-carbon-water-materials, aimed at protecting the indoor environments of building in neighbouring areas of chemical cleaning plants.
- Regulations for motor vehicles to reduce emissions, and proposals to reduce traffic flows.
- Garbage depots are being supervised according to the regulations of the *Abfallgesetzes* (garbage law).
- There are regulations for storage of above ground and underground "special garbage".⁶⁵

Further improvement of outdoor air quality, especially through the reduction of emissions from traffic and industrial areas, is seen as a necessary future goal. In addition, further investigations into the effects of harmful substances from industrial sites and garbage depot sites are required so that necessary redevelopment procedures can be put into place. Additional steps currently being considered by the German government include:

- reduction of new industries whose harmful substances have a considerable effect on the indoor air quality in neighbouring structures (e.g., chemical cleaning plants, gas stations, certain laboratories);
- establishment of more traffic free zones in city centres;
- inclusion of measures for the supervision of former industrial locations which are contaminated, as defined in the *Bundesabfallrecht* (Federal Garbage Law); and
- the systematic inclusion, examination and assessment of buildings on former industrial sites, especially with regard to emissions which pose a health hazard.

⁶⁵ "Special garbage" is garbage which is very hazardous to the environment (e.g., paint, oil, batteries, etc.) and is treated separately from regular household garbage.

5.7.3 Protective Policies

No formal protective policies are currently in place with respect to environmental liability issues in the residential sector. In addition, indications are that the German government does not perceive environmental liability generally, and liability litigation with respect to the residential sector specifically, as an issue; hence, the development of protective policies is seen as a remote requirement. As indicated above, however, the German government is looking at the development of procedures for the systematic inclusion, examination and assessment of buildings on former industrial sites. These site assessment procedures could form the basis for protective policy measures if liability for residential environmental hazards does become an issue in Germany.

5.7.4 Summary

Within the Federal Republic of Germany, policy activity with respect to residential environmental hazard issues appears to be very much in its infancy. As is the case in many of the other European jurisdictions reviewed in this study, the German government has implemented product standards and building code regulations to mitigate the risks associated with certain long-standing hazards such as formaldehyde and asbestos. However, for the most part, policy activity with respect to residential environmental hazards remains largely at the risk assessment level. With respect to certain pollutants -- such as radon, micro-organisms present in ventilation systems and outdoor pollutants -- a number of risk management strategies have been recently proposed to the German government for consideration. Where the control measures implicit in these strategies do not directly interfere with the behaviour of residential occupants, then the measures tend to be more regulatory in nature. In other instances, where regulatory measures could be viewed as interfering with the rights of residential occupants, the measures under consideration tend to be non-regulatory in nature and largely involve educational activities.

5.8 Residential Environment Hazard Policy in the Netherlands

Over the past two decades, environmental quality has become an issue of serious concern in the Netherlands. Reflecting the experience of other jurisdictions in Europe, many of the policies and regulations that have been developed in the Netherlands have been implemented primarily to address concerns in the outdoor and industrial indoor environments. Some of the measures implemented to address indoor environmental issues in the non-residential sector have, in an indirect way, influenced the quality of the residential indoor climate (i.e., in regulating the use of specific non-toxic building materials, etc.). However, it is only in the last few years that, as a direct result of increased public health complaints, policy focus in the Netherlands has begun to turn toward the indoor environment generally, and the residential sector specifically.

Policy development with respect to the indoor environment in the Netherlands involves a number of different government departments; however, the primary legislative body is the Ministry of Housing, Planning and the Environment (MHPE). In terms of policy, the MHPE define the indoor environment as "the structural enclosures where the physical, chemical and biological

qualities are of direct importance and relationship to human wellbeing."⁶⁶ This being so, the MHPE further identified the following three major influential factors that directly effect indoor environmental quality:

- pollutants generated or reflected through the structure itself (including installations inherent in the structure);
- pollutants generated outside of the structure; and
- pollutants generated from within the structure primarily due to lifestyle.

Inasmuch as public health has been clearly effected by one or all of the above factors, it has been a difficult task for those who influence policy development to identify the exact cause of all "indoor climate-related" physical complaints (e.g., relating them directly to building materials). Nevertheless, over time the Netherlands has developed a number of policies and regulations that have minimized public exposure to a wide range of identifiable environmental hazards typically detected indoors.

5.8.1 Residential Environmental Hazard Issues

The environmental hazard issues that directly relate to the residential sector are similar to those identified in the other jurisdictions we reviewed for this study. In fact, as is the case in Denmark, the Netherlands regularly monitors international developments in this area to assist them in identifying, or at least confirming, important issues that need to be addressed. The hazards that have been identified as a policy concern in the Netherlands include the following:

- 1) *Formaldehyde*: formaldehyde and urea formaldehyde (commonly used in a variety of building materials and some glues) were isolated because of their carcinogenic characteristics. Existing bylaws regarding the use of products containing formaldehyde (initially developed in 1973) have recently been revised and applied more stringently.
- 2) *Asbestos*: the use of all asbestos-containing materials (including insulating and building materials) has been strictly regulated in the Netherlands for some time.
- 3) *Radon*: studies have indicated that, of the radon radiation that occurs in the Netherlands, 65% enters from outside the building structure (contaminated sites, etc.), while building materials (including particle board, gypsum, and some concretes) are responsible for 35% of indoor radon radiation. Mechanisms which are proving to facilitate the infiltration of radon from the ground into crawl spaces is an area of particular concern and has recently prompted additional research. The infiltration of

⁶⁶ The Ministry of Housing, Planning and Environment (1986), pg. 1.

radon is addressed by both voluntary measures (guidelines and information leaflets) and building code restriction stipulating ventilation requirements.

- 4) *Carbon Filters and Humidifiers*: the immediate concern with respect to both carbon filters and humidifiers in air treatment and air conditioning systems is the fact that, after five months of use, the systems' carbon filter has been proven to host a range of bio-organisms which have been identified as carcinogen emitters. Further research activities are currently underway.

5.8.2 Regulatory Responsibilities and Public Policy Measures

As previously noted, regulatory authority with regard to indoor environmental risk management has been distributed across a number of government departments in the Netherlands. For example, the National Board of Health recommends minimum ventilation rates that are applicable to both non-residential and residential buildings, and the MHPE develops standards and codes which regulate the use of toxic building materials.

Despite these measures, however, according to the MHPE, more information is needed with regard to chemical and biological agents in order to adequately comment on their complexity; that is, to understand the interrelationships among various agents in order to identify issues that directly effect public health and welfare. The preferred approach, suggested by the MHPE, to environmental risk policy development and implementation is to conduct further research on source emissions (e.g., the spread, diffusion and risks related to radon exposure). To this end, they recommend the following actions:

- identify pollutants, their frequency of occurrence and degree of concentration;
- estimate the exposure and toxic characteristics of both individual pollutants as well as combinations of separate agents;
- identify the emission and dispersal mechanism of these agents (e.g., polluted or toxic soil, demand gas heaters used without ventilation, etc.); and
- develop choices with respect to measures that will likely limit emissions which could be introduced either at the time of construction or, where possible, when correcting Sick Building Syndrome.

However, despite their continued research efforts to identify and understand indoor source pollutants, and contrary to existing legal regulations with regard to air quality in general, indoor air quality standards, according to the MHPE, will not be developed by virtue of the fact that compliance monitoring would be most difficult. Nevertheless, the MHPE has recommended a comprehensive public education program where developers, designers and builders will be informed of the current bylaws and regulations. In addition, this group will be instructed on the importance of understanding the relationship between lifestyle and indoor environmental quality since, to a degree, lifestyle can ultimately be influenced by design.

Finally, a Public Education Program will include a number of media efforts, such as television and newspaper advertisements and books and leaflets, that will promote responsible actions on the part of individuals with regard to the environment (e.g., choosing non-hazardous products, adhering to voluntary guidelines that ultimately protect their indoor climate, etc.).

5.8.3 *Protective Policies*

According to the information received from the Netherlands, no protective policies are in place with respect to the residential sector, nor is their development seen as an issue of any priority.

5.8.4 *Summary*

In the Netherlands, the environmental hazard issues of concern reflect those encountered in the other jurisdictions reviewed as part of this study. Similarly, the state of policy activity with respect to residential environmental hazard issues is characterized by extensive research activities. In addition, the measures taken to address the more long-standing hazards of concern (formaldehyde, asbestos, etc.) have also reflected those adopted in other jurisdictions; namely, product standards, prohibitions and building code restrictions. However, the Netherlands does depart from the behaviour of its European neighbours in that, while it has, and continues, to focus its research efforts on identifying and understanding indoor source pollutants, it has recognized the futility of residential indoor air quality standards due to the impossibility of effective compliance monitoring. As a result, while regulatory measures will continue to be implemented to mitigate the hazards posed by products *before* they enter the home, with respect to pollutants in the home and the behaviour of residential occupants, the preference of the government of the Netherlands is to rely on educational measures.

6.0 Summary and Conclusions

The past two decades have witnessed an increasing dedication of research resources, by the majority of the democratic, industrialized nations, towards the development of a more comprehensive understanding of the nature and severity of the human health risks associated with a variety of environmental hazards -- both man-made and naturally occurring. The research areas that have, and continue to be, of particular interest have focused on the identification of the suite of environmental hazards capable of posing risks to human health; measurement of the pollutant concentrations at which the risks to human health are most acute; and an assessment of the severity of the health risks associated with exposure to environmental hazards. The results of many of the research efforts undertaken to date have provided the incentive for a number of countries to focus their regulatory efforts towards the promulgation of laws directed at the abatement, control and avoidance of particular hazards, and of pollutant emissions generally.

Until quite recently, the majority of the research and regulatory activities undertaken with respect to the links between human health and environmental hazards have been directed towards understanding and ameliorating the health risks posed by exposure to pollutants in both the outdoor and industrial indoor environments. In essence, the assumption which appears to have guided most government activity in the past was that "... exposures from which people should be protected occur primarily in industrial and outdoor settings. This implies that the air quality in other environments, such as inside buildings or vehicles, is acceptable from a public health perspective."⁶⁷ However, since the mid to late 1980s this assumption has been progressively challenged. Specifically, the research undertaken to-date to assess the potential health effects of exposure to pollutants in both the outdoor and industrial indoor environments, not only served to raise the level of awareness concerning the risks posed by environmental hazards generally, but it also led researchers and policy makers to continually reevaluate their definitions of what constituted a safe environment from a human health perspective. As a consequence, research activities, and subsequent regulatory attention, progressively expanded to encompass the potential health concerns associated with exposures to environmental hazards within the occupational sector (e.g., sick-building syndrome), in commercial/public buildings and, most recently, the residential sector.

A variety of departments and agencies, in a number of countries, are now in the process of assessing the range of policy responses capable of addressing the concerns associated with residential environmental hazards. Within Canada, much of the responsibility for investigating and developing these options falls to the Canada Mortgage and Housing Corporation. Residential environmental hazards are of concern to CMHC for a number of reasons. To begin with, as the federal government's housing agency, CMHC has the authority, under the *National Housing Act*, to investigate issues which pose a risk to housing accommodations in Canada. Residential environmental hazards represent such a risk and, therefore, the task of assessing and

⁶⁷ Sexton, K. (1985), pg. 106.

monitoring the potential health risks posed by these hazards is clearly within CMHC's mandate. Residential environmental hazards also represents an issue of concern to CMHC due to the financial and legal risks that these hazards may impose on the Corporation as a consequence of executing its roles as a landlord, administrator of social and federally assisted housing programs, a developer, and as an insurer of mortgages. For example, CMHC could be held liable for the remediation of environmental hazards present on the properties it administers/controls, as well as any compensation for damages associated with these hazards. Similarly, the Corporation could face significant financial risks if it is assigned the responsibility of remediating a contaminated property acquired as a consequence of a default on a mortgage guaranteed by CMHC.

Given the Corporation's authority to investigate issues affecting housing conditions, and given the potential financial and legal risks that residential environmental hazards may impose on the Corporation, CMHC is in the process of developing policy options with respect to these hazards. As part of that process, the ARA Consulting Group was contracted to evaluate the residential environmental hazard policy options developed in a variety of jurisdictions external to Canada, and to assess their applicability to CMHC. The execution of this study involved: (i) a review of the literature respecting environmental hazard policy; and (ii) a case study analysis involving interviews with housing policy representatives in seven international jurisdictions, including: the United Kingdom, the United States, the State of California, the Federal Republic of Germany, the Netherlands, Sweden and Denmark. In conducting this study, the focus of the analysis was confined to policy options developed with respect to environmental hazards associated with the site of a residence or its physical structure. Policy options designed to address the hazards associated with appliances and products, which are not part of the physical structure of the residence and can be removed, were not addressed. Similarly, hazards that arise directly as a result of the personal habits of homeowners and residential occupants (such as smoking, etc.), and the applicable policy options, were not addressed. The main findings from the two components of our analysis are summarized below.

6.1 Residential Environmental Hazard Issues

The published literature addressing the residential hazards of concern to policy makers is extensive in terms of the presentation of epidemiological studies of the health effects associated with particular hazards; the concentrations at which the health risks were most acute; the factors that could affect the dose-response relationships; etc. However, descriptions of the present and emerging environmental hazards of concern in the residential sector are quite limited. On the basis of the limited information presented in the literature, the hazards which appear to be of primary concern to policy makers essentially represent a sub-set of the hazards under investigation in the commercial, industrial and occupational indoor environments. The specific hazards are presented in Exhibit 6.1 below.

Exhibit 6.1: Summary of Residential Environmental Hazard Issues

- Formaldehyde Concentrations
 - Volatile Organic Compound Concentrations
 - Lead Based Paints
 - Soil Contamination and Soil-Gas Infiltration
 - Radon Infiltration
 - Asbestos Concentrations
 - Respirable Particles
 - Mould Spores
-

The results of the interview analysis confirmed that these hazards represented the issues of current or emerging concern in the residential sector. The interview results further indicated that, while each of the environmental hazards presented has been identified as legitimate issues of concern to policy makers, differences exist in terms of the priorities assigned to these hazards in the various jurisdictions. However, despite these differences, the hazards indicated as having the highest priorities for assessment and management in each of the jurisdictions reviewed include radon, formaldehyde, asbestos and lead.

6.2 Public Policies

Public Policy Options

While certain countries have maintained residential environmental hazard issues as an active research topic for a number of years, for the majority of the jurisdictions reviewed as part of our analysis, the emergence of residential environmental hazards as a subject of active policy development and implementation is a very recent event. As a consequence, it was not surprising to find that the results of the literature review and the interview analysis were not particularly enlightening in terms of defining the range of policy approaches available to address residential environmental hazard issues. In fact, the suite of policy options described in the literature, and by the individuals interviewed in other jurisdictions, as being applicable to the residential sector, are no different from the measures that governments have traditionally relied upon to address environmental hazard issues in the non-residential sector. The particular regulatory and non-regulatory policy options suggested are presented in Exhibit 6.2 below.

Exhibit 6.2: Summary of Public Policy Tools

Regulatory Public Policy Tools

Air Quality Standards
Emission/Product Standards
Application Standards
Prohibitive Bans
Building Code Restrictions
Warnings

Non-Regulatory Public Policy Tools

Health Guidelines
Information/Education Programs

The apparent lack of innovation in either regulatory or non-regulatory management measures, indicated by our analysis, may simply reflect the recent emergence of residential environmental hazard issues as an active policy area in most countries. However, the lack of innovation in policy measures has implications in terms of the likelihood that governments can effectively address the hazard issues of concern in the residential sector. Specifically, while each policy tool presented has its own particular strengths and weaknesses, our analysis suggests that these tools, taken individually or collectively, are unlikely to offer a unique or comprehensive solution to the problems that residential environmental hazards present (this is especially true of the regulatory measures) for the following reasons:

- The majority of the identified policy measures can only effectively address residential environmental hazard issues arising in the future: the setting of product standards, bans or building code regulations will not normally effect existing structures.
- In non-residential environments, public exposures to environmental hazards are not seen as voluntary acts. Thus, given its responsibility to protect public health, governments can impose air quality standards, ventilation requirements, HVAC maintenance procedures, and smoking restrictions to address environmental hazards arising from inadequacies in existing structures, and to limit behavioural impediments to hazard reduction. With respect to environmental hazards in the residential sector, exposures are not seen as an involuntary act. Furthermore, many of the environmental hazards present in existing residential structures stem from, or are exacerbated by, the behaviour of residential occupants. Due to the nature of the exposure relationship in the private, residential sector, a number of governments are grappling with the question of whether they have a legitimate right to directly regulate the behaviour of homeowners within the

confines of their residences. The resolution of this issue may indicate that policy tools which can adequately address environmental hazards in the non-residential sector may not be permissible in the residential environment (e.g., due to possible infringement of rights, resistance by homeowner's to government intervention, inability of the government to prescribe behaviour, etc).

- The effectiveness of many of the available tools is dependent, to a certain degree, on the recognition by residential occupants of the nature and severity of the risks associated with the hazards to which the various measures apply.
- Irrespective of whether policy makers would be willing to actively, and overtly, intervene in the residential sector, given the nature of the residential sector, effective compliance monitoring and enforcement of many of the traditional regulatory measures (such as air quality standards) is a practical impossibility.

Public Policy Responses in Other Jurisdictions

The results of our analysis demonstrated that the level of activity exhibited by each of the jurisdictions reviewed with respect to the development and implementation of public policies pertaining specifically to residential environmental hazards is quite limited. In the majority of the countries reviewed, policy activity with respect to residential environmental hazards has, for the most part, been limited to: (i) research with respect to the measurement of the risks posed by environmental hazards; (ii) research with respect to the development of protocols for measuring pollutant concentrations in the residential environment; and (iii) the production and dissemination of information with respect to the nature of particular hazards and the methods available to reduce pollutant concentrations and minimize exposures.

For certain hazards, which were initially identified in the non-residential sector, and which have represented long-standing concerns to policy makers (e.g., formaldehyde, asbestos, VOCs, radon, lead), broadly similar policy measures have been implemented in each of the jurisdiction to address the risks involved. In the main, these responses have involved the development of exposure guidelines (generally developed with reference to the non-residential sector); the implementation of prohibitive bans and product standards (e.g., formaldehyde emission standards for plywood and particle board, bans or restrictions on the use of asbestos in construction and building materials, bans or restrictions on the use of urea-formaldehyde foam insulation, etc.); the implementation of building code restrictions (e.g., minimum ventilation requirements, the installation of soil-gas retarder membranes to limit the infiltration of radon and other soil gases, etc.); and the distribution of information pamphlets. However, as these examples point out, the majority of the management measures that have been developed and implemented to-date have been designed to address hazard issues common to both the non-residential and residential indoor environments.

The reasons for the apparent immaturity of policy development and implementation activities targeted specifically on hazard issues as they present themselves in the residential sector vary by country. However, the results of the case study interview analysis suggest that the following

factors appear to represent the primary impediments to the development and implementation of residential environmental hazard policy, and apply, to greater or lesser degrees, to each of the jurisdictions reviewed:

The first issue which has impeded the development and implementation of policy, and which also serves to clearly distinguish Europe from North America, involves a general lack of awareness, on the part of both policy makers and the public, as to the nature of residential environmental hazards and the risks they pose. In contrast to the United States, where research and policy activity with respect to indoor air pollution generally has occurred since the late 1970s, an understanding of the risks posed by environmental hazards in both the residential and non-residential sector has only recently developed in the majority of the European countries. As a consequence, until quite recently there was very little public pressure to investigate residential environmental hazard issues, or to develop policies to mitigate the associated health risks.

The second key impediment to the implementation of policy measures relates to the absence of accurate and defensible guidelines for pollutant exposures in the residential sector. In each of the European countries, and to a lesser extent in the United States, these guidelines are seen as a basic requirement for the development of defensible and publicly acceptable policy measures for addressing environmental hazard issues in the residential sector. The development of these guidelines is being delayed, however, due to the fact that existing measurement protocols are unable to provide accurate, robust and defensible exposure measures. As a consequence, many of the countries reviewed are currently focusing their research efforts toward the resolution of the scientific and technical issues surrounding the development of robust and defensible measurement protocols.

The third factor underlying the lack of active policy development and implementation in the various jurisdictions relates to the issue of whether governments have the legal right to intervene in the residential sector, and/or whether they ought to intervene. While governments have the right to take action to protect the health of the populations they govern, they also have a responsibility to protect a citizen's personal and property rights. A determination of the balance between these responsibilities is seen as a prerequisite to the development of policy as the balance selected will place limits on the types of measures that can be considered to address residential environmental hazards.

The final explanatory factor relates to issues of enforceability and cost-effectiveness. While it is possible to conceive of a variety of policy measures to address environmental hazards, given the nature of the residential sector, many of the potential measures may have to be ruled out simply because they cannot be enforced in a practical and cost-effective manner -- this is especially true of the more traditional management options.

As demonstrated in the interview analysis, the resolution of the majority of these issues is generally seen as a necessary precursor to the development of effective public policy responses to residential environmental hazard issues. Furthermore, the inability to resolve many of these issues (and particularly the development of measurement protocols and exposure guidelines) has curtailed policy development and implementation activities in a number of countries. Until these

issues are resolved, and governments (predominantly in Europe) become confident that they have established the bases for the development and implementation of policy measures which would be acceptable and defensible in the eyes of politicians, the courts and the public, policy activity with respect to residential environmental hazards will continue to be characterized by research and the dissemination of information.

6.3 Protective Policies

The last issue addressed in both the literature review and interview analysis involved the identification and assessment of protective policies; i.e., policies adopted by organizations in an attempt to limit their liability and exposure to litigation. Protective policies are of particular interest to lending institutions and mortgage guarantors, such as CMHC, due to the legal and financial risks associated with exposure to environmental liability. Specifically, through its role as developer, landlord, administrator and insurer of mortgages, CMHC may incur financial losses as a result of having to incur remediation expenses, through devaluation of property assets, legal expenses, etc.

The results of the literature review indicated that a small number of policies/practices have been developed to minimize the legal and financial risks associated with exposure to environmental liability. The specific protective policy tools identified in the literature include:

- Borrower Warranties
- Borrower Credit Assessments
- Site Assessment
- Red-lining Industries and Locations
- Disclosure Policies

In terms of the application of these policies, the results of the interview analysis indicated that the United States and the European countries differed dramatically in terms of both the importance attached to the issue of environmental liability, and the priority assigned to the development of protective policies. In the United States, environmental liability issues have been prominent for a considerable period of time, and specific assignments of liability for environmental hazards have been enshrined in a variety of statutes, such as the *Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)* of 1980. As a consequence, a variety of lending institutions and government agencies have adopted policies to shield themselves against liability. The most common form of protective policy encountered in the United States, and the one adopted by the Department of Housing and Urban Development, the Federal National Mortgage Association (Fannie Mae) and the Federal Home Loan Mortgage Corporation (Freddie Mac), is the requirement for environmental site assessments as a condition of mortgage approval and/or guarantee.

In contrast to the situation in the United States, the European countries view protective policies as either unnecessary, or a very remote priority for development. In addition, while liability for residential environmental hazards is a realistic concern in the United States, most European countries do not anticipate that it will emerge as a policy issue.

6.4 Implications for CMHC

The broad objective of this study was to determine whether a review of the public and protective policies developed and implemented to address environmental hazard issues, in a variety of jurisdictions external to Canada, would provide new and unique alternative for CMHC to explore, or particular insights for CMHC to consider. In terms of public policies, the literature review and the interview analysis demonstrated that very little new information can be garnered from the international community with respect to emerging environmental hazard issues of concern, or the types of public policy measures available to address environmental hazards in the residential sector. What was of particular interest, however, was that the analysis uncovered a number of issues which will have a bearing on the development and implementation of an effective strategy for addressing residential environmental hazards (e.g., the development of effective exposure guidelines, issues surrounding compliance monitoring and enforceability, the inadequacy of traditional measures in addressing environmental hazard issues, etc.).

With respect to protective policies, again the analysis was not very revealing. A small number of protective measures were identified in the analysis. However, none of the tools provided a particularly novel approach to limiting and/or shifting liability. Rather, for the most part, the protective measures identified in the literature review and the interview analysis simply represent formal expressions of common sense solutions to limiting legal risks. Nevertheless, CMHC could usefully adopt the requirement for site assessments. However, the question then becomes one of who would finance the assessment, especially given CMHC's mandate to provide affordable accommodations to Canadians. Finally, none of the measures presented in the analysis are capable of adequately addressing the liability issues associated with properties already acquired by CMHC. Thus, even if site assessment requirements are adopted, environmental liability will continue to represent a risk to the Corporation given its existing property holdings and the claims it maintains on other properties as a result of its role as a mortgage guarantor.

Country Study Interviewees

The United Kingdom

- Dr. A.J. Burke, Building Regulations Division, Department of the Environment
- Dr. E. Dron, Department of the Environment
- Dr. Moore, Building Regulations Division, Department of the Environment
- Dr. P. Wroe, Toxic Substances Division, Department of the Environment
- Dr. Harrison, Toxic Substances Division, Department of the Environment
- Dr. J.W. Llewellyn, Building Research Establishment
- Dr. P. Warren, Building Research Establishment

The United States

- Mr. R. Ginella, Legal Review Division, Department of Housing and Urban Development
- Mr. R. Alexander, Office of Environment and Energy, Department of Housing and Urban Development
- Mr. R. Axlerod, Indoor Air Division, Environmental Protection Agency
- Ms. B. Spark, Indoor Air Division, Environmental Protection Agency
- Ms. R. Daniels, National Association of Home Builders
- American Society for Testing and Materials
- Mr. D. Sandela, General Council, Environmental Protection Agency

State of California

- Mr. T. Phillips, Air Exposure Assessment Program, Environmental Protection Agency
- Ms. P. Jenkins, Air Exposure Assessment Program, Environmental Protection Agency

- Dr. Liu, Indoor Air Quality Program, State of California
- Dr. Hayward, Indoor Air Quality Program, State of California

Sweden

- Sture Blomgren, Swedish Council for Building Research
- Ingersiw Mattson, Swedish Council for Building Research
- Birgitta Berglund, International Academy of Indoor Air Sciences
- Kerstin Wennerstrand, Ministry of Industry and Commerce
- Eva Reedan, The National Board of Housing, Building and Planning
- Mr. Bowman, National Swedish Institute for Building Research
- Nicoljai Tolstoy, National Swedish Institute for Building Research
- Urban Norlen, National Swedish Institute for Building Research
- Thomas Lindvall, Karolinska Institute of Environmental Medicine
- Jan Sundell, National Board of Occupational Safety and Health
- Gustav Akerblom, The Swedish Radiation Protection Institute
- Gun Astri Swedjemark, The Swedish Radiation Protection Institute

Denmark

- Ove Nielsen, Danish Agency of Housing and Buildings
- Peder Wolkoff, National Institute of Occupational Health
- Lars Molhave, Institute of Environmental and Occupational Health
- Ove Fanger, Danish Technical University
- Ove Valbjorn, National Building Research
- Michael J. Suess, World Health Organization

Federal Republic of Germany

- Dr. Bernd Seifert, Institute for Water, Soil and Air Hygiene
- Dr. Horst Esdorn, Hermann Rietschel Institute of Heating and Air Conditioning, Technical University of Berlin
- Dr. Jurgen Wegner, Institute for Water, Soil and Air Hygiene
- Dr. Reiner Turck, Federal Ministry of Environment
- Dr. Volkmar Hartje, Technical University of Berlin

The Netherlands

- Dr. N. Duinkerken, Ministry of Housing, Physical Planning and Environment
- Erik Lebrecht, National Institute of Public Health and Environmental Protection
- Il Van Duysen, Ministry of Housing, Physical Planning and Environment
- Dr. C. Van der Bogaard, Ministry of Housing, Physical Planning and Environment
- A.B. Holtkamp, Directorate General Milieubeheer, Soil Protection
- Dr. J.A. Suurland, Directorate General Milieubeheer, Physical Structure
- Leonard Alavald, Bouwcentrum
- N.A.L. Boonekamp, Bouwcentrum
- Rien Rolloos, Department of Indoor Environment, Building, Physics and Systems

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