Analysis of the Risk Regulation Regime in Canada for Controlling Major Incidents Involving Dangerous Chemicals

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List of Acronyms

BM	Behaviour modification
CBRNE	Chemical, Biological, Radiological, Nuclear and Explosive
CCPA	Canadian Chemical Producers' Association
CEPA	*Canadian Environmental Protection Act, 1999*
CIAC	Chemical Industry Association of Canada
CFATS	Chemical Facility Anti-Terrorism Standards
CI	Critical infrastructure
CIP	Critical infrastructure protection
CRTI	CBRNE Research and Technology Initiative
C-TPAT	Customs-Trade Partnership Against Terrorism
DCI	Dangerous chemical interview
DHS	United States Department of Homeland Security
E2	CEPA Environmental Emergency Regulations
HRO	High Reliability Organization
IG	Information gathering
IGH	Interest group hypothesis
MIACC	Major Industrial Accidents Council of Canada
MFH	Market failure hypothesis
NA	Normal Accidents
ORH	Opinion-responsive hypothesis
PSC	Public Safety Canada
RAP	Rational actor paradigm
RC	Responsible Care
SS	Standard setting
SMEs	Small- and medium-sized enterprises
TISN	Trusted Information Sharing Network
WaterISAC	Water Information Sharing and Analysis Center
WMDs	Weapons of mass destruction

1.0 Executive Summary

This paper reports on the results of a research project designed to identify how Canada regulates risks associated with low-probability/high-consequence events involving the chemical sector, and the contextual factors that influence this risk regulation. In referring to the chemical sector, we mean facilities, both public and private, that manufacture, store or use large quantities of chemicals. We omit from this definition petroleum, or oil and gas companies, as well as nuclear power plants. Although we acknowledge that one might classify these as dangerous chemicals, we have chosen to exclude them from the present study both for reasons of brevity and to align with Public Safety Canada's categories of critical infrastructure, which treat energy generation and chemical manufacturing separately. For the same reason, we focus primarily on the manufacture and storage of chemicals rather than their transport by truck, rail, pipeline or other means, which again falls into a separate critical infrastructure category. We do, however, include water utilities in our study given their extensive use of chemicals such as chlorine.

In addition, we are interested primarily in *major incidents*, whether the product of technological (or process) failure, natural disaster or malicious intent. Major incidents are sudden events that necessitate a departure from routine emergency response procedures. They often cause property damage, evacuations and, in extreme cases, death, but less destructive events may also qualify as major incidents. We include in this category the fertilizer plant explosion in West, Texas, and the Sunrise Propane incident in Toronto. In short, we are concerned with rare adverse events whose severity requires a non-standard response, often by more than one emergency service.

Our definition of major incident includes terrorism, an uncertain risk (Renn 2008). There is insufficient data about the risk of terrorism to build a robust risk modelling framework. Indeed, our literature review, which relied on data available in the public domain, uncovered very few cases of either planned or executed terrorism-related violence against Canadian facilities that use or store chemicals.[1] A study of water-related

[1] The details of some incidents, including for example the alleged 2013 plot by an industrial biotechnology doctoral student to derail VIA Rail trains (Shephard and Livingstone, 2013), suggest not all attempts to use

terrorism, for example, found in the past century only one instance of a threat, which went unfulfilled, against a Canadian water utility (Gleick, 2006). Although the risk to such facilities should not be discounted, especially given that terrorists and militaries have in the past used industrial chemical facilities as makeshift WMDs (United States, 2000), a successful attack generally requires the perpetrator to possess "sufficient technical background [in] chemical operations" (Lou *et al.*, 2003: 418). The sophistication of many chemical facilities serves in this way as a security feature. The same is true of water facilities, whose complexity precludes the easy deliberate contamination of a community's water supply (Salzman, 2012).

More likely, and potentially more damaging, is the weaponization by malicious groups of stolen or purchased chemicals. A prominent recent example of this is the Toronto 18 group, whose plans included bombs made of ammonium nitrate fertilizer (Wilner, 2010). Still, even these activities require at least some familiarity with chemical processes. Barrett and Adams (2011), for example, report that the damage caused by detonating a chlorine truck in an urban centre varies considerably based on the perpetrator's knowledge of the manner in which the chlorine is stored, the proportion of chlorine vapour that will be consumed by the initial detonation and prevailing weather conditions.

Finally, note that the focus of this paper is the regulatory regime in place to prevent these and other types of major incidents. Hood *et al.* define regime as "the complex of institutional geography, rules, practice and animating ideas that are associated with the regulation of a particular risk or hazard" (Hood *et al.*, 2001: 9). In general, we do not discuss specific plans or processes for responding to crises involving chemicals; the paper is not intended to provide detailed emergency management guidelines or comment on such guidelines. Rather, the paper should be read as an account of the regulatory regime that controls risks associated with dangerous chemicals *before* they manifest as major incidents.

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chemicals for violent purposes are immediately made public. In addition, incidents such as the alleged plot by a Surrey couple to bomb the BC legislature highlight the relative ease with which common products can be weaponized (Bolan and Hager, 2014).

1.1 Methodology

We employ the Hood, Rothstein and Baldwin (2001) meso-level risk regulation regime framework to frame our analysis. Between 2011 and 2013, we conducted 18 semi-structured interviews, which included regulators, owners, operators and managers. Interview subjects came from four types of organizations: water utilities, which use chemicals for treatment purposes; emergency management offices and fire departments, which are responsible for responding to chemical disasters; chemical industry associations; and government regulatory agencies. Most interview subjects worked for Canadian organizations, although we also interviewed specialists from Australia, the UK and the U.S. to provide some comparative perspective (see Appendix A for a full list of interview participants). Throughout the paper, we use the acronym DCI (i.e. Dangerous Chemical Interview) to refer to evidence gathered from an interview participant. The interview tool and process were approved by Dalhousie University's Research Ethics Board. We also conducted a review of the academic and grey literature and a media analysis of 24 post-9/11 critical infrastructure (CI) events, four of which primarily affected the dangerous chemical sector. For a more detailed description of our methodology, please see Appendix B.

1.2 Limitations

As with all social science work, our research must be considered in light of certain methodological limitations. Our findings reflect the knowledge and perceptions of a small group of highly qualified interview participants at a specific moment in time. Our literature review was restricted to information available in the public domain. Our interpretation of this data reflects the analytical model (the Hood *et al.* framework) that we employed to draw observations from the interview transcripts. Our objective is not to provide an exhaustive account of chemical safety and security regulation in Canada, but rather to contribute to a deeper understanding of specific issues with respect to major incident risk perception and management. Above all, our analysis suggests that further

research in the area of chemical risks and risk governance – a broad and complex subject – is warranted.

1.3 What We Found

The use of chemicals is heavily regulated in Canada. Chemical facilities are subject to numerous regulatory requirements related to safety and security, including in the areas of occupational health and safety, emissions, waste disposal and so on. These requirements emanate from federal and provincial statutes and, in some cases, from municipal bylaws. The regime for controlling chemicals risks is thus an amalgamation of separate mechanisms: it is more accurate to speak of multiple, loosely related regulatory systems than of a single, cohesive, national approach to regulating chemical safety and security risks. Acknowledging the diverse and at times haphazard nature of the regime is an important first step in understanding its dynamics and identifying areas of potential improvement.

In areas beyond formally regulated health and safety and environmental protection, however, the regime is less dense. A key finding of our research is that in the context of *major incidents*, the Canadian regime is balanced towards an approach that values flexibility, particularity (rather than rigid standardization, or 'one-size-fits-all') and collaboration between CI operators and government regulators. Thus, when we refer in the following paper to the absence of government standards with respect to major incidents, we mean the absence of what Neil Gunningham calls "direct regulation" (1998: 548); we do not mean to imply that the regulatory space is empty or that governments and industry are unconcerned with controlling major incident risks.

Our findings are organized according to the structure of the Hood *et al.* framework. This model considers the *content* and the *context* of a risk regulation regime. The former concept – content – builds on the cybernetic theory of control to examine the management of a specific policy area. It asserts that the three dimensions of control – information gathering, standard setting and behaviour modification – must be present in order for the entire system to be under control. The latter concept – context – refers to three factors that typically shape regime content: the technical nature of the risk (market

failure hypothesis), the public's and media's opinions about the risk (opinion-responsive hypothesis) and the way power and influence are concentrated (interest group hypothesis).

1.3.1 Regime Content

Information Gathering

Information gathering represents the largest component and primary focus of the regime, encompassing a wide range of monitoring, research and information-sharing mechanisms. There is an emphasis on formal multi-jurisdictional and public-private structures, but informal and discreet information sharing also occurs on the basis of trusted personal relationships. Interview participants reported largely positive and effective relationships when sharing information *within* their organizations – within industry associations, government agencies and CI facilities. Participants disagreed, however, on the quality, relevance and regularity of information sharing *between* CI operators and government agencies responsible for CI protection, which may be a product of conflicting expectations with respect to how, why and with whom information may be disseminated.

Sectors differed in their opinions of how things might be improved. Water utilities and fire fighters, for example, called for the creation of information-sharing platforms on which CI operators could freely exchange information and best practices with one another, while chemical industry participants preferred that context-specific information be provided by government on demand and in industry-preferred format. The former attitude suggests a preference for flat organizational structures and communitarian decision-making, whereas the latter reflects a desire for limited government intervention, and a preference for market-type efficiency and corporate autonomy with respect to risk regulation. The responses provided by government regulators, which emphasize the importance of rules and structure in the context of information sharing, suggest a bureaucratic orientation.

Standard Setting

Overall, the regulatory space for controlling major incidents is characterized by low levels of policy aggression, meaning standards have limited ambition with respect to behavioural change and are intended to be minimally disruptive (Hood *et al.*, 2001). On balance, standards are set through a combination of technocratic processes and bargaining among stakeholders. This is particularly true in the case of the chemical industry, where the regime's standard-setting component reflects a collaborative, consensus-based relationship between government and the private sector. Industry-promulgated standards, such as Responsible Care, are prevalent, and the development of new standards by government generally involves extensive consultation with representative industry associations. In permitting facilities a degree of freedom to implement practices tailored to their unique circumstances, the regime is generally responsive to private sector interests, which can assist with commercial innovation and growth. Water utility operators, however, reported limited interaction with government agencies responsible for CIP and that, consequently, they tend to rely on best practices and standards developed by U.S. or international organizations. The emergency responders we interviewed similarly called for greater clarity and guidance with respect to standards for storing dangerous chemicals (although they reported satisfaction with standards for *responding* to chemical incidents). Regulators consistently expressed satisfaction with the standard-setting component of the regime. Overall, we found that the relative absence of stringent, government-imposed standards enables flexibility and reflects a high-reliability approach towards safety and security, in which processes and structures are designed to be adaptable, responsive, redundant and dispersed (La Porte, 1996). Yet at the same time, this orientation potentially permits inconsistency across the regime, facilitating lax or ineffective safety and security practices among CI operators who choose not to prioritize safety and security. Where regulations do exist (for example, the Environmental Emergency (E2) Regulations of the *Canadian Environmental Protection Act, 1999* (CEPA 1999)), attitudes vary with respect to their effectiveness and stringency.

Behaviour Modification

Behaviour modification appears to be the smallest component of the regime. The academic and grey literature suggest that the resources dedicated to enforcement may be low in absolute terms. This was also the perception among our water utility, emergency management and industry interview subjects. Enforcement and compliance appears to be a particular problem in the case of SMEs that are less organized (and often do not subscribe to self-regulation initiatives), possess fewer resources and less expertise and, compared to large organizations (multinational chemical companies, for example), struggle to achieve compliance. Interview participants were generally in agreement that industry associations are typically successful in securing compliance with industry self-regulation initiatives through verification audits and other means; these are also an effective means by which to share best practices across the industry. The academic literature, however, is inconclusive regarding the effectiveness of compliance efforts, which tend to use education, persuasion and collaboration rather than punitive sanctions. Whereas some research suggests that RC membership reduces the likelihood of accidents (Finger and Gamper-Rabindran, 2013), other studies find that RC participating firms raise their pollution rates (Gamper-Rabindran, 2013) and that commitment to the initiative is difficult to maintain without explicit sanctions (King and Lenox, 2000). Again, differences in style or organizational culture between sectors appear to influence perspectives on behaviour modification. Water utilities and fire fighters tended to support greater government intervention while industry participants preferred collaborative enforcement mechanisms, in which government supports industry self-regulation efforts. None of our participants called for the reduction of efforts to influence the behaviour of high-risk facilities; at issue was the style and scope of the processes to be used.

1.3.2 Regime Context

Market Failure Hypothesis

The market for chemicals is variegated, complex and dynamic, both in terms of firm structures and products. While there are significant differences between multinationals

and SMEs, the sector as a whole is largely competitive, and product and process innovations are key sources of profit. Chemical products and firms vary in their significance to CI. Some are easily substitutable; others are not. Some represent high-consequence single points of failure; others have multiple redundancies. Some chemicals can be weaponized; others cannot.

On the one hand, MFH has some explanatory power in the context of dangerous chemicals. The market seems to be reasonably stable and efficient; catastrophic events are extremely rare; information is difficult to come by and government has tended to focus its efforts on facilitating information exchange. On the other hand, such events cause considerable social and economic damage to communities. Because they are low-probability events, market logic would rarely justify investing much in these unlikely, what-if scenarios. Reliable risk models are difficult to develop and are not entirely reliable or trustworthy. Several factors, including information asymmetries, moral hazard problems, negative externalities, problematic insurance requirements and limited tort-law processes, point to a context that perpetuates vulnerabilities. Moreover, the ubiquity of chemicals in modern society indicates high costs for opting out of chemical-related risks. A government risk regulation regime underpinned by market failure logic would intervene to reduce *both* information and opt-out costs. While the regime does exhibit some degree of government intervention, for example in the form of information sharing mechanisms intended to reduce information costs, on the whole our research suggests a preference for industry self-regulation, which is largely voluntary, excludes many SMEs and lacks transparency and at times, rigour. Therefore, while the probability of these events may be low, the consequences are also catastrophic; weaknesses persist and government does not seem to take a sufficiently aggressive stance to address these weaknesses. In short, the regime's position does not fully reflect the predictions of the market failure hypothesis.

Opinion-Responsive Hypothesis

The psychology of risk literature and our media analysis highlight several reasons why CI operators who use, manufacture and store dangerous chemicals are sensitive to

media coverage. The public has a fascination with and strong aversion to low-probability/high-consequence events. The aversion the public feels towards these events is reinforced in chemical events, in particular due to public distrust of multinational corporations, the perceived artificiality of chemicals (a process seemingly contrary to nature), the availability heuristic (previous chemical disasters are easily recalled, such as *Exxon Valdez*, or the BP oil spill in the Gulf of Mexico), the perceived lack of control over chemical risks (particularly in the case of chemical facilities in urban centres, such as the Sunrise Propane explosion and West, Texas, fertilizer disaster) and the (often over-simplified) demand for accountability in the wake of disasters caused by human error. More generally, public anxiety regarding chemicals has been growing in the modern era since at least the First World War (van Courtland Moon, 1984), with efforts to regulate chemicals gaining momentum in the 1960s with the publication of Rachel Carson's *Silent Spring* and the Cuyahoga River fire (Opheim, 1993). In Canada, rising public concern is evident with respect to the sustainability of the country's freshwater supply and the risks associated with fracking (De Villiers, 2003; Salzman 2012; Pentland and Wood, 2013).[2] At the same time, it is unclear whether the public would be willing to pay the full cost of improving the safety and security of the water supply.

With respect to well-organized industry associations, the Opinion-Responsive Hypothesis (ORH) highlights how industry outreach efforts may be understood as a stratagem to shape public opinion rather than as a product of increased demand for transparency. At the same time, the ORH helps to explain the tendency by government to explore (if not act on) regulatory changes in the immediate aftermath of major incidents, such as Sunrise Propane.[3] At a minimum, low-probability/high-consequence events usually disrupt the normal control mechanisms and create an opportunity for change.

[2] According to Renn's (2008) risk typology, the uncertainty associated with fracking may contribute to risks, perhaps in the form of civil unrest, stemming from public distrust or hesitation regarding its perceived hazards.

[3] Two weeks after the Sunrise Propane explosion, Ontario announced the formation of an independent panel to review how propane was regulated in the province. The panel submitted a report within three months. About a year later, the Ontario Legislature introduced stricter safety standards for propane facilities and a new, independent safety officer to oversee the Province's regulatory activities (Ontario, 2011).

Interest Group Hypothesis

Our application of Wilson's typology of interest group pressures suggests that notwithstanding periods of instability in the 1970s and 1980s following increased environmental activism, the chemical regime tends towards stable *Client politics* involving government and larger chemical firms with limited participation from environmental groups. The relationship between industry and government provides concentrated benefits to industry while producing diffuse costs, spread across consumers. By retaining regulatory influence through programs such as Responsible Care, the largest chemical companies are able to calibrate the level and nature of competition in the market, thereby preserving crucial structural advantages. In addition, the regime enables industry to maintain compliance with U.S. standards, which is necessary to ensure continued access to that country's market. The effects of this arrangement are evident in policy changes following 9/11, which introduced low-aggression information sharing mechanisms such as the Environmental Emergency (E2) regulations and the Suspicious Incident Reporting (SIR) system rather than prescriptive standards or stringent behaviour modification programs. It is also not clear the Responsible Care program has modified its governance structure or membership to demonstrate increased security concerns, for example. Despite the association of client politics with regulatory capture, we found evidence that the existing regulatory system may enable the achievement of government objectives. For example, the close relationship with industry allows regulators at the federal level to influence the regulation of chemical risks in a manner that might otherwise exceed their jurisdictional authority. Water utilities, by comparison, generally operate in non-competitive environments and arguably have limited incentive (or capacity) to influence regulatory standards. As well, their geographic disparity and varying sizes preclude their easy organization into an effective interest group. The apparent absence of lobbying by fire fighters for stricter standards for chemical use and storage is not, on the face of it, in accord with the predictions of the Interest Group Hypothesis (IGH). This may be due to the relatively low importance fire fighters place on this issue vis-à-vis other priorities. At the same time, events such as the fertilizer explosion in West, Texas, the Sunrise Propane explosion and the continued urban

expansion into areas in which dangerous chemicals are traditionally stored may prompt fire fighters to organize more effectively on this issue in the future. We conclude that IGH offers the strongest explanation for the day-to-day operation of the chemical regime with respect to controlling risks associated with major incidents, although, as we note above, its regular dynamics are susceptible to disruption by ORH.

1.4 What We Recommend

The following recommendations reflect the results of our analysis of interview transcripts and the related academic and professional literature. The evidence that supports these recommendations is developed more fully in the body of the report.

With regard to Water Utilities, Emergency Response Services (Fire Service) and Municipalities

- Develop improved information sharing platforms for both emergency responders and water utilities. For emergency responders, access to a centralized database of chemicals stored at fixed sites would enhance safety and may reduce the lethality of future West, Texas, type incidents. For water utilities, many of which operate in relative isolation and with few resources and limited technical capacity, more effective common information sharing platforms, perhaps modelled on the United States' WaterISAC, would help disseminate best practices with respect to risk management and security techniques related to the storage and use of dangerous chemicals.
- Conduct an audit of security practices of Canadian water utilities and use the results to improve consistency across jurisdictions and to support targeted capacity-building in areas where utilities are underperforming.
- Provide additional support (for example, in the form of guidelines and training) to municipalities in order to improve their land-use planning, and where and how they can store dangerous chemicals. The expansion of towns and cities into zones in

which dangerous chemicals are traditionally stored exemplifies an emerging challenge.

- Improve access, especially for small communities, to expert resources needed to deal with major incidents. Build resilience by expanding on existing adaptive capacity and mutual assistance agreements to ensure major incident responses are timely, effective and integrated. In scenario planning exercises, for example, exercises should include (among other things) a focus on containment, vulnerabilities caused by single points of failure, recovery, coping with surprises, extensive and emotive media coverage, risk trade-offs, judgement under stress, liability and insurance issues and interacting with different (and unpredicted) players. At the national level, identify where expertise and resources are located for rapid deployment. The recent response to the potential radiation leak at the Port of Halifax in 2014 (CP, 2014) highlights the benefits of national coordination in this area.

With regard to Small- and Medium-Sized Enterprises (SMEs)

- Address vulnerabilities among SMEs by incentivizing business continuity and risk management planning. Because the cost of compliance with existing standards and best practices can be prohibitive for small companies, develop programs targeted specifically at the unique needs and capacities of SMEs. Encourage SMEs to build on existing safety practices to enhance security practices and in so doing introduce and enhance security culture.

With regard to Government-Industry Interaction

- Improve transparency, outward reporting, public engagement and democratic oversight regarding the state of private sector CI preparedness. Use public inquiries, reports and audits in the aftermath of failures, for example, to identify lessons in a timely manner; use these inquiries also to encourage a learning culture among private sector CI operators and government regulators, and to develop a more informed

citizenry and media better able to hold government and industry to account on such matters.

- Clarify accountability in order to improve pre-event effort and to reduce the potential for post-failure blame-shifting. Collaborative arrangements normalize opacity and ambiguity with respect to the distribution of responsibility among interested parties. As a result, industry self-regulation as a suitable alternative to direct regulation allows challenges to linger unaddressed and calls into question the accountability of government regulators and industry. Improving transparency and clarity in this area will encourage both regulators and CI operators to take a more active role in addressing chemical risks in advance of events.
- Take a North American perspective. Canadian manufacturers export regularly to the American market and as a result meet American standards, such as C-TPAT. American regulators, therefore, have a considerable impact already on the behaviour of Canadian manufacturers. To a degree, then, influencing Canadian manufacturers depends on influencing American regulators. In addition, different standards between countries generate new costs and raises questions about the effectiveness of Canadian standards. This in itself can be a risk to the Canadian industry, particularly should an event occur.

With regard to Regulators of Dangerous Chemicals

- Adopt new approaches to sanctioning compliance failures and changing behaviour, since tort and criminal law proceedings often require significant resources and time. At times, voluntary industry self-regulation may not be sufficiently transparent or aggressive. In addition, legal proceedings – while necessary – may diminish public confidence in the efficacy of accountability and enforcement mechanisms due to the time required to reach a conclusion; behaviour change strategies must be prompt and efficient and have an appropriate reach across the sector. In addition, focus on addressing early warning signs, which were ignored, for example, in the case of the Sunrise Propane explosion.
- Major chemical incidents are few; each one has to be studied. Encourage organizational learning across the sector after failures in Canada or abroad that

contribute to major incidents. Focus on using failure data to develop more reliable probability models and enhanced understanding of risk trade-offs and the costs and controversies of precautionary approaches.

- While this paper does not address transportation issues explicitly, better communication and coordination between orders of government with respect to the safe transportation of dangerous chemicals would improve the overall effectiveness of the regulatory regime.

1.5 Future Research

Our analysis uncovered several areas where further research is warranted. These areas are identified below. They are included for various reasons. In some cases, they were frequent themes in the academic and grey literature yet were rarely mentioned by our interview participants. In other cases, they grew out of questions that emerged from our analysis. We highlight these themes because they represent potential threats and opportunities for the chemical sector in particular and Canadian society more generally.

- US policy already influences the behaviour of Canadian chemical facilities, including chemical manufacturers and water utilities. How can Canada coordinate more effectively with the US regarding major incident risk regulation?
- What is the appropriate level of public engagement regarding chemical regulation? In light of the potential for public anxiety about chemicals, is it possible to improve democratic oversight and transparency of the sector in a sensible, effective manner? How can government conduct public consultations, for example, that elicit reasonable input without being commandeered by extreme interest groups or industry? What is the proper balance between transparency and security in the context of sharing information about chemical facility risks?
- How is the sector addressing cyber-security? According to some of our interview participants, particularly those representing industry, cyber risks remain a key vulnerability for the sector. Other participants did not mention cyber issues at all. Although our interview tool did not focus on cyber-security, the academic and grey literature suggests that additional research in this area is needed.

- What methods to bring about immediate change, outside of courts, can government use to modify behaviour? Beyond the legal system, what tools are available to regulators to change attitudes and behaviours regarding chemical safety and security? How can government use public education, or arguably a more aggressive stance, to achieve desired outcomes?[4]
- More generally, how does the regime react to failures that lead to major incidents? Given the types of risks posed by dangerous chemicals, what emergency management strategies are best suited to responding to and controlling major incidents? The Hood *et al*. framework explains the status quo of the regime; it is less helpful in identifying how contextual pressures – the market, public opinion and interest groups – behave following disruptive events. Although this paper considers this issue briefly, a more thorough analysis would lend deeper theoretical rigour to questions about how organizations react to failures.

[4] Consider, for example, President Obama's admonishment of BP executives in the wake of the Deepwater oil spill (Goldenberg, 2010). By applying considerable pressure on BP executives, Obama was able to extract a commitment to invest in the clean-up and reconstruction of the affected communities on the Gulf Coast.

2.0 Résumé exécutif

Cet article dresse un rapport relativement aux résultats d'un projet de recherche pour identifier la façon dont le Canada régularise les risques liés aux événements à faible probabilité/lourde de conséquence impliquant le secteur chimique, et les facteurs contextuels qui influencent ce règlement de risque. En nous rapportant au secteur chimique, nous entendons par là les établissements, publics et privés, qui fabriquent les produits chimiques, qui en font un stockage ou qui en utilisent en grandes quantités. Nous omettons de cette définition les compagnies de pétrole et de gaz aussi bien que les centrales électriques nucléaires. Bien que nous reconnaissons qu'on pourrait classifier ces derniers comme produits chimiques dangereux, nous avons choisi de les exclure de la présente étude par souci de brièveté et pour nous aligner avec les catégories de l'Acte de la sécurité publique Canada de l'infrastructure essentiel qui traitent séparément la génération d'énergie et la fabrication de produits chimiques. Pour la même raison, nous nous concentrons principalement sur la fabrication et le stockage des produits chimiques plutôt que leur transport par camion, par rail, par pipeline ou par tout autre moyen, ce qui entre encore dans une catégorie critique et distincte de l'infrastructure. Nous incluons cependant les services d'eau dans notre étude étant donné l'utilisation extensive de produits chimiques tel le chlore.

En outre, nous nous intéressons principalement aux *incidents majeurs*, si ceux-ci sont le produit (ou le processus) d'un échec technologique, d'une catastrophe naturelle, ou d'une intention malveillante. Les incidents majeurs sont des évènements soudains qui rendent nécessaire un écart par rapport aux procédures courantes d'intervention d'urgence. Ils causent souvent des dégâts matériels, des évacuations et, dans les cas extrêmes, la mort, mais les évènements moins destructifs peuvent également être qualifiés d'incidents majeurs. Nous incluons dans cette catégorie l'explosion de l'usine d'engrais à West, au Texas et l'incident de Sunrise Propane à Toronto. En bref, nous nous intéressons aux évènements indésirables et rares dont la sévérité exige une réponse non standard, souvent par plus d'un service de secours.

Notre définition d'incident majeur inclut le terrorisme, un risque incertain (Renn 2008). Il y a des données insuffisantes au sujet du risque de terrorisme pour établir un

modèle robuste. En effet, notre révision de la littérature, qui s'est fiée aux donnés dans le domaine public, a découvert très peu de cas de violence reliés au terrorisme, soit projeté ou exécuté, contre les installations canadiennes qui emploient les produits chimiques ou qui en font le stockage.[5] Une étude au sujet du terrorisme lié a l'eau, par exemple, a trouvé pendant le siècle dernier un seul exemple de menace, qui est disparue sans exécution, contre un service d'eau canadien (Gleick, 2006). Bien que le risque à de telles installations ne devrait pas être escompté, particulièrement étant donné que des terroristes et les forces armées ont employé dans le passé des installations industrielles ADM improvisées (États-Unis, 2000), une attaque réussit exige généralement que le malfaiteur possède ''suffisamment d'antécédents techniques [dans] des opérations chimiques'' (Lou *et al.*, 2003 : 418). La sophistication de beaucoup d'installations chimiques sert de cette façon de dispositif de sécurité. Ceci est aussi vrai des installations d'eau, dont la complexité exclue la contamination délibérée et facile de l'approvisionnement en eau d'une communauté (Salzman, 2012).

Ce qui serait plus probable, et potentiellement plus préjudiciable, c'est la transformation en armes de produits chimiques volés ou achetés par des groupes malveillants. Un exemple récent et important serait le groupe Toronto 18, dont les projets incluaient des bombes fabriquées avec de l'engrais de nitrate d'ammonium (Wilner, 2010). Cependant, même ces activités exigent une certaine connaissance des processus chimiques. Barrett and Adams (2011), par exemple, rapportent que les dommages provoqués en détonnant un camion transportant le chlore dans un centre urbain varient considérablement dépendant de la connaissance du malfaiteur, du stockage de chlore, et de la proportion de vapeur qui serait consommée par la détonation initiale et les conditions atmosphériques courantes.

Enfin, il faut noter que le focus de ce travail est le régime réglementaire en place pour éviter ces incidents et d'autres catégories d'incidents majeurs. Hood et al. définit le terme régime comme « une complexité associée à la géographie institutionnelle, les règlements,

[5] Les détails de certains incidents, incluant par exemple, le présumé complot 2013 par un étudiant de doctorat en biotechnologie industrielle de faire dérailler des trains de VIA Rail (Shephard and Livingstone, 2013) suggèrent que pas tous les attentats utilisant des produits chimiques à des fins violents sont immédiatement transmis au public. En plus, des incidents tels que le présumé complot par un couple de Surrey en Colombie Britannique pour faire exploser une bombe dans l'assemblée législative soulignent la facilité avec laquelle on peut faire l'utilisation de produits de tous les jours pour les changer en armes (Bolan and Hager, 2014).

les pratiques et les idées animatrices qu'on associe avec la régulation d'un risque en particulier ou à un danger » (Hood et al., 2001 : 9). De manière générale, nous ne discutons pas de projets spécifiques ou des processus pour répondre aux crises qui impliqueraient les produits chimiques; cet ouvrage n'a pas pour intention d'offrir des standards organisationnels détaillés pour la gérance des cas d'urgence, ni de commenter sur de tels standards. On devrait lire cet ouvrage plutôt, comme compte rendu de régime réglementaire qui contrôle les risques associés avec les produits chimiques *avant* toute manifestation d'incidents majeurs.

2.1 Méthodologie

Nous employons la méthode méso-niveau de Hood, Rothstein et Baldwin (2001) pour régulariser les risques pour encadrer notre analyse. Entre 2011 et 2013, nous avons mené 18 entrevues semi-structurées avec des régulateurs, des propriétaires, des opérateurs et des directeurs. Les sujets d'entrevues sont venus de quatre types d'organismes : les services d'eau, qui emploient les produits chimiques pour le traitement; les bureaux de gestion des urgences et les services d'incendie, qui ont la responsabilité de répondre aux désastres chimiques; les associations de l'industrie chimique : les organismes de normalisation du gouvernement. La plupart des sujets interviewés travaillaient pour des organismes canadiens, bien que nous ayons également interviewé des spécialistes d'Australie, du R-U et des États-Unis pour fournir une certaine perspective comparative (voir l'annexe A pour une liste complète de participants d'entrevues). Dans ce rapport, nous employons l'acronyme ECD (c.-à-d. Entrevue chimique dangereuse) pour se rapporter au témoignage recueilli d'un participant d'entrevue. L'outil et le processus d'entrevue ont été approuvés par le Conseil d'éthique de recherches de l'Université Dalhousie. Nous avons aussi passé en révision la littérature académique et la littérature grise et une analyse médiatique de 24 événements d'infrastructure essentielle (IE) post-9/11, dont quatre événements qui portaient principalement sur le secteur des produits chimiques dangereux. Pour une description plus détaillé de notre méthodologie, prière de vous référer à l'Appendice B.

2.2 Les Limitations

Comme tout travail en sciences sociales, nos recherches doivent être considérées à la lumière de certaines limitations méthodologiques. Nos résultats reflètent la connaissance et les perceptions d'un petit groupe de participants hautement qualifiés interviewés à un moment précis dans le temps. Notre révision de la littérature était limitée à l'information du domaine public. Notre interprétation de ces informations reflète le modèle analytique (l'infrastructure Hood *et al.*) que nous avons employé pour tirer nos observations des transcriptions d'entrevues. Notre objectif n'est pas de fournir un compte rendu exhaustif des règlements de sûreté et de sécurité chimique au Canada mais de contribuer plutôt à une connaissance plus approfondie des questions spécifiques en ce qui concerne la perception et la gestion d'incidents majeurs à risque. Par-dessus tout, notre analyse suggère que davantage de recherches, dans le secteur risque et dans la réglementation des produits chimiques dangereux — un sujet vaste et complexe — seraient justifiées.

2.3 Ce que nous avons découvert

L'usage de produits chimiques est fortement réglementé au Canada. Les installations chimiques sont soumises à de nombreuses conditions de normalisation liées à la sûreté et à la sécurité, y compris dans les secteurs de la santé et la sécurité au travail, les émissions, l'élimination des résidus ainsi de suite. Ces conditions émanent de statues fédéraux et provinciaux et, dans certains cas, de règlements municipaux. Le régime pour le contrôle des risques de produits chimiques est ainsi un regroupement de mécanismes séparés : il serait plus précis de parler de multiples systèmes de normalisation connexes que d'une approche simple, cohésive et nationale pour réglementer la sécurité chimique et les risques à la sécurité. Reconnaître la nature diverse et parfois aléatoire du régime est un premier pas important dans la compréhension de sa dynamique et pour identifier les domaines pour une amélioration potentielle.

Dans les secteurs en dehors de la santé et la sécurité et de la protection de l'environnement qui sont réglementés de façon formelle, cependant, le régime est moins dense. Une conclusion importante de notre travail est que dans le contexte des *incidents*

majeures, le régime canadien se penche vers une approche qui valorise particulièrement la flexibilité, la particularité (plutôt qu'une normalisation inflexible, où une approche 'taille unique') et une collaboration entre les operateurs IE et les régulateurs gouvernementaux. Ainsi, quand nous nous référons dans le travail suivant à l'absence de normes gouvernementales en ce qui concerne les incidents majeurs, nous entendons par là l'absence de ce que Neil Gunningham qualifie de "réglementation directe'' (1998 : 548); nous ne voulons pas laisser entendre que l'espace de normalisation est vide ou que les gouvernements et l'industrie sont insouciants pour ce qui est de contrôler les risques d'incidents majeurs.

Nos résultats sont organisés selon l'infrastructure du cadre Hood *et al*. Ce modèle considère le *contenu* et le *contexte* d'un régime de règlement de risque. Le premier concept — le contenu — est basé sur la théorie cybernétique de contrôle pour examiner la gestion de secteurs spécifiques de principes directeurs. Il affirme que les trois dimensions de contrôle — la collecte d'information, la normalisation, et la modification du comportement — doivent être présentes pour que le système en entier soit sous contrôle. Ce dernier concept — du contexte — se réfère à trois facteurs qui viendront typiquement façonner le contenu du régime : la nature technique du risque (hypothèse d'échec du marché), l'opinion publique et médiatique concernant le risque (hypothèse sensible à l'opinion publique) et la façon dont le pouvoir et l'influence sont concentrés (hypothèse groupe d'intérêt).

2.3.1 Régime du contenu

La collecte d'information

La collecte d'information représente la plus grande composante et le focus principal du régime, qui se trouve entouré d'un éventail de mécanismes de surveillance, de recherches et de partage d'informations. Il y a une emphase sur les structures multi-juridictionnelles et publiques et privées formelles, mais le partage d'informations discret et sans cérémonie se produit également sur la base des rapports de confiance personnels.

Les participants interviewés étaient en grande partie positifs et efficaces en partageant l'information *à l'intérieur de* leurs organismes — dans les associations d'industrie, les organismes gouvernementaux et les installations d'infrastructures essentielles. Les participants étaient en désaccord, cependant, sur la qualité, la pertinence et la régularité du partage d'informations *entre* les opérateurs d'infrastructures essentielles et les organismes gouvernementaux responsables de la protection d'infrastructures essentielles, ce qui peut être le produit des attentes contradictoires en ce qui concerne la façon dont l'information peut être diffusée, à qui, et pour quelles raisons.

Les secteurs ont différé dans leurs avis sur la façon dont les choses pourraient être améliorées. Les services d'eau et d'incendie, par exemple, réclament la création de plateformes de partage d'informations sur lesquelles les opérateurs d'infrastructures essentielles pourraient librement échanger l'information et les pratiques exemplaires entre eux, alors que les participants de l'industrie chimique préféraient que les informations qui seraient spécifiques au contexte soient fournies sur demande par le gouvernement et dans le format préféré par l'industrie. L'ancienne attitude suggère une préférence pour les structures d'organisation horizontales et la prise de décision communautaire, tandis que le dernier reflète une préférence pour une intervention gouvernementale limitée, pour une efficacité type marché et une autonomie corporative en ce qui concerne la question de la normalisation des risques. Les réponses fournies par les régulateurs de gouvernement, qui soulignent l'importance des règles et de la structure dans le contexte du partage d'informations, suggèrent une orientation bureaucratique.

La normalisation

Hors tout, l'espace à vocation en vue de l'application des règlements pour contrôler des incidents majeurs est caractérisée par de faibles niveaux d'agression politique, signifiant que les normes ont limité l'ambition en ce qui concerne le changement comportemental et sont prévues pour le moins de perturbation possible. (Hood *et al.*, 2001). Tout bien pesé, les normes sont fixées par une combinaison de processus technocratiques et de négociation parmi les parties intéressées. C'est particulièrement le cas pour ce qui est de l'industrie chimique, là où le composant de normalisation reflète

une relation de collaboration, basée sur un consensus d'une entente entre le gouvernement et le secteur privé. Les normes promulguées par l'industrie, comme la gestion responsable, sont répandues, et le développement de nouvelles normes par les gouvernements implique généralement une consultation étendue avec des associations représentatives de l'industrie. Dans les installations permettant une certaine liberté pour ce qui est de la mise en application des pratiques conçues en fonction de leurs circonstances uniques, le régime est généralement sensible aux intérêts du secteur privé, ce qui pourrait promouvoir l'innovation et la croissance commerciales. Les operateurs des services d'eau, cependant, ont rapporté une interaction limitée avec les organismes gouvernementaux responsables du PIE et ceux-là, par conséquent, ont tendance à compter sur les pratiques exemplaires et les normes développées par les États-Unis ou autres organismes internationaux. Le personnel de première intervention que nous avons interviewé a aussi réclamé une plus grande transparence et d'avantage de directives en ce qui concerne les normes pour le stockage des produits chimiques dangereux (bien qu'on ait rapporté une certaine satisfaction avec les normes *pour répondre* aux incidents chimiques). Les régulateurs ont uniformément exprimé une satisfaction avec la composante de normalisation du régime. De façon générale, nous avons constaté que l'absence relative de normes rigoureuses et imposées par le gouvernement permet la flexibilité et reflète une attitude de haute fiabilité en ce qui concerne la sûreté et la sécurité, là où les processus et les structures sont conçus pour être adaptables, sensibles, superflus et dispersés (La Porte, 1996). Pourtant, en même temps, cette orientation permet potentiellement la contradiction à travers le régime, facilitant des pratiques inefficaces de sûreté et de sécurité parmi les opérateurs IE qui choisissent de ne pas donner la priorité à la sûreté et à la sécurité. Là où les règlements existent (par exemple, l'urgence écologique (E2) les règlements de *l'Acte pour la protection de l'environnement canadien*, 1999 (CEPA 1999), les attitudes changent en ce qui concerne leur efficacité et leur rigueur.

Modification du comportement

La modification de comportement semble être le plus petit composant du régime. La littérature grise et la littérature universitaire suggèrent que les ressources consacrées à son application peuvent être minimales en termes absolus. C'était également la perception parmi les services d'eau, la gestion de secours et les sujets d'entrevue de l'industrie. L'application et la conformité semblent être un problème particulier dans le cas des PME qui sont moins organisées (et souvent ne souscrivent pas aux initiatives d'autorégulation), possèdent peu de ressources et moins d'expertise et, quand on les compare à de grands organismes (compagnies chimiques multinationales, par exemple), se débattent pour réaliser la conformité. Les participants d'entrevue étaient généralement d'accord que les associations d'industrie réussissent en général à fixer la conformité aux initiatives d'autorégulation d'industrie par l'approche de la vérification et d'autres moyens; ceci est aussi un moyen efficace par lequel on peut partager à travers l'industrie les pratiques exemplaires. La littérature universitaire, cependant, est inconcluante en ce qui concerne l'efficacité des efforts à la conformité, qui ont tendance à employer l'éducation, la persuasion et la collaboration plutôt que des sanctions punitives. Attendu que certaines recherches suggèrent que le fait d'être membre du GR réduit la probabilité d'accidents (Finger et Gamper-Rabindran, 2013), d'autres études ont trouvé que les établissements du GR participants font monter leurs taux de pollution (Gamber-Rabindran, 2013) et qu'une adhésion à l'initiative est difficile à maintenir sans sanctions explicites (King et Lenox, 2000). Encore une fois, les différences dans le style ou la culture d'organisation entre les secteurs semblent influencer les perspectives sur la modification du comportement. Les services d'eau et les services d'incendie ont tendance à soutenir une plus grande intervention gouvernementale tandis que les participants d'industrie préféraient les mécanismes d'application de collaboration, dans lesquels des efforts d'autorégulation d'industrie sont soutenus par le gouvernement. Aucun de nos participants n'a réclamé la réduction d'efforts pour influencer le comportement des installations à haut risque; en litige étaient le modèle et la portée des processus à employer.

2.3.2 Régime de contexte

L'hypothèse d'échec du marché

Le marché pour les produits chimiques est varié, complexe et dynamique, à la fois en termes de structures fermes et de produits. Tandis qu'il y a des différences significatives entre les multinationales et les PME, le secteur dans l'ensemble est en grande partie concurrentiel, et les produits et les innovations de processus sont les sources principales de profit. Les produits chimiques et les sociétés varient dans leur importance face aux IE. Certains sont facilement remplaçables; d'autres ne le sont pas. Certains représentent des points uniques d'échecs à conséquences élevées; d'autres ont des redondances multiples. Quelques produits chimiques peuvent être transformés en armes; d'autres ne le peuvent pas.

D'un côté, le HÉM possède quelques pouvoirs explicatifs limités dans le contexte des produits chimiques dangereux. Le marché semble être raisonnablement stable et efficace ; les événements catastrophiques sont extrêmement rares; il est difficile d'obtenir certaines informations et le gouvernement a tendance à mettre le focus sur des efforts pour faciliter les échanges d'informations. De l'autre coté, de tels événements causent des dommages économiques et sociaux considérables dans les communautés. Vue la faible probabilité de ces événements, la logique du marché pourrait rarement justifier un investissement dans ces scenarios peu probables. Il est difficile de développer des modèles de risque fiables et ils ne sont pas entièrement fiables ou digne de foi. Plusieurs facteurs, y compris les asymétries de l'information, les problèmes de risque subjectif, les extériorités négatives, les conditions problématiques d'assurance et les processus limités d'actes de droit de la responsabilité délictuelle, indiquent un contexte qui perpétue les vulnérabilités. De surcroît, l'ubiquité desproduits chimiques dans la société moderne indique des coûts élevés pour l'option de retraite pour ce qui est des risques reliés à des actes de terrorisme chimique.

Un régime réglementaire de risque gouvernemental soutenu par une logique d'échec du marché interviendrait pour réduire les coûts d'information et les coûts d'une option de retraite. Tandis que le régime exhibe un certain degré d'intervention gouvernementale,

par exemple sous forme de mécanismes de partage d'informations prévues pour réduire des coûts de l'information, dans l'ensemble notre recherche suggère une préférence pour l'autorégulation dans l'industrie, ce qui est en grande partie volontaire, exclue plusieurs PME et manque de transparence et parfois de rigueur. Par conséquent, tandis que la probabilité de ces événements est faible, les conséquences seraient catastrophiques; les faiblesses persistent et il semblerait que le gouvernement n'adopte pas une position assez agressive pour adresser ces faiblesses. En bref, la position du régime ne reflète pas pleinement les prévisions de l'hypothèse d'échec du marché.

L'hypothèse sensible à l'opinion publique

La psychologie de la littérature au sujet du risque et notre analyse des médias accentuent plusieurs raisons pour lesquelles les opérateurs d'infrastructures essentielles qui emploient, qui fabriquent et qui font le stockage de produits chimiques dangereux sont sensibles à la couverture médiatique. Le public a une fascination pour les événements peu probable, et aussi une forte aversion pour de tels événements à faible probabilité mais qui pourraient avoir des conséquences sérieuses. L'aversion que le public ressent envers ces événements est renforcée dans des événements chimiques, en particulier à cause de la méfiance publique face aux sociétés multinationales, de l'artificialité perçue des produits chimiques (un processus apparemment contraire à la nature), à la disponibilité heuristique (des désastres chimiques précédents sont facilement rappelés, comme *Exxon Valdez*, le déversement de pétrole de BP dans le Golfe du Mexique), au manque perçu de contrôle des risques chimiques (en particulier dans le cas des installations chimiques près des centres urbains, tels que l'explosion de Sunrise Propane et à West, au Texas, le désastre d'engrais) et à la demande (souvent trop simplifiée) de responsabilisation à la suite de désastres provoqués par l'erreur humaine. De façon plus générale, l'inquiétude publique au sujet des produits chimiques se développe dans l'ère moderne depuis au moins la première guerre mondiale (van Courtland Moon, 1984), avec des efforts pour réglementer les produits chimiques s'accélérant dans les années soixante avec la publication de *Silent Spring* de Rachel Carson et l'incendie du fleuve de Cuyahoga (Opheim, 1993). Au Canada, le souci

accroissant du public est évident en ce qui concerne la viabilité écologique de l'approvisionnement d'eau douce et les risques au pays liés à la fracturation hydraulique (De Villiers, 2003 ; Salzman 2012 ; Pentland et Wood, 2013).[6] En même temps, il est peu clair si le public serait disposé à payer le plein coût pour améliorer la sûreté et la sécurité de l'approvisionnement en eau.

En ce qui concerne les associations industrielles bien organisées, on peut comprendre que l'hypothèse sensible à l'opinion publique (HSO) accentue comment les efforts d'intervention directe peuvent être vus comme un stratagème ayant pour but de former l'opinion publique, plutôt que le produit d'une demande accrue de transparence. En même temps, le HSO aide à expliquer la tendance du gouvernement à explorer (mais pas nécessairement à mettre en exécution) les changements de normalisation au lendemain immédiat d'incidents majeurs, comme dans le cas de Sunrise Propane.[7] À tout le moins, les événements peu probables mais ayant des conséquences sérieuses perturbent habituellement les mécanismes normaux de contrôle et créent une occasion pour le changement.

L'hypothèse groupe d'intérêt

Notre application de la typologie de Wilson sur les pressions venant de groupes d'intérêt suggère que nonobstant les périodes d'instabilité des années soixante-dix et quatre-vingts suite à un activisme écologique accru le régime chimique se montre enclin vers une politique du client stable, impliquant le gouvernement et les compagnies de produits chimiques plus importantes avec une participation limitée de groupes écologiques. Le rapport entre l'industrie et le gouvernement fournit des avantages concentrés pour l'industrie, tout en produisant des coûts diffus disséminés parmi les

[6] Selon la typologie du risque de Renn(2008), l'incertitude associée à la fracturation hydrologique peut ajouter aux risques, possiblement sous forme d'agitation civile, ayant sa cause dans la méfiance du public ou dans une hésitation quant a ses supposés dangers.

[7] Quinze jours après explosion de Sunrise Propane, l'Ontario a annonce la formation d'un groupe indépendant d'experts afin de réviser comment le propane était réglementé dans la province. Le panel a soumis un rapport dans les trois mois suivants. Environ un an plus tard, l'assemblée législative de l'Ontario a introduit des standards de sécurité plus stricts pour les installations de gaz propane et un nouveau chargé de sécurité indépendant pour surveiller les activités régulatrices de la province (Ontario, 2011).

consommateurs. En conservant l'influence de normalisation par des programmes comme la gestion responsable (GR), les plus grandes compagnies chimiques peuvent calibrer le niveau et la nature de la concurrence sur le marché, préservant de ce fait des avantages cruciaux de structure. En outre, ce régime permet à l'industrie de maintenir la conformité des normes avec les États-Unis, ce qui est nécessaire pour assurer un accès soutenu au marché de ce pays. Les effets de cet arrangement sont évidents dans les modifications de politiques suivant le 9/11, qui a présenté des mécanismes de partage d'informations peu agressifs comme les règlements environnementaux de secours (E2) et le rapport d'incident grave (SIR) plutôt que des normes prescriptives **o**u des programmes rigoureux de modification du comportement. Il n'est pas évident non plus si le programme de la gestion responsable (GR) a modifiée sa structure de gouvernance ou ses membres afin de démontrer une préoccupation accrue pour la sécurité, par exemple. En dépit de l'association entre la politique du client et la capture de la normalisation, nous avons trouvé des indices que le système de normalisation existant peut permettre l'accomplissement des objectifs gouvernementaux. Par exemple, un rapport étroit avec l'industrie permet à des régulateurs au niveau fédéral d'influencer en quelque sorte le règlement des risques chimiques, ce qui pourrait autrement excéder leur autorité juridictionnelle. Les services d'eau, par comparaison, fonctionnent généralement dans les environnements non compétitifs et on pourrait soutenir donc ont une incitation (ou une capacité) limitée pour influencer les standards de normalisation. De surcroît, leur disparité géographique et leurs tailles variables excluent l'organisation facile d'un groupe d'intérêt efficace. L'absence apparente de lobbying par les services d'incendie pour des normes plus strictes en ce qui concerne l'utilisation et le stockage de produits chimiques n'est pas, à prime abord, en accord avec les prévisions de l'hypothèse de groupe d'intérêt (HGI). Ceci peut être dû au peu d'importance accordée par les travailleurs des services d'incendie à cette question vis-à-vis d'autres priorités. En même temps, les événements tels que l'explosion d'engrais à West, au Texas, l'explosion de Sunrise Propane et l'expansion urbaine en croissance dans les secteurs où on fait traditionnellement le stockage de produits chimiques dangereux pourraient inciter les services d'incendie à s'organiser plus efficacement sur cette question à l'avenir. Nous concluons que le HGI offre l'explication la plus solide pour l'opération quotidienne du régime chimique en ce

qui concerne les risques de contrôle liés aux incidents majeurs, bien que, comme nous notons ci-haut, sa dynamique régulière serait susceptible à la rupture par le HGI.

2.4 Ce que nous recommandons

Les recommandations suivantes reflètent les résultats de notre analyse des transcriptions d'entrevues et de la littérature relative, soit universitaire ou professionnelle. Les preuves qui soutiennent ces recommandations sont développées plus en profondeur dans le corps du rapport.

En ce qui concerne les services d'eau, les services de réponse de secours (services d'incendie) et les municipalités

- Développer des plateformes améliorées de partage d'informations pour les intervenants en cas d'urgence et les services d'eau. Pour les intervenants en cas d'urgence, l'accès à une base de données centralisée des produits chimiques stockés aux emplacements fixes augmenterait la sûreté et peut réduire la létalité d'incidents futurs de type West, au Texas. Pour les services d'eau, qui fonctionnent souvent dans l'isolement relatif et avec peu de ressources et une capacité technique limitée, des plateformes communes plus efficaces de partage d'informations peut-être modelées sur le WaterISAC - (Le centre d'échange de renseignement et de l'information sur l'eau) des États-Unis, aideraient à disséminer les pratiques exemplaires en ce qui concerne les techniques de gestion des risques et de sécurité liées au stockage et à l'utilisation des produits chimiques dangereux.
- Procéder à une vérification des pratiques de sécurité des services d'eau au Canada et employer les résultats pour améliorer la cohérence à travers les juridictions et pour soutenir le renforcement des capacités visée là où les services ne performent pas à la hauteur.
- Fournir un appui additionnel (par exemple, sous forme de directives et de formation) aux municipalités afin d'améliorer leur planification pour l'utilisation de leur territoire, et où et comment ils peuvent stocker les produits chimiques dangereux. L'expansion

des municipalités et des villes dans des zones dans lesquelles des produits chimiques dangereux sont traditionnellement stockés exemplifie un défi émergeant.

- Améliorer l'accès, particulièrement pour les petites communautés, aux ressources expertes requises pour traiter des incidents majeurs. Construire sur une base solide par un examen de la capacité adaptative existante et les accords d'aide mutuelle pour assurer que les réponses aux incidents majeurs soient opportunes, efficaces et intégrées. Pour ce qui est des exercices de planification de scénario, par exemple, ces exercices devraient inclure (entre autres) un focus sur le confinement, sur les vulnérabilités provoquées par la centralisation d'échec, le rétablissement, la réaction face aux surprises, sur la couverture médiatique extensive et émotive, les compromis quant aux risques, le jugement sous pression, la responsabilité et les assurances et l'interaction avec des participants variés (non prévus). Au niveau national, identifier où l'expertise et les ressources sont situées pour le déploiement rapide. La réponse récente à la fuite potentielle de radiation au port de Halifax en 2014 (CP, 2014) accentue les avantages de la coordination nationale dans ce secteur.

En ce qui concerne les petites et moyennes entreprises (PME)

- Adresser les vulnérabilités parmi les PME en motivant la continuité d'affaires et la planification de gestion des risques. Puisque le coût de conformité aux normes existantes et aux pratiques exemplaires peut s'avérer prohibitif pour de petites compagnies, développer des programmes visés spécifiquement aux besoins et aux capacités uniques des PME. Encourager les PME à bâtir sur des pratiques existantes en matière de sûreté pour augmenter des pratiques en matière de sécurité et, ce faisant, ainsi introduire et mettre en valeur une culture de sécurité.

En ce qui concerne l'interaction gouvernement-industrie

- Améliorer la transparence, le reportage vers l'extérieur, l'engagement public et la surveillance démocratique en ce qui concerne l'état de préparation du secteur privé pour les incidents IE. Utiliser les demandes de renseignements du public, les rapports

et les vérifications à la suite des échecs, par exemple, pour identifier les leçons en temps opportun; employer ces enquêtes pour aussi encourager une culture d'apprentissage parmi les operateurs IE du secteur privé et les régulateurs gouvernementaux, et pour développer une population mieux informée et des medias mieux adaptés à tenir le gouvernement et l'industrie responsables sur ces questions.

- Clarifier la question de la responsabilité afin d'améliorer les efforts préincidents et réduire l'attribution du blâme post-échec. Les arrangements collaboratifs normalisent l'opacité et l'ambiguïté en ce qui concerne la distribution de la responsabilité parmi les parties intéressées. Par conséquent, l'autorégulation de l'industrie comme alternative appropriée pour la règlementation directe permet aux défis sans direction de trainer en longueur et met en question la responsabilité des régulateurs et de l'industrie et du gouvernement. Améliorer la transparence et la clarté dans ce secteur encouragera à la fois, régulateurs et opérateurs IE, d'assumer un rôle plus actif en adressant les risques chimiques préévénement.
- Adopter une perspective nord-américaine. Les fabricants canadiens exportent régulièrement vers le marché américain et en conséquence répondent à des normes américaines, telles que C-TPAT. Les régulateurs américains ont, donc, déjà un impact considérable sur le comportement des fabricants canadiens. À un certain degré, alors, pour influencer les fabricants canadiens il faudrait influencer les régulateurs américains. En outre, les différentes normes entre les pays produisent de nouveaux coûts et soulèvent des questions au sujet de l'efficacité des normes canadiennes. Ceci en soi peut représenter un risque à l'industrie canadienne, en particulier si un événement devait se produire**.**

En ce qui concerne les régulateurs de produits chimiques dangereux

- Adopter de nouvelles approches afin de sanctionner le comportement d'échecs et pour changer de comportement, puisque les démarches d'acte délictuel et du droit pénal exigent souvent des ressources importantes et du temps. Parfois, l'autorégulation volontaire de l'industrie ne serait pas suffisamment transparente ou agressive. De plus, les instances judiciaires - tandis que nécessaires - peuvent diminuer la confiance

publique dans l'efficacité des mécanismes de responsabilité et d'application en raison du temps requis pour arriver à une conclusion ; les stratégies de changement de comportement doivent être promptes et efficaces et avoir une portée appropriée à travers le secteur. En outre, on doit focaliser pour adresser les mises en garde précoces, qui ont été ignorées, par exemple, dans le cas de l'explosion de Sunrise Propane.

- Les incidents chimiques majeurs sont peu nombreux; chacun doit être étudié. Encourager l'apprentissage organisationnel à travers le secteur après les échecs au Canada ou à l'étranger qui ont contribué aux incidents majeurs. Se concentrer sur l'emploi des données sur les échecs pour développer des modèles plus fiables de probabilité et une compréhension accrue des compromis de risque et les coûts et les polémiques des approches de précaution.
- Tandis que cet article ne s'adresse pas explicitement aux questions de transport, une meilleure communication et une coordination accrue entre les niveaux du gouvernement en ce qui concerne le transport sécuritaire des produits chimiques dangereux amélioreraient l'efficacité globale du régime de normalisation.

2.5 Des recherches à venir

Dans notre analyse nous avons découvert plusieurs secteurs où des recherches plus en profondeur seraient justifiées. Ces secteurs sont identifiés plus bas. On les a inclus pour des raisons variées. Dans certains cas, ils revenaient souvent comme thèmes dans la littérature universitaire et dans la littérature grise mais furent rarement mentionnés par les participants interviewés. Dans d'autres cas ils ont émergé suite à des questions soulevées par notre analyse. Nous faisons ressortir ces thèmes parce qu'ils représentent des menaces potentielles et des opportunités pour le secteur des produits chimiques et pour la société canadienne en générale.

- La politique des États-Unis influence déjà le comportement des installations de produits chimiques au Canada, y compris les fabricants de produits chimiques et les

services d'eau. Comment le Canada peut-il coordonner plus efficacement avec les États-Unis en ce qui concerne la réglementation des risques d'incidents majeurs?

- Quel est le niveau approprié d'intéressement du public à la réglementation des produits chimiques? Étant donné le potentiel pour de l'inquiétude chez le public en rapport avec les produits chimiques, est-il possible d'améliorer une surveillance démocratique et la transparence dans le secteur de façon sensible et efficace? Comment le gouvernement pourrait-il mener des consultations publiques, par exemple, qui susciteraient des commentaires sans pour autant se faire réquisitionner par des groupes d'intérêt extrêmes ou par l'industrie? Quel est le juste équilibre entre transparence et sécurité dans le contexte des échanges d'information sur les risques associés aux installations de l'industrie chimique?
- De quelle façon le secteur fait-il face à la cyber-sécurité? D'après certains de nos participants interviewés, plus particulièrement ceux qui représentent l'industrie, les risques cybernautiques demeurent un point clé de vulnérabilité pour le secteur. D'autres participants n'ont fait aucune mention de questions cybernautiques. Même si notre outil d'interview n'avait pas pour focus la cyber-sécurité, la littérature universitaire et la littérature grise suggèrent un besoin de recherches supplémentaires dans ce domaine.
- Quelles méthodes pour effectuer un changement immédiat le gouvernement pourrait-il employer, en dehors des cours, pour modifier le comportement? Au delà du système judiciaire, quels outils sont disponibles aux régulateurs afin de changer les attitudes et les comportements en ce qui concerne la sécurité et la sûreté chimiques? Comment le gouvernement pourrait-il faire usage de l'éducation du public, ou de sa position, possiblement plus agressive, pour atteindre les buts escomptés?[8]
- De façon plus générale, comment le régime réagit-il aux échecs qui aboutissent à des incidents majeurs? Étant donné les types de risques posés par les produits chimiques dangereux, quelles stratégies pour la gestion des urgences conviennent le mieux pour répondre aux incidents majeurs et pour les contrôler? Le cadre de Hood *et al.*,

[8] Revoir, par exemple, l'admonestation du président Obama aux gestionnaires de BP à la suite du déversement de pétrole Deepwater (Goldenburg, 2010). En appliquant une pression considérable sur les gestionnaires de BP, Obama a pu extraire une garantie pour un investissement dans la remise en état et la reconstruction des communautés affectées de la côte du golfe.

explique le statu quo du régime; il est moins utile pour identifier comment les pressions contextuelles – le marché, l'opinion publique, les groupes d'intérêt – se comportent suite à des événements perturbateurs. Bien que ce travail aborde cette question que brièvement, une analyse plus compréhensive ajouterait une rigueur théorique plus profonde aux questions sur la réaction des organismes face aux échecs.

3.0 Introduction

This paper describes the Canadian risk regulation regime for controlling major incident hazards involving dangerous chemicals. In doing so, the paper examines how the sector characterizes and addresses safety and security threats, and it explores the contextual issues that influence the chemical regime. The paper draws on an analysis of 18 interviews with critical infrastructure (CI) regulators, owners, operators and managers from four sub-sectors relevant to the dangerous chemicals sector – water utilities, emergency management agencies, the chemical industry and government regulators.[9] It aims to offer an enhanced qualitative understanding of sector-specific risks, as well as recommendations for addressing vulnerabilities.

In referring to the 'chemical sector', we mean facilities that manufacture, use or store large quantities of chemicals. This includes the subset of the manufacturing industry involved in creating and transforming chemical substances for use in subsequent chemical processes, by other industries or as end-use products (Mahdi *et al.*, 2002: 6; OECD, 2001: 10). We omit from this definition petroleum, or oil and gas companies, as well as nuclear power plants. Although we acknowledge their interconnectivity with the chemical industry, we have chosen to exclude them from the present study both for reasons of brevity and to align with Public Safety Canada's critical infrastructure model, which divides energy generation and chemical manufacturing into separate sectors (PSC, 2013). For the same reason, we focus primarily on the manufacture and storage of chemicals rather than their transport by truck, rail, pipeline or other means, which again falls into a separate critical infrastructure sector. Nevertheless, we are confident that aspects of our analysis are relevant to the energy and transportation sectors, which present many of the same risks as chemical manufacturing.

Finally, in referring to 'chemical risks', we mean *major incidents*, whether the product of technological (or process) failure, natural disaster or malicious intent. There are various terms in the academic and grey literature that refer to similar concepts, including 'major industrial accident' (for example, Cozzani *et al.*, 2010; Lacoursiere,

[9] We cite interview participants using the code 'DCI', for Dangerous Chemical Interview. For a list of the affiliations and job roles of participants see Appendix A, and for a description of our methodology see Appendix B.

2006), ‘major accident hazard’ (for example, Hirst and Carter, 2002), ‘major chemical incident’ (for example, Candiotti *et al*., 2005) and ‘chemical catastrophe’ (for example, Baxter, 2002). For our purposes, we use the definition of ‘major incident’ provided by the London (UK) Emergency Services Liaison Panel: “A major incident is any emergency that requires the implementation of special arrangements by one or more of the emergency services and will generally include the involvement, either directly or indirectly, of large numbers of people” (2012: 5). Major incidents are sudden events that necessitate a departure from routine emergency response procedures. They often cause property damage, evacuations and, in extreme cases, death, but less destructive events may also qualify as major incidents. We include in this category the Sunrise Propane incident in Toronto, the fertilizer plant explosion in West, Texas and the explosion at the Buncefield oil storage depot in Hertfordshire, England, for example. In short, we are concerned with rare adverse events whose severity requires a non-standard response, often by more than one emergency service.

Finally, note that the focus of this paper is the regulatory regime in place to prevent these and other types of major incidents. Hood *et al.* (2001: 9) define regime as “the complex of institutional geography, rules, practice and animating ideas that are associated with the regulation of a particular risk or hazard”. In general, we do not discuss specific plans or processes for responding to crises involving chemicals; the paper is not intended to provide detailed emergency management guidelines or comment on such guidelines. Rather, the paper should be read as an account of the regulatory regime that controls risks associated with dangerous chemicals *before* they manifest as major incidents.

3.1 Definitions

We refer frequently in this paper to the terms safety, security, critical infrastructure protection, risk and regulation. We define these terms as follows.

Safety and Security

These terms are often used interchangeably, and indeed at times our interview participants conflated the two subjects. Security risks involve human aggressors who are

influenced by a variety of environmental and personal factors and may come from within or outside the target institution (Reniers and Pavlova, 2013: 8). While their outcomes may be similar, security and safety risks demand different approaches to risk management. "[P]rotecting installations against intentional attacks," write Reniers and Pavlova, "is fundamentally different from protecting against random accidents or acts of nature" (2013: 9; see also Russell and Simpson, 2010). Human aggressors, for example, are adaptive agents; they will modify their behaviour in light of security practices organizations adopt. Generally, safety plans tend to be more transparent, are informed by more reliable data and are regulated more clearly. Safety plans are also more clearly entrenched in the organizational culture and legal tradition of many critical sectors.

Critical Infrastructure Protection

Critical infrastructure protection seeks to enhance the physical and cyber security of key public and private assets and mitigate the effects of natural disasters, industrial accidents and terrorist attacks. The Government of Canada has identified ten critical sectors. Most Western governments have similar – though not identical – lists for their countries. The UK government has identified nine sectors and the U.S. government has identified 16, for example.

Risk and Regulation

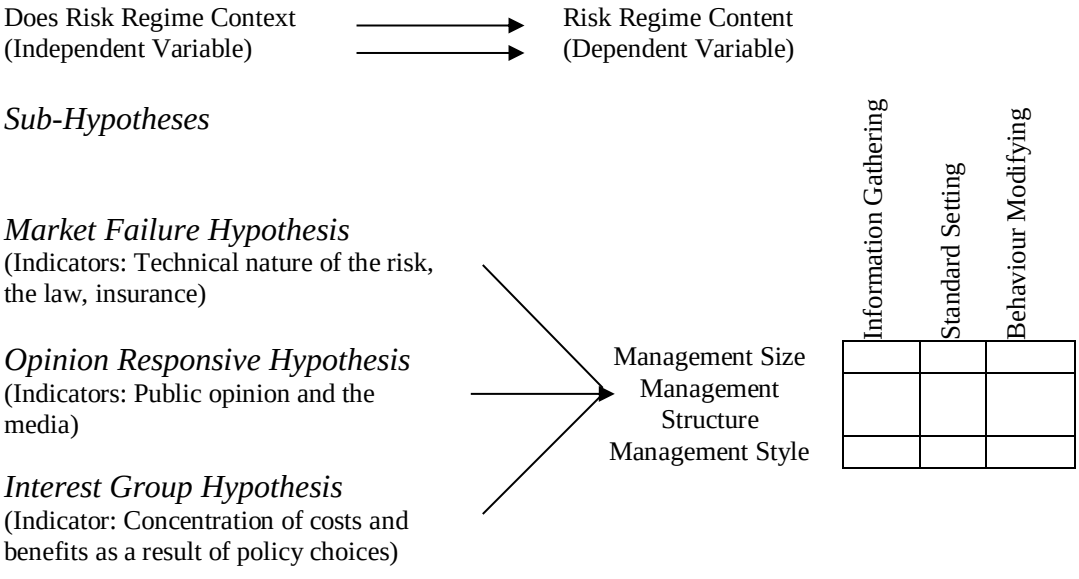
Risk is a probability, though not necessarily calculable in practice, of adverse consequences (Hood et al., 2001). Regulation means attempts to control or mitigate risk, mainly by setting and enforcing product or behavioural standards (Hood et al., 2001). Risk regulation is governmental intervention in market or social processes to influence and control to varying degrees potential adverse social and economic consequences.

3.2 The Hood Framework

Our research, including the analysis of the interview transcripts, is structured according to Hood *et al.*'s (2001) meso-level risk regulation regime framework. In their study of risk regulation in the UK, Hood *et al.* define regimes as "the complex of institutional geography, rules, practice and animating ideas that are associated with the regulation of a particular risk or hazard" (Hood *et al.*, 2001: 9). Hood *et al.* hypothesize that within these regimes context shapes the manner in which risk is regulated. 'Regime context' refers to the backdrop of regulation. There are three elements that Hood *et al.* use to explore context: the technical nature of the risk; the public's and media's opinions about the risk; and the way power and influence are concentrated in organized groups in the regime.

Hood *et al.* (2001) employ the cybernetic theory of control to examine the management of the specific policy area; they refer to this as 'regime content'. The theory asserts that if the three dimensions of control – information gathering, standard setting and behaviour modification – are under control, the system is effectively under control.

Figure 1: Understanding risk regulation regimes



Source: Hood *et al.* (2001)

We will discuss each of the three control components in turn. Information gathering is the capacity to obtain data that can be used to shape regime content. Information may be gathered actively or passively, both beyond the system and within it (Hood *et al.*, 2001: 22). Standard setting involves establishing goals, or guidelines; in government, standards often take the form of policy. Finally, behaviour modification refers to the preferences, incentive structures, beliefs and attitudes that shape systems – the capacity to modify behaviour of participants is the capacity to change systems. The distinction between these dimensions is not always tidy; Hood *et al.* (2001: 21) note, for instance, that information gathering may influence behaviour if people know they are being watched.

Each dimension of control may be further considered according to: size – the amount and scope of regulation and the resources used to sustain it; structure – the institutional arrangements of regime content, such as public-private sector relationships; and, style – the formal and informal codes and conventions that help shape regime content (Hood *et al.*, 2001: 30-32).

4.0 Regime Content

Broadly speaking, the major chemical incident regime has emerged haphazardly, coalescing around an array of federal and provincial legislation on numerous chemical risk–related subjects. Its initial focus was on mitigating industrial failures, but it took on added security significance after 9/11 (Creedy *et al.*, 2004; Macza, 2008). Canadian governments possess varying responsibilities across these policy areas, meaning the overall regime differs in its centralization and consistency. Municipalities, through their devolved authority over land-use planning and emergency management, are also involved. In a certain sense, then, the chemical regime lacks national coherence, exhibiting what Hood *et al.* (2001) might call a diverse and erratic pattern of administrative and institutional geography. In plain terms, Canada does not have a single, national framework for controlling major chemical incident risks. Complicating the picture further is the presence of an influential set of self-imposed industry standards. Surveying the regime requires navigating this complex and sometimes overlapping regulatory patchwork.

4.1 Information Gathering

4.1.1 Size

In terms of size, the information-gathering component of the chemical regime exhibits a relatively high level of investment and aggression. It includes mandatory reporting requirements for chemical facility operators, information-sharing fora, research initiatives and communication channels between law enforcement and industry. Running parallel to these formal mechanisms are informal networks, which emerge and expand on the basis of personal relationships among colleagues and peers.

At the federal level, the CEPA E2 regulations – introduced in response to 9/11 (EC, 2003; Shrives, 2004: 17) – establish reporting requirements with respect to dangerous chemicals. Environment Canada stores information received under the E2 regulations in a database accessible to public safety authorities and the Department of National Defence

(DCI 13). In some provinces, environmental statutes establish similar, though not identical, reporting requirements for chemical facilities (for example, the Ontario *Environmental Protection Act* and the Quebec *Environmental Quality Act*). In addition to receiving information via these mandatory reporting mechanisms, government-funded research provides a proactive method for learning about major incident chemical risks. The federal government's Chemical, Biological, Radiological-Nuclear and Explosives (CBRNE) Research and Technology Initiative (CRTI),[10] for example, funded research in support of counter-terrorism from chemical, biological, radiological and nuclear threats (Volchek *et al.*, 2006: 126; DCI 6).

Yet not all aspects of the information-gathering component are necessarily aggressive or ambitious. In our interviews, fire fighters trained as hazardous materials (hazmat) first responders and an emergency management professional called for enhanced reporting requirements for fixed chemical sites. One participant explained that fire fighters face increased risks when responding to emergencies at facilities for which there is little data about the chemicals on-site (DCI 6). Indeed, the lethality of the 2013 West, Texas, fertilizer plant explosion has been blamed, in part, on first responders' lack of knowledge about the quantity of ammonium nitrate at the facility (DCI 18; Pell *et al*., 2013). Two of our interview participants, including a first responder and an emergency management official, recommended the creation of provincial repositories of hazmat data, to be updated regularly by chemical facility operators (DCI 5; DCI 10). Although improved information sharing is often discussed in the context of the transportation of dangerous chemicals, it seems that it is equally important when it comes to their storage.[11]

4.1.2 Structure

The structure of the regime's information-gathering component is characterized by significant levels of third-party, or private-sector contributions, as well as by a high degree of jurisdictional and system complexity (Hood *et al.*, 2001: 34). These features are

[10] The CRTI's mandate was recently amalgamated into the Canadian Safety and Security Program (DRDC, 2013).
[11] Data in the Canadian Disaster Database indicates that fixed site incidents occur approximately as frequently as transit incidents (see Figure 13 in Appendix C).

evident in the numerous channels established to facilitate information sharing between government, industry and, to a lesser extent, private citizens. Figure 2 shows a selection of the information-sharing channels and fora mentioned in our interviews, organized according to their membership.

Figure 2: Examples of chemical regime information-gathering mechanisms

	Membership		
Mechanism	Government	Industry	Private Citizens
American Water and Wastewater Association (AWWA)	✓	✓	
Canadian Water and Wastewater Association (CWWA)	✓	✓	
CBRNE Sub-Working Groups	✓	✓	✓
CBSA Partners in Protection (PIP)	✓	✓	
Comité mixte municipal-industriel (CMMI)	✓	✓	✓
Community Awareness and Emergency Response (CAER) risk communication fora	✓	✓	✓
CRTI	✓		
DHS Customs-Trade Partnership Against Terrorism (C-TPAT)	✓	✓	
F/P/T Critical Infrastructure Working Groups	✓	✓	✓
OECD Working Group on Chemical Accidents	✓	✓	
Professional associations (Canadian Association of Fire Chiefs, Canadian Institute of Planners, etc.)	✓	✓	
Provincial emergency management fora	✓	✓	
RCMP ChemWatch	✓	✓	
RCMP Suspicious Incident Reporting (SIR) system	✓	✓	
Responsible Care audits	✓	✓	✓
Responsible Care committees		✓	
Water Information Sharing and Analysis Center (WaterISAC)	✓	✓	

Source: DCI 2-4; DCI 5-6; DCI 8-14

Although not exhaustive, Figure 2 reveals key structural features of the regime's information-gathering component. First, several of the fora are multi-jurisdictional. The critical infrastructure and CBRNE working groups, for example, involve participation by

the federal and provincial (and, in some cases, territorial) governments. U.S. information-sharing mechanisms are also prominent. Second, industry involvement in most fora occurs on a voluntary basis. ChemWatch (intended to limit the accessibility of illicit drug and explosive precursors) and the SIR (Suspicious Incident Reporting) system, for example, are voluntary partnerships between the RCMP and the chemical industry. Information-sharing fora led by industry – CAER risk communication efforts, Responsible Care committees – are similarly voluntary, although participation is typically a requirement for industry association membership. Note also that relatively few fora include participation by private citizens. Finally, Figure 2 reinforces the broad range of policy areas implicated in the control of major chemical incidents; included in the list are fora on a diverse range of topics, including environmental protection, law enforcement, international trade, municipal emergency management and others.

4.1.3 Style

According to Hood *et al.* (2001: 32), the style of a regime denotes, among other things, the operating conventions and attitudes of those involved in regulation. The style of the information-gathering component of the chemical regime is shaped by divergent degrees of operational rule-following and competing perspectives on the extent and reliability of information shared among CI operators and chemical manufacturers, and between these groups and government. For example, a water utility participant stated that strict adherence to security clearance requirements for accessing federal intelligence is a hindrance for small CI operators (DCI 2). Similarly, a chemical industry respondent argued that the 'For Canadian Eyes Only' restriction on sensitive information provided by the federal government is impractical given that the security offices of many chemical companies are located outside of Canada (DCI 11).

Participants also disagreed about the quality of information provided by public agencies. While one water utility manager described the ongoing exchange of information in positive terms (DCI 4), others said that federal agencies provide only limited information to CI operators (DCI 2; DCI 9; DCI 11). A representative of a chemical industry association stated that at the time of the interview his organization had

received no contact from the federal government regarding the establishment of a CI working group for the manufacturing sector (DCI 11). In general, industry participants preferred to receive from government safety and security information on demand and in convenient, context-specific formats, which they argued they do not often receive (DCI 1; DCI 4; DCI 9; DCI 11). In contrast, participants from all sectors reported strong working relationships between CI and law enforcement in particular, including local police, RCMP and CSIS (DCI 2-4; DCI 8-9; DCI 11; DCI 14-15).

In general, participants differentiated between formal rules and informal practices for information sharing. Interview participants from the water sector suggested that informal networks facilitated by collegial relationships are more effective than formal information-sharing structures as conduits for disseminating accurate and relevant information (DCI 1-4). One participant implied that the information shared via these informal networks may exceed what is formally or legally permitted (DCI 2). The importance of establishing trust was a common theme among all participants, as was the notion that forums are useful primarily as an opportunity to build personal relationships (DCI 1-3; DCI 5; DCI 8-10; DCI 14-15). Notably, none of the participants defined 'trust'; in the academic literature there is a variety of distinct and sometimes incompatible definitions of the term (Kramer, 1999).[12] Two participants acknowledged that information-sharing networks based primarily on personal relationships are vulnerable to staff turnover (DCI 2; DCI 8).

In sum, information gathering represents the largest component and primary focus of the regime, encompassing a wide range of monitoring, research and information-sharing mechanisms. There is an emphasis on formal multi-jurisdictional and public-private structures, but informal and discreet information sharing also occurs on the basis of trusted personal relationships. Interview participants reported largely positive and effective relationships when sharing information *within* organizations – within industry associations, government agencies and CI facilities. Participants disagreed, however, on the quality, relevance and regularity of information sharing *between* CI operators and government agencies responsible for CI protection, which may be a product of

[12] Kramer (1999) describes many types of trust, including personal, rules-based, roles-based and process-based.

conflicting expectations with respect to how, why and to whom information may be disseminated. Different attitudes towards regulation and the role of government in general might help to explain the reasons for some of these conflicts. Water utilities and fire fighters, for example, called for the creation of information-sharing platforms on which CI operators could freely exchange information and best practices with one another, while chemical industry participants preferred that context-specific information be provided by government on demand and in industry-preferred format. The former attitude suggests a preference for flat organizational structures and communitarian decision-making, whereas the latter reflects a desire for limited government intervention, market efficiency and corporate autonomy with respect to risk regulation. The responses provided by government regulators, which emphasize the importance of rules and structure in the context of information sharing, suggest a bureaucratic orientation.

4.2 Standard Setting

4.2.1 Size

Regulatory size relates to the balance between the state and the market, the degree of 'anticipationism' in risk regulation and the extent of regulatory bureaucracy (Hood *et al.*, 2001: 31). By these measures, the standard-setting component of the dangerous chemicals regime is small relative to its information-gathering component. Despite the introduction of new government standards after 9/11, the regime continues to exhibit a low degree of policy aggression. To be clear, this is not due to oversight or inattention; as we emphasize below, our interviews (DCI 8-9; DCI 13) and the academic literature (for example, Lacoursiere, 2006; Moffet *et al.*, 2004: 189-190) agree that the Canadian regulatory model has been shaped by a preference for public-private collaboration and an acknowledgement that industry standards represent a valid alternative to traditional regulation. The decision to refrain from prescriptive, top-down standard setting is deliberate. Recall also that responsibility for chemicals is distributed across both orders of government, limiting each jurisdiction's range of potential regulatory options.

The scarcity of government-imposed standards was a common theme in our interviews. Water utility operators reported a lack of standards with respect to the storage of dangerous chemicals (DCI 2-4), while chemical industry experts emphasized the absence of government standards for process safety management and site security (DCI 8-9; DCI 11). Hazmat-trained fire fighters called for improved capabilities-based planning among emergency services (DCI 5; DCI 6), and one fire fighter recommended stricter requirements for facilities that store chemicals (DCI 6). Yet the regulatory space is not empty. Participants said that water utilities and chemical companies tend to follow guidelines and best practices promulgated by industry associations (DCI 3, DCI 5-6; DCI 9, DCI 11), as well as by international and, specifically, American agencies (DCI 9; DCI 11).[13]

Of course, the regime includes Canadian government standards also. In our interviews, however, participants expressed hesitation about their value and stringency. Two industry association participants (DCI 9; DCI 11) stated that members of the chemical industry's Responsible Care program maintain environmental plans that match or exceed the requirements of the E2 regulations.[14] Other research in this area has registered similar scepticism about the effectiveness of the E2 regulations (for example, O'Neill *et al.*, 2009: 6).

Municipal authority over land-use planning represents a second source of potentially powerful risk management standards (DCI 12). However, reconciling economic development pressures with risk management considerations in order to make informed land-use decisions can be difficult, particularly for small municipalities (DCI 8).[15] There appear to be few resource materials for communities to consult (O'Neill *et al.*, 2009: 33-

[13] These include standards established by the Department of Homeland Security's C-TPAT program, the United Nations Chemical Weapons Convention (DCI 11) and the American Institute of Chemical Engineers (DCI 9).

[14] Beyond the reporting requirements outlined in the previous section, the E2 regulations require that implicated facilities prepare an environmental emergency plan (DCI 13). These plans must identity and address the full range of hazards present on site, as well as prevention, preparedness, response and recovery measures.

[15] According to data in the Canadian Disaster Database (PSC, 2014), of fixed site incidents in Canada involving chemicals between 1900 and 2008, more than half occurred within the boundary of a population centre (see Appendix C).

34).[16] According to Alp (2004), the placement of chemical facilities is an issue that is "falling through the cracks … and remains a significant gap within the Canadian legislative framework" (17). An illustrative example is the Toronto Sunrise Propane facility, which in 2009 exploded, killing two and causing the evacuation of thousands, yet whose location was in full compliance with municipal zoning laws (Barber, 2008). This was also the case for the West Fertilizer Company's facility in West, Texas (Gillum and Plushnick-Masti, 2013), which suggests there may be a similar problem in the United States.

In comparison, interview participants expressed in positive terms the current relationship between CI operators and municipal authorities with respect to emergency planning (DCI 5-6; DCI 9-11). Still, it is worth recalling that provincial emergency management standards apply to *municipal* preparedness, and establish few, if any, mandatory requirements for CI operators who handle dangerous chemicals. In addition, at the federal level, a 2009 report of the Auditor General of Canada found that manufacturing had made the least progress on emergency management of the ten CI sectors (OAG, 2009).

4.2.2 Structure

One way of thinking about structure is to consider the "extent to which regulation involves a mix of public and private sector actors" (Hood *et al.*, 2001: 31). In this sense, the concept of structure highlights the role of Responsible Care (RC), the industry's self-regulation initiative and a defining feature of the Canadian major chemical incident regime. Introduced by the Canadian Chemical Producers' Association (CCPA) in the 1980s,[17] RC contains three sets of codes, or standards, to which member companies must adhere.[18] The codes are intended to provide flexibility for the implementation of facility-specific practices. They contain safety and security standards, as well as guidelines for

[16] In general, the federal government stopped promoting best practices for community planning in the early 1980s (Millward, 2006: 481). The Major Industrial Accidents Council of Canada (MIACC) published several guidelines in the mid-1990s, but they are seldom referenced today (Hosty, 2008).
[17] Today it is managed by the CCPA's successor organization, the Chemistry Industry Association of Canada (CIAC).
[18] See Appendix D for more information about the RC codes.

communicating site risks with first responders and community members (Belanger *et al.*, 2009: 21; CIAC, n.d.; DCI 11; Lacoursiere, 2006).

In our interviews, industry participants expressed satisfaction with the RC commitments (DCI 8-9; DCI 11; DCI 16-17), although one suggested that improved standards were necessary with respect to cyber-security (DCI 11). Government participants, including Canadian and American industry regulators and a law enforcement officer (DCI 13; DCI 14; DCI 18), also described the program as effective. However, not all chemical companies are CIAC members, and non-members have no obligation to subscribe to RC.[19] Interview participants reported significant variation between the risk management and safety practices of large companies, many of which tend to have membership in CIAC (or other, similar organizations) and their smaller counterparts (DCI 9; DCI 13).

In any case, RC is a prominent feature of the Canadian regulatory landscape and a key source of standards for the chemical industry. The initiative informed the creation of the Major Industrial Accidents Council of Canada (MIACC) (DCI 8; Lacoursiere, 2006: 311). Jointly funded by government and industry, MIACC was seen as a consensus-based alternative to the sort of top-down, regulatory approach preferred by most governments in Bhopal's wake. Although it ceased to exist in 1999, MIACC's emphasis on working collaboratively towards common objectives continues to influence the development of standards, serving as the foundation for the E2 regulations and joint municipal-industry emergency planning efforts (DCI 8-9; Lacoursiere, 2006: 313). Interview participants also cited recent efforts by chemical facilities to replace voluntarily dangerous chemicals with less hazardous ones – often in response to programs such as Canada's Chemicals Management Plan – as evidence of the collaborative relationship between the private and public sectors (DCI 13; DCI 18; see also Meek and Armstrong, 2007: 613).

[19] Some research has found that large firms are generally successful at imposing industry-wide standards on smaller companies (for example, Engelhardt and Maurer, 2012). However, the extent to which these smaller companies actually *commit* to the initiative's principles is in dispute.

4.2.3 Style

Regime style can be conceived of in numerous ways. One way is to consider the cultural traits, or the attitudes and beliefs of standard-setters. By turning our attention to the overall degree to which regulation is governed by hierarchical measures – formal rules, clear lines of accountability, etc. – rather than vague or informal practices, group pressures or financial incentives, style illuminates aspects of the source and purpose of standards. The preceding sections suggest, to an extent, a preference for limited market intervention. At the same time, the RC commitments reflect a traditional hierarchical approach to regulation, despite being industry-promulgated: in principle, they establish clear rules and lines of accountability and are intended to promote stability.

In a different sense, the style of the regime suggests an approach to standards based on the principle of 'collibration', which Hood *et al.* describe as "control through opposed maximizers" (2001: 25). Here, the regulatory regime is calibrated to balance competing principles – risk against cost, for example – by facilitating deliberative processes that enable individual actors to implement controls appropriate to their particular circumstances.[20] One chemical industry interview participant attributed this to the small scale of industry in Canada (compared to the United States), which requires government to tailor regulations to specific industrial sub-sectors or even specific facilities, an onerous and inefficient undertaking (DCI 11). RC is similarly characterized by standards that permit flexibility and adjustment. A CIAC guidance document, for instance, emphasizes that the codes "are deliberately open to interpretation to inspire companies to think more deeply and broadly about the complex issues associated with their Responsible Care commitment" (CIAC, 2010: 5).

It may be illustrative here to draw parallels to the literature on high reliability organizations (HROs). According to this paradigm, safety and security are achieved by inculcating in organizations an attitude, or culture, of mindfulness about potential risks. It is more important, in other words, that an organization possess the capacity to identify and respond to emerging failures than it is for the organization to meet a set of rigid

[20] This is in contrast to a 'homeostatic' approach, in which acceptable-risk thresholds are applied uniformly across the entire system (Hood *et al.*, 2001: 26).

standards designed by a distant authority with limited knowledge of the conditions at a specific facility (La Porte, 1996; La Porte and Consolini, 1991; Weick and Sutcliffe, 2001). The preceding section suggests that the Canadian regulatory model might have been based on this sort of approach. Certainly, with RC we see a preference for the dissemination of a certain attitude towards safety and security risk management as opposed to the application of prescriptive standards.

The HRO literature, however, is challenged by the Normal Accidents (NA) literature, whose advocates generally dismiss the possibility of achieving a positive learning culture. From the perspective of NA theorists, employees are self-interested; they blame-shift and avoid disclosing information that reveals poor performance; large bureaucracies are generally non-responsive; and the optimism that training and education can lead to controlling human and technological systems is naïve. For these theorists, failure of complex systems is inevitable; the question is whether or not one can cope with them (Perrow, 1999; Sagan, 1993; Vaughan, 1996). In short, whereas HRO advocates might view the regime's regulatory flexibility as providing latitude for firms to develop their own safety and security awareness based on their own unique circumstances, NA proponents might perceive it as allowing the spread of inconsistent or lax attitudes and practices underpinned by, at best, naïve optimism, and at worst, self-serving behaviour.

In sum, the regulatory space for dangerous chemicals is characterized by low levels of policy aggression, meaning standards have limited impact with respect to behavioural change and are intended to be minimally disruptive (Hood *et al.*, 2001). On balance, standards are set through a combination of technocratic processes and bargaining among stakeholders. This is particularly true in the case of the chemical industry, where the regime's standard-setting component reflects a collaborative, consensus-based relationship between government and the private sector. Industry-promulgated standards, such as Responsible Care, are prevalent, and the development of new standards by government generally involves extensive consultations with representative industry associations. In permitting facilities a degree of freedom to implement practices tailored to their unique circumstances, the regime is generally responsive to private sector interests that can assist with commercial innovation and growth. Water utility operators,

however, reported limited interaction with government agencies responsible for CIP and that, consequently, they tend to rely on best practices and standards developed by U.S. or international organizations. The emergency responders we interviewed similarly called for greater clarity and guidance with respect to standards for storing dangerous chemicals, and for better coordination and capabilities-based planning among emergency services when responding to chemical incidents. Regulators consistently expressed satisfaction with the standard-setting component of the regime. Overall, we found that the relative absence of stringent, government-imposed standards enables flexibility and reflects a high-reliability approach towards safety and security, in which processes and structures are designed to be adaptable, responsive, redundant and dispersed. Yet, at the same time, this orientation potentially permits inconsistency across the regime, facilitating lax or ineffective safety and security practices among CI operators who choose not to prioritize safety and security. Moreover, the Normal Accidents literature highlights the potential institutional challenges to achieving effective safety and security cultures. Where regulations do exist (for example, the E2 Regulations of CEPA 1999), attitudes vary with respect to their effectiveness and stringency.

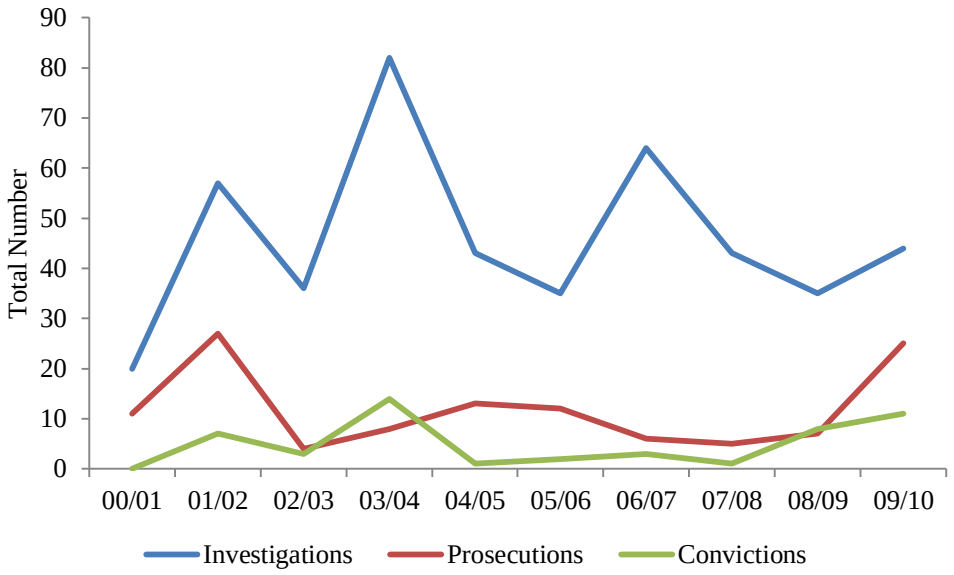
4.3 Behaviour Modification

4.3.1 Size

The size of the behaviour modification component of the major chemical incident regime can be gleaned from the funding and time committed by government and industry to enforcing the standards described above. With respect to the E2 regulations, in a 2011 audit the federal Auditor General described Environment Canada's enforcement program as suffering from poor management, insufficient information about regulated companies, inadequate training for enforcement officers and a failure to follow up on enforcement actions in a fair, predictable and consistent manner (OAG, 2011: 2). In the same year, the environmental organization Ecojustice reported that while the number of Environment Canada enforcement officers had increased since 2000, the number of inspections had remained stable and the number of investigations had declined (Ecojustice, 2011: 33-39;

see also Girard *et al.*, 2010). In summarizing this data, Ecojustice concludes that the figures are low in absolute terms, giving rise to "concern regarding the overall effectiveness of the *CEPA* enforcement regime" (Ecojustice, 2011: 39).[21]

Figure 3: CEPA 1999 enforcement rates



Source: Ecojustice (2011)

Similar issues may be present in the critical infrastructure protection and emergency management realm. Creedy *et al.* (2004: 378) found that a lack of funding and enforcement has led to considerable variation in quality among community emergency plans (see also Henstra and McBean, 2005; Shrubsole, 2000). In general, evidence suggests a discrepancy between the preparedness of large, urban centres and small, rural communities (DCI 12).

Interview participants offered a variety of perspectives on this topic. A fire fighter estimated that 20% of chemical facilities regularly violate standards, either intentionally or due to ignorance (DCI 5), and that insufficient monitoring and enforcement are to blame (DCI 5-6). In Canada, as well as the United States (DCI 18), these facilities are

[21] Others have raised similar questions about implementation and enforcement at the provincial level. Krajnc, for example, points to the reduction in abatement and enforcement officers at the Ontario Ministry of Environment as a contributing factor in the 1997 fire at the Plastimet recycling facility in Hamilton (2000: 120). In Alberta, many environmental impact assessments are said to contain large informational gaps, and many fail to consider extreme weather events (Weinhold, 2011: A130).

typically operated by SMEs. A water utility participant suggested that CI operators are occasionally reluctant to implement standards deemed unnecessary or onerous (DCI 4). Two other participants, both federal government employees, acknowledged that recent budget changes have had operational implications, although neither suggested that the quality of enforcement activities has declined (DCI 13; DCI 14).

Others sought to explain the perceived lack of enforcement. Three water utility participants argued that safety and security are not well integrated into workplace culture (DCI 1; DCI 2; DCI 4), although safety was thought to receive more attention than security (DCI 2; DCI 4). Others pointed to the priorities of Canadian regulatory agencies, which, according to one participant, have failed to motivate CI operators to focus on security (unlike their American counterparts) (DCI 3) and, according to a chemical industry participant, have prioritized standard setting over enforcement (DCI 9). Industry participants generally did not cite enforcement as a problem, arguing instead that the Canadian industry has a strong record on safety and security risk management, the product of initiatives such as RC.

4.3.2 Structure

As we emphasize above, a defining feature of the structure of the major chemical regime is the RC initiative. With respect to enforcement, every three years each member company must undergo an external, inputs-based[22] audit of its implementation of the program (DCI 11; Green and Harb, 2003: 20-25). Additional oversight and accountability for the initiative is provided by the National Advisory Panel (NAP), which is composed of 12 to 16 non-industry-employed activists, advocates and academics (CIAC, 2009). The NAP is authorized to conduct an annual review of the performance of the initiative as well as issue challenges for improvements. Current NAP members possess considerable expertise and experience in areas related to corporate social responsibility, environmental protection and sustainability; participation by individuals with security expertise, however, is less evident. In addition, RC uses soft enforcement mechanisms such as peer

[22] In other words, whether they have the appropriate systems in place, not whether they are achieving desired compliance or environmental protection outcomes (Green and Hrab, 2003: 25).

pressure, which creates an atmosphere of mutual accountability and an incentive for laggards to improve performance (Moffet *et al.*, 2004: 195-196).[23] Green and Hrab (2003) argue further that the diffusion of RC norms, technology and information among chemical facility managers serves as an additional, if subtle, enforcement mechanism.

Interview participants with expertise or experience in the chemical industry (DCI 8-9; DCI 11; DCI 16-17) offered few comments on the enforcement of RC.[24] In general, they conveyed a sense of satisfaction that the initiative operates as intended, with one participant stating that verification audits are successful in ensuring that member companies meet RC expectations (DCI 11). When asked questions related to potential enhancements, participants suggested that member companies could improve their business continuity planning efforts (DCI 11) and that CIAC should review existing standards to determine if amendments are necessary (DCI 9).

The academic literature on this topic suggests that the industry has had mixed results with respect to enforcement (see Finger and Gamper-Rabindran, 2013; Gamper-Rabindran and Finger, 2013; Gunningham, 1995; King and Lenox, 2000; Prakash 2000). However, this research focuses on the U.S. industry during the period prior to the implementation of RC's security codes; to our knowledge, there have been no comparable studies on the enforcement of RC in Canada.[25]

At present, RC behaviour modification efforts appear to be focused on improving performance on safety and environmental sustainability issues; security-related concerns are comparatively underemphasized. The results of RC verification audits are available on the CIAC website. Fifty-five audits have been conducted since 2010. We queried each report for the frequency of various terms related to three categories: safety, security and environmental risks. Figure 4 contains the results of our queries. Not every term fit neatly into the three categories of safety, security and environmental risks. 'Security' was

[23] For example, each quarter the CEOs of RC member companies meet in six Regional Leadership Groups to discuss performance; the potential embarrassment of reporting to peers that one's company has failed to meet even the minimum standards serves as a compliance motivator (Moffet *et al.*, 2005: 196; see also Conzelmann, 2012: 205).

[24] It is worth reiterating here that not all chemical companies are members of CIAC and the RC initiative.

[25] We conducted a very preliminary study of this issue using the Canadian Disaster Database. Although our results must be considered in light of significant caveats, it is worth noting that the absolute number of chemical incidents since 1985 appears to have remained steady despite the introduction of both RC and new government programs after 9/11. (See appendix C.)

sometimes used generically in the context of maintaining the physical integrity of a facility. Note also that eight reports were in French. In those cases, we recorded use of the term 'sécurité' under the 'security' heading, even though the term can be used to indicate safety (i.e. the phrase 'occupational health and safety' is typically translated as 'la santé et la *sécurité* au travail'). As well, the term 'emergency' was rarely clarified in the reports, so we could not determine whether the language in question was concerned with emergencies caused by malicious actors, natural disasters, accidents or some combination thereof.

Figure 4: Frequency of safety and security terms in RC verification reports

Term	**Total Frequency**	**Per Report**		
		Average	Median	Mode
Security:				
Terror*	47	0.85	0	0
Malicious Incident	19	0.35	0	0
Security	761	13.84	3	10
Safety:				
Accident	155	2.82	0	1
Safe*	1,469	26.71	32	24
Natural Disaster	3	0.05	0	0
Environment:				
Environment*	1,134	20.62	11	20
Sustainab*	927	16.85	17	17
Emergency:				
Emergency:	1,006	18.29	10	14

Calculations based on data from CIAC (2014)

** Includes all terms sharing the identified stem (e.g. terror, terrorist and terrorism). In the case of 'terror', the term 'bomb' was also included in the query.*

On average, each verification report contained almost 17 references to sustainability, over 20 references to the environment and nearly 27 references to safety. Security, meanwhile, received fewer than 14 references per report (or about 10 references, if the eight French reports are omitted). Specific security-related terms, including terror and malicious incident, were hardly mentioned at all. Although preliminary, this analysis calls

into question whether security concerns have infiltrated Responsible Care to the same extent as safety and environmental concerns, at least when it comes to behaviour modification.

4.3.3 Style

The two preceding sections underscore important aspects of the style of the regime's behaviour modification component. They illustrate both the density of formal behaviour modification mechanisms and the extent of government's commitment to enforcement. The issue is not the attitudes or qualifications of individual regulators or compliance officers but rather the broader cultural orientation of the regime itself. Hood *et al.* describe this in terms of the toothpaste-tube-like characteristic of regulatory systems; that is, their tendency, "if squeezed in one place, to bulge out in another" (2001: 15). The 'squeeze' (or increased pressure) on information gathering and, to a lesser extent, standard setting, corresponds with a 'bulge' (or reduction or vulnerability) in behaviour modification and enforcement.

A related theme is the difference between large and small organizations. Large organizations, such as multinational chemical companies and water utilities in large cities, are generally (although certainly not always) more compliant than smaller ones. Small firms can find compliance difficult because regulations are often written with large corporations in mind. Indeed, larger critical infrastructure operators often contribute to the development of regulations whereas small operators tend to lack the requisite technical expertise or financial resources (Ashford and Heaton, 1983; OECD, 2001; Walkerton Inquiry, 2002b). Routinized institutional practices are also a potential factor, as large corporate entities may be better attuned to and organized for the exigencies of prescriptive, bureaucratic standards than small firms operating on a more fluid, competitive and uncertain basis.

Interview respondents from the water utility and chemical industry sectors provided similar information, noting that smaller facilities often have fewer staff hours to devote to safety and security matters (DCI 2; DCI 8). An emergency management respondent argued that small jurisdictions are challenged by the complexity of preparing for

chemical hazards (DCI 6). In many ways, thinking about dangerous chemical risks in terms of large and small actors offers a helpful framework for understanding the style of the behaviour modification component, with larger companies and jurisdictions arguably playing a larger role in influencing the development of standards and exhibiting a greater commitment to enforcing them than their smaller counterparts.

With respect to RC, the preferred style of behaviour modification involves collaboration, persuasion and education instead of punitive sanctions. Of the 55 verification audits studied in the previous section, 52 (95%) were deemed to require no further involvement from the verification team.[26] That is, the verification team determined it was not necessary to follow-up regarding any findings requiring action. Thus, the potential for any RC member to 'fail' an audit seems quite low. This is consistent with an approach to compliance that values self-motivated compliance over deterrence. Indeed, in their introductory text, each audit report explains that the external verification process is intended to provide firm executives with "an external perspective … along with advice," as well as to "identify opportunities for assisting the company" in improving performance (for example, CIAC, 2013: 5).

Finally, as with the preceding two components of regulatory content, we observed that each sector – water, emergency management, industry and regulatory – exhibits a unique attitude towards behaviour modification. The four sectors, in other words, represent a second dimension in which organizational approaches may be measured and categorized. Water utilities participants described their sector as community-based and non-competitive, while emergency management participants highlighted the importance of resilience and adaptive capacity. Industry participants emphasized the competitiveness, dynamism and global nature of the chemical market. Regulators, in comparison, were concerned with issues related to comprehensiveness, stability and routinization in the context of safety and security risk management. These are broad characterizations; within each set of responses there was important variation and nuance. This typology does reveal, however, how underlying institutional context between organizational types may affect attitudes regarding behaviour modification.

[26] Two of the three audits where follow-up was deemed necessary involved the same company.

In sum, behaviour modification appears to be the smallest component of the regime. The academic and grey literature suggest that the resources dedicated to enforcement may be low in absolute terms. This was also the perception among our water utility, emergency management and industry interview subjects. Enforcement and compliance appears to be a particular problem in the case of SMEs who are less organized (and often do not subscribe to self-regulation initiatives), possess fewer resources and expertise and, compared to large organizations (multinational chemical companies, for example), struggle to achieve compliance. Interview participants were generally in agreement that industry associations are typically successful in securing compliance with industry self-regulation initiatives through collaborative and flexible mechanisms, such as non-prescriptive verification audits. There is, however, less consensus on this point in the academic literature. Again, differences in style or organizational culture between sectors appear to influence perspectives on behaviour modification. Water utilities and fire fighters tended to support greater government intervention while industry participants preferred collaborative enforcement mechanisms, in which government supports industry self-regulation efforts. None of our participants called for the diminishment of efforts to influence the behaviour of high-risk facilities; at issue was the style and scope of the processes to be used.

5.0 Regime Context

Having defined the *content* of the major chemical incident regime we next turn to an analysis of its *context*. In the following section, we identify the factors that help to explain content by introducing the second major component of the Hood *et al.* framework.

5.1 Market Failure Hypothesis

The first hypothesis, the *Market Failure Hypothesis*, assumes that cases of government intervention in the market are necessary given the technical nature of the risk and the inability of the market to manage the risk effectively without such intervention. Most economic arguments for government intervention are based on the idea that the marketplace cannot provide public goods or respond appropriately to externalities. Public health and welfare programs, education, roads, research and development, national and domestic security, and a clean environment all have been labeled public goods (Cowen, 1993).

The Market Failure Hypothesis (MFH) posits that the content of a regime will reflect the extent to which markets fail to operate as regulators of socially unacceptable risk (Hood *et al.*, 2001: 70). In Canada, the market for chemicals (insofar as a single 'market' can be said to exist) is variegated, complex and dynamic, both in terms of firm structures and products. The market is competitive, and product and process innovations are key sources of profit (Bauer and Leker, 2013; Doria, 2010). Supply chains in the chemical industry are "long, complex, and vertically and horizontally differentiated" (Doria, 2010: 4). Because of these features, chemical products and firms vary in terms of their significance to CI: for chemicals that are prevalent and easily substituted, a major incident at one production site would cause minimal disruption to the supply chain. In other cases, an incident at a single facility could have international repercussions. For example, an interview participant (DCI 9) described the closure during Hurricane Katrina of a Louisiana plant that produced a chemical required by auto manufacturers. The only other producer of the chemical in North America – a site in Sarnia, Ontario – had halted

production to carry out maintenance work, and had to be re-opened on an emergency basis to prevent broader disruptions to the auto industry.

As a means of testing the explanatory power of the MFH, Hood *et al.* select two costs that can lead markets or tort law processes to fail in handling risks: information costs and opt-out costs. Information costs are faced by individuals in their efforts to assess the level or type of risk to which they are exposed. From a MFH perspective, Hood *et al.* expect regulatory regime content to be larger for high-cost cases than for low-cost ones because individuals would be more likely to resist expensive information-gathering activities unless pressured by government intervention (2001: 73). 'Opting out' costs are incurred by individuals to avoid risk exposure through, among other things, civil law processes or insurance. The cost of individually opting out of a hazard can be considered in absolute terms, but it can also be considered relative to a collective opt-out strategy (2001: 73).

If the market failure approach to risk regulation is followed, regulatory size will be substantial only for risks where opt-out costs and information costs are high, and only for the specific control component that is affected by high costs. Conversely, if both information and opt-out costs are low, the market failure approach would lead us to expect regulatory size to be small. If information costs were high but opt-out costs were low, market failure logic suggests regulatory size would be high for information gathering but low for behaviour modification. If information costs were low but opt-out costs were substantial, regulatory size would be low for information gathering but high for behaviour modification. Figure 5 summarizes Hood *et al.*'s expectations of an approach to regulation dictated by the logic of market failure.

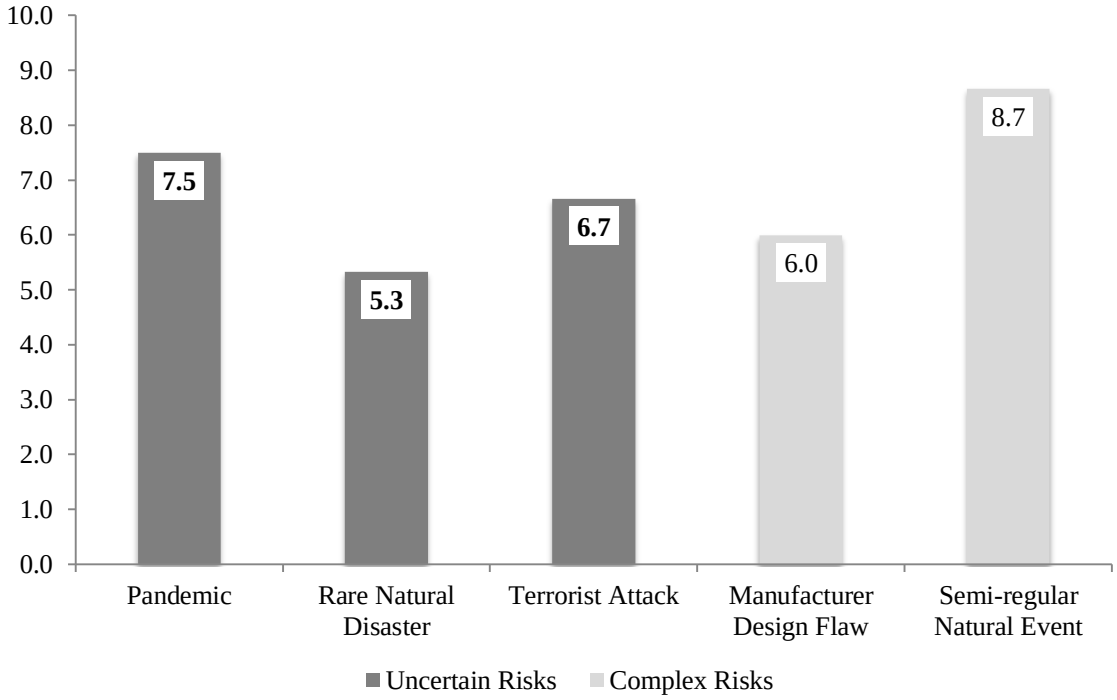
Figure 5: Market failure explanation of regime size

		Cost of obtaining information on exposure to risk	
		Low	**High**
Costs of opting out of exposure to risk by market or contractual means	**Low**	Minimal regulation	Regime content high on regulatory size for information gathering, with behaviour modification through information dissemination
	High	Regime content high on regulatory size for behaviour modification	Maximal regulation

Source: Hood *et al.* (2001: 74)

Both information costs and opt-out costs are present to varying degrees in the chemical industry. Information costs tend to vary according to risk type. Terrorism and rare natural disasters – low-probability, high-consequence phenomena – are difficult to predict due to insufficient reliable data, limited predictive models and technologies and, in the case of terrorism, a reactive, human enemy. Regularly occurring natural events, such as seasonal flooding, are more easily anticipated given the availability of historical data. We asked several interview participants to comment on whether a chemical facility manager would receive reliable and timely information in advance of various hypothetical risk scenarios. Figure 6 shows the average scores for those participants who attached numerical values to their responses (on a scale of one to ten, with one meaning 'no confidence' and ten 'very confident'). Borrowing from the typology developed by Renn (2008), we have divided the queried risk types into two groups: uncertain risks, for which the causal factors are known but their likelihood is unpredictable; and complex risks, which are technically difficult to understand due to the number of variables that potentially influence the risk but for which there is usually some experiential learning (Quigley, 2013).

Figure 6: Interview participants' confidence in the availability of information prior to selected risks



Source: DCI 8-11; DCI 14-17

Note on Figure 6: The small sample size would preclude the use of any rigorous statistical analysis to support generalizations of the findings. We present the data as indicative of the relative importance of the contextual influences as assessed by these individual interview subjects and use it as a departure for analysis and discussion. Please see the Methodology section (Appendix B) for further discussion on this approach.

A number of factors influence the perceived cost of obtaining information about risks. First, interview subjects seemed confident that they would receive reliable information in natural events with which they have some experience. Interview participants are comfortable, for example, with the mechanisms in place to gather and disseminate information about pandemics; this may be a function of recent efforts by governments to strengthen pandemic preparedness in the wake of SARS and the considerable effort in 2009 to contain the spread of H1N1 (DCI 11; DCI 16-17). They are also confident that they would receive reliable information about semi-regular natural events, like floods. Second, and perhaps surprisingly, interview subjects showed less confidence in receiving

reliable information about design flaws in their infrastructure. This low number suggests that, in Renn's terms, complex risks as well as uncertain ones raise questions about the cost and difficulty of obtaining reliable information. The mid-level score for terrorism is perhaps unsurprising given the investment by government in programs such as SIR, which are intended to reduce information costs for CI operators. In fact, the presence of these programs suggests that the government response is at least partly explained by the market failure hypothesis.

Information costs may also be understood from the perspective of citizens. In other words, how difficult is it for community members to gain detailed information about major incident risks posed by facilities in their neighbourhood? The answer is unclear. As noted above, the RC initiative includes site risk communication guidelines, which are intended to help facilitate "a protected, informed community, having both an awareness of the chemical industry's presence and a reasonable comfort level that hazards and risks are under competent control" (Lacoursiere, 2006: 312). Interview participants from the chemical industry emphasized efforts by RC members to implement these guidelines (DCI 9; DCI 11). These interview respondents also noted, however, that security concerns limit the specificity of the information that is made public. In a version of the guidelines published by the Canadian Society for Chemical Engineering, companies are encouraged to invite interested citizens – who may have to undergo security clearance – to participate in "a dialogue process involving site operators and [first] responders" (CSCE, 2012: 7). Under this model, information exchange is initiated primarily by industry and occurs in an ad hoc fashion. There appears to be no centralized database or website that citizens can access at their convenience to access site-specific risk information.[27] Significant information asymmetry – further evidence of market failure – thus exists between CI operators and government on the one hand and citizens on the other.

In general, the industry's aforementioned competitiveness means companies are unlikely to disclose sensitive information to competitors or (as we shall see below) to the public. Moreover, company vulnerabilities tend to be "dirty little secrets;" industry leaders are reluctant to discuss the vulnerabilities of assets because of the risk to their

[27] Environment Canada's E2 database, described above, shows only the addresses of regulated companies.

organization's security, liability, share value and public image. At a minimum, highly competitive industries will almost certainly insist on anonymized data sharing and non-disclosure agreements to preclude proactive disclosure to the public (Quigley, 2013).

Information costs thus vary across the regime. Industry and CI operators face a range of both low- and high-cost risks. For citizens, accessing information about the risks posed by local facilities can be a high-cost activity, given the potential investment of time and energy required. Returning to Figure 5, the information costs associated with chemical risks are thus best illustrated as a continuum spanning the horizontal axis, rather than as a single point in either quadrant.

Few, if any, would choose to 'opt out' completely from risk exposure, even if they could. The cost of opting out of risks associated with major incidents involving chemicals tends to be high due to the variety of risks and the unreliability of information. Moreover, given the large number of chemical installations across North America, most owners do not believe their sites will be targeted by terrorists, for example, nor will they succumb to rare natural disasters (Schierow, 2005). As a result, there are limited incentives for owners and operators to invest against a risk they perceive to be small. This sentiment was common among our interview participants, many of whom suggested that terrorism, in particular, was less of a threat to the chemical industry than other risks, including natural disasters and risks related to cyber-security (DCI 8-9; DCI 11; DCI 16-17).[28] In other words, there are limited market incentives to prepare for low-probability risks, despite their potential consequences.

A related problem confronts RC. As Gunningham (1995) emphasizes, the initiative is vulnerable to pressures imposed by (1) the chemical market's demand for short-term profit, and (2) the divergence between the interests of large, often transnational corporations and SMEs (63). Further, given the tendency for the general public to perceive the chemical industry as a single entity, companies that devote time and money to implementing RC are at a competitive disadvantage to 'free-rider' companies who neglect to adopt voluntary safety and security practices (Gunningham, 1995).

[28] Although 'cyber-security' might refer to a diverse range of strategies aimed at mitigating an even broader range of malicious cyber activities, such as interstate cyber warfare, cyber terrorism, 'hacktivism' and corporate IP theft (Quigley, Burns and Stallard, 2013), only one interview participant specified what he meant by the term; the other participants used it in a general sense.

Even when incentives are aligned, the costs involved in reducing risks are high given the volatile and hazardous nature of many chemicals. Companies that attempt to replace dangerous chemicals with less hazardous ones may find it difficult or expensive to adjust their manufacturing processes, particularly if they are unable to identify alternatives due to insufficient research and development capacity, if alternatives are unavailable or other companies in their supply chain have not made the substitution (Lofstedt, 2013). Although chemical substitution was highlighted by two interview participants (DCI 13; DCI 18), it remains a potentially high-cost solution that is not applicable in every case.

The existing regulatory and market solutions are also limited and can be traced to the flawed incentives generated by insurance markets and tort-law processes. With respect to the former, interview participants consistently described insurance concerns as having little influence over how CI operators, including water utilities and chemical companies, spend their time on matters of safety and security (DCI 1-8; DCI 11). One participant suggested that this was because most large chemical companies are self-insured (DCI 11). Low-probability/high-consequence risks are notoriously difficult to insure because there is insufficient data for insurance companies to develop sustainable policies. U.S. flood insurance and terrorism insurance are recent and salient examples; they continue to be subsidized by the U.S. government. Recent disasters in Canada also suggest that small companies carry insufficient insurance coverage for major losses. In the case of Lac-Mégantic, the Montreal, Maine and Atlantic Railway filed for bankruptcy for this reason (Van Praet, 2013) and, later that year, the federal government announced it would "require shippers and railways to carry additional insurance so they are held accountable" (Canada, 2013: 15).

In 2004, the federal government implemented changes to the *Criminal Code* that affected the Canadian tort-law system. Specifically, Bill C-45, the so-called 'Westray bill',[29] extended the criminal liability of corporations in the field of health and safety (Creedy *et al.*, 2004: 376-378). When prosecuting companies for offences such as criminal negligence it is no longer necessary to prove *mens rea* – criminal intent. Instead,

[29] In 1992, an incident at the Westray coal mine in Nova Scotia caused the death of 26 miners. The subsequent public inquiry revealed "an almost wilful avoidance of basic safety by the mine operator coupled with a 'do nothing' attitude by the provincial safety inspector overseeing the working conditions at the mine" (Creedy *et al.*, 2004: 376).

it is enough to show that the company failed to take sufficient measures to prevent the incident. However, these changes have gone largely unenforced, and thus have had little effect on corporate behaviour (Bittle and Snider, 2011).[30] More generally, criminal and tort-law proceedings often require significant resources and time, delaying the immediacy with which those liable for failures are held accountable.

In sum, chemical industry risks present high opt-out costs and both high and low information gathering costs. This corresponds with the bottom two quadrants of Figure 5. According to the market failure hypothesis, these factors should translate into either a maximalist, aggressive regulatory system or a regime with a large behaviour modification component. However, as is clear from the preceding section on content, the chemical regime does not reflect these characteristics; in practice, the regime exists likely in the top right quadrant of Figure 5. For these reasons, the MFH appears to offer only a partial account of the content of the chemical regime.

This conclusion is generally in line with the findings of Hood *et al.* (2001: 71), who argue that the MFH is "more useful as a method of analytical benchmarking than as a reliable predictor of regulatory content". This is not to suggest that market forces are unimportant: share values typically tumble after disasters (Capelle-Blancard and Laguna, 2010; Carpentier and Suret, 2013). But disasters are in fact low-probability events; market logic would rarely justify investing much in these unlikely, what-if scenarios. At the same time, while social and economic costs of the events are high, government is apparently loath to step in and enforce high regulatory standards that could potentially – and arguably unnecessarily – decrease the competitiveness of the industry. Indeed, such an intervention could be described as a government failure. As a result, and notwithstanding the traditional government standards, we continue to see a growth in voluntary self-regulation in the industry (Bittle and Snider, 2011: 380). Such a conclusion

[30] In a comprehensive study of Canadian criminal laws relating to corporate crime, Bittle and Snider (2011) note that between 2004 and 2010 there were only three charges and one conviction under the new provisions. They argue that Bill C-45 and other attempts to criminalize corporate negligence have been undermined by the prevailing "consensual/cooperative" model of corporate regulation, which is animated by the "erroneous belief that corporations will self-regulate under the influence of market forces" (Bittle and Snider, 2011: 380). In addition, a new consulting market has arisen in Canada, in which lawyers and occupational safety experts advise companies on how to avoid responsibility under the Westray amendments, effectively non-criminalizing workplace accidents (Bittle and Snider, 2011: 381).

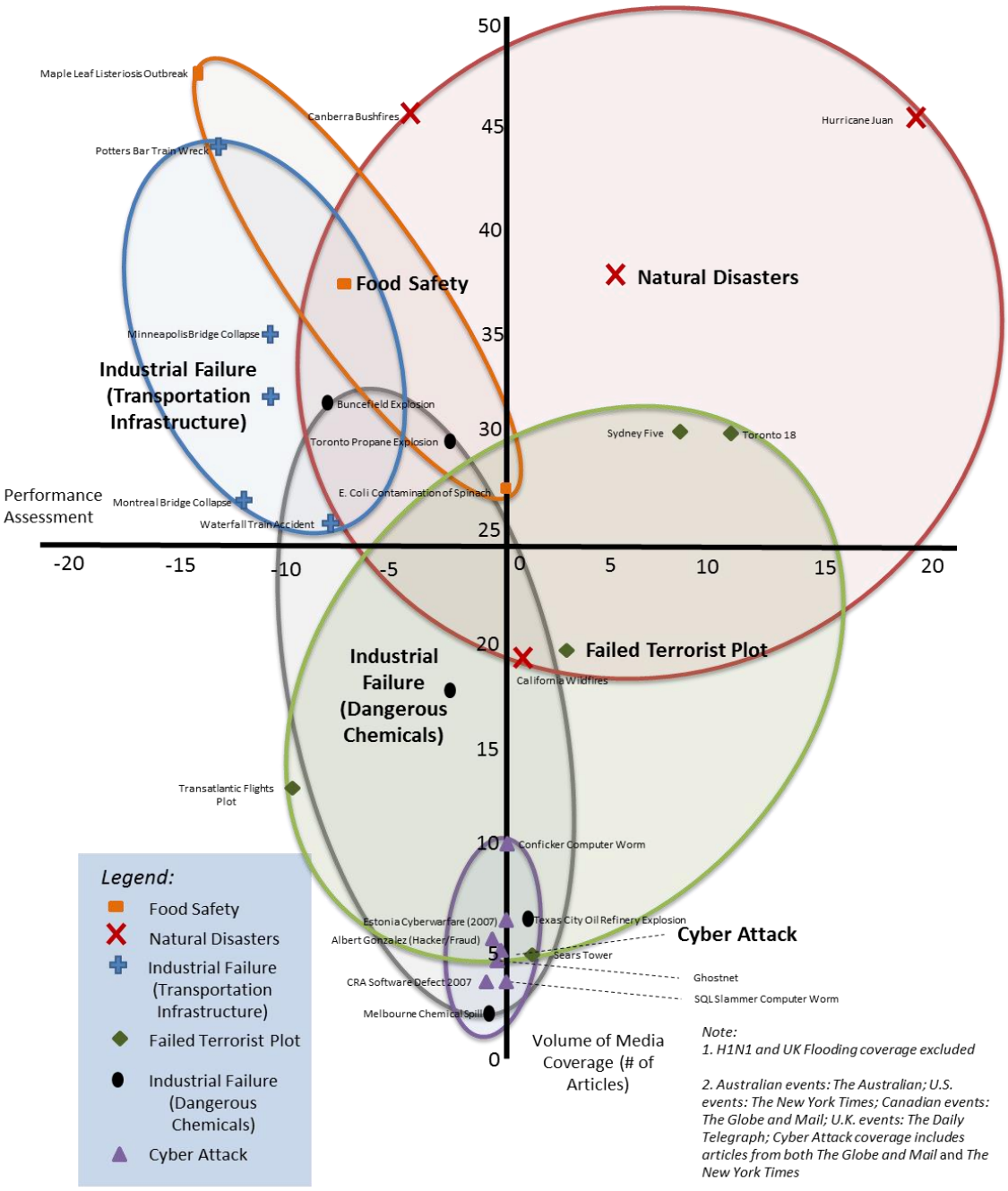
suggests that high-consequence risks persist, and governments are increasingly prepared to let organizations manage them. While markets may tolerate such risk-taking, the public has an aversion to such disasters – a point we explore in the next section.

5.2 Opinion-Responsive Hypothesis

The *Opinion-Responsive Hypothesis* (ORH) states that a risk regulation regime is a certain way because that is how those affected by the risks, or the cost of reducing the risks, want it to be (Hood *et al.*, 2001: 90). In short, regime content reflects public preferences and attitudes. As we argue below, congruity of this type exists to varying degrees in the dangerous chemicals regime.

The availability of newspaper and media archives on the Internet enables us to draw on empirical data for our analysis. Here, we borrow from Hood *et al.*, who similarly use media coverage to gauge not public opinion per se but rather the flavour of public debate not least because leaders in civil society read these news sources. Figure 7 is the result of a study of media coverage of selected CI events that have occurred since 9/11. It shows volume of media coverage on the Y-axis and government performance assessment (as determined by the media) on the X-axis. The chemical incidents in the study are: the Sunrise Propane explosion, the Buncefield explosion (UK), the Texas City oil refinery explosion and the Melbourne chemical spill. For more detail about our methodology for preparing this graph, please see Appendix B.

Figure 7: Assessment of government performance and volume of coverage for selected events



Sources: The Australian, The Globe and Mail, The Daily Telegraph; The New York Times

We have to be cautious when interpreting media coverage. Researchers have noted the media's propensity to report the dramatic over the common but more dangerous (Soumerai *et al.*, 1992), their tendency not only to sensationalize (Johnson and Cavello, 1987), but also to sensationalize the most negative aspects of events, in particular (Wahlberg and Sjoberg, 2000). Moreover, the number of events is relatively low and therefore we have to be careful about the conclusions we draw. Finally, the four chemical events are the result of industrial accidents rather than malicious intent, which can further influence the type of coverage.

Notwithstanding these cautionary notes, some patterns emerge that are reinforced by other academic research. Chemical events received less total coverage than most other types of events, including transportation, food safety and natural disasters. Figure 7 is clear, however, that the *potential* for negative coverage of chemical accidents exists, as evidenced by the results for the Buncefield explosion and the Toronto Sunrise Propane explosion. Natural disasters typically received high volume coverage and, like terrorist plots, tended to include positive performance assessments of government (Quigley and Quigley, 2013). In contrast, the transportation, food safety and chemical events had high variation in total coverage and largely negative performance assessments of government. Despite interview subjects raising concerns over cyber risks, cyber events generated little coverage.[31] Among failed terrorist plots, the arrest of the Toronto 18 group (who planned to detonate bombs made of commercially-available chemicals) generated largely positive assessments of government (and of the police in particular), at least in the immediate aftermath of the incident. Some scholars have argued, however, that media coverage of the plot was alarmist, distortionary and irresponsible (Miller and Sack, 2010; Morano, 2010; Smolash, 2009). The period between the arrests and trial was four years; in the interim, doubts emerged about the credibility of the charges. The duration of criminal proceedings thus contributed to questions about the efficacy of the process, and raised questions concerning accountability and performance of law enforcement.

Content analysis of the media coverage reinforces the point that after an industrial failure the hunt for individual or institutional accountability – be it government or private

[31] Recently we have seen a rise in coverage of cyber events that relate to on-line bullying, government collection of meta-data and insider threats.

sector – is intense and over-simplified (Pidgeon, 1997), while more complex systemic questions are often ignored. Media coverage is also volatile, fluctuating in tone and quantity over time. Of the events displayed in Figure 7, about 70% of total coverage occurred in the first month. Investigations often result in a second spike, although it tends to be smaller and shorter-lived than the initial coverage.[32]

In many respects, media reaction to events such as those in Figure 7 contrasts with a rational approach to risk. These events cause less cumulative damage than high-probability, low-consequence accidents, such as workplace injuries or chronic exposure to chemical substances. Nevertheless, people have a strong aversion to high-consequence events. According to the psychology literature, the psychometric paradigm (as opposed to a rational actor paradigm (RAP)) conceptualizes risks as personal expressions of individual fears or expectations. Individuals respond to their perceptions whether or not these perceptions reflect reality. The psychometric approach seeks to explain why individuals do not base their risk judgments on expected values, as RAP advocates would suggest (Jaeger *et al.*, 2001; 102-104). The approach has identified several biases in people's ability to draw inferences. Risk perception can be influenced by properties such as perception of dread (Slovic *et al.*, 1982), personal control (Langer, 1975), familiarity (Tversky and Kahneman, 1973), equitable sharing of both benefits and risks (Finucane *et al.*, 2000) and the potential to blame an institution or person (Douglas and Wildavsky, 1982). It can also be associated with how a person feels about something, such as a particular technology or a disease (Alhakami and Slovic, 1994). People also show confirmation bias (Wason, 1960), which suggests people seek to affirm their beliefs, not challenge them. People can also be vulnerable to 'probability neglect' (Slovic *et al.*, 2005). When probability neglect is at work, "people's attention is focused on the bad outcome itself, and they are inattentive to the fact that it is unlikely to occur" (Sunstein, 2003: 122).

Sandman (2012) propose a model to explain public perception of risk as a function of two components, hazard and outrage. The former refers to the technical expert risk

[32] There is thus an incentive for companies to resort to legal wrangling to turn investigations into drawn out, highly technical and convoluted affairs. The legal proceedings for the *Exxon Valdez*, for example, lasted over 20 years. During this period public attention shifts elsewhere, the event overtaken by newer headlines (but perhaps not entirely forgotten).

assessment of the event while the latter refers to the emotional reaction people have concerning the event. He lists 20 characteristics of events that affect the magnitude of outrage, many of which can be identified in the events noted above.

Thus, the concern described above may be a product of such things as the public's high dread and perceived lack of control over chemical risks (Slovic *et al.*, 1982). The availability heuristic – which suggests that familiarity with exemplars of a particular risk causes individuals to overestimate the frequency at which such risks occur (Kahneman and Tversky, 1982) – may also be at play, a result of the high media coverage stemming from disasters such as Bhopal. One might add here issues of public distrust of large corporations in general (for example, Adams *et al.*, 2010), as well as negative perceptions stemming from the perceived artificiality or 'unnatural' aspects of manufactured chemicals (Petrie and Wessely, 2002; Trivedi, 2012). Engdahl and Lidskog highlight that citizens' perceptions of the trustworthiness of chemical companies and regulatory agencies are also important (2012: 5). More generally, public anxiety regarding chemicals has been growing in the modern era since at least the First World War (van Courtland Moon, 1984), with efforts to regulate chemicals gaining momentum in the 1960s with the publication of Rachel Carson's now famous *Silent Spring* and the Cuyahoga River fire (Opheim, 1993).

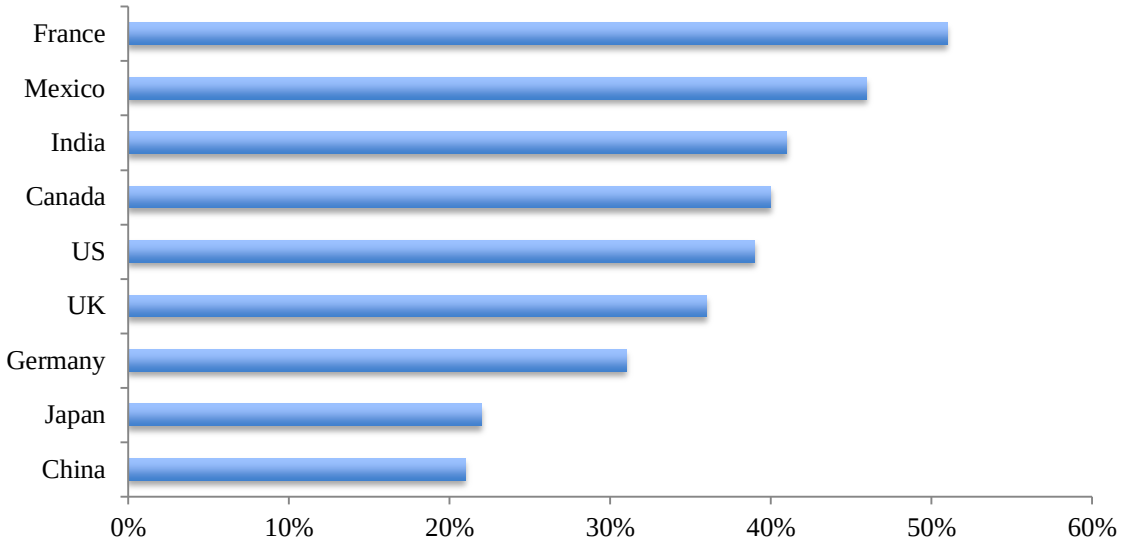
Taken together, the psychology literature underlines that low-probability events are likely to generate extensive media coverage, public anxiety and political activity even though, in many cases, these events in fact cause less cumulative damage than many high-probability, low-consequence accidents.

In short, there are numerous reasons why the chemical industry ought to be particularly sensitive to public opinion and media coverage. The influence of these factors is particularly evident starting in the 1980s after Bhopal (King and Lenox, 2000: 699) and Seveso, which provided the impetus for the creation for RC (Moffet *et al.*, 2004). A 1986 public opinion poll indicated that 48% of Canadians felt that the chemical industry's risks outweighed its benefits (Wise, 1994: 215)[33]. More than ten years later,

[33] A study by Dow Chemical at around the same time found revealed that within six kilometres of Dow's plants, people held opinions about the company that differed from their opinions about the industry as a whole. Beyond six kilometres, peoples' image of Dow was influenced by their views on the broader industry (Moffet *et al.*, 2004: 177).

40% of Canadian respondents to an international poll answered that the chemical industry was doing "very little" or "nothing at all" to reduce its impact on the environment.

Figure 8: Percentage of global survey respondents who reported negative impression of chemical industry, by country



Source: Schmitt (2000: 25)

Note on Figure 8: This figure illustrates the percentage of respondents who answered "very little" or "nothing at all" to the statement: "Taking all your knowledge and impressions of the chemical industry into account, I'd like you to tell me how much you feel it is doing to try and reduce any harmful effects its activities have on the environment" (Schmitt, 2000: 25).

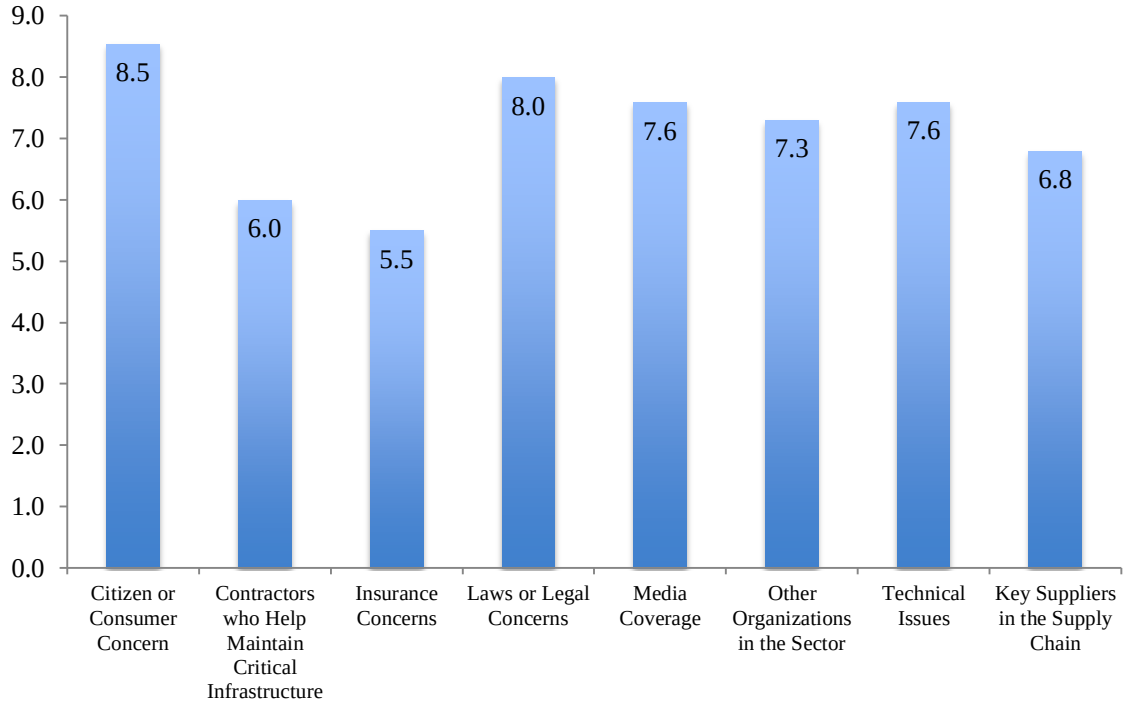
Other CI operators, such as water utilities, need also be aware of these pressures. As the report of Walkerton Inquiry emphasizes, the public assumes that treated drinking water is safe (Walkerton Inquiry, 2002a: 36), and so failures, particularly those resulting in deaths, are troubling, controversial events. Other research points to rising public concern with respect to the sustainability of the country's freshwater supply and the risks associated with activities such as fracking (De Villiers, 2003; Pentland and Wood 2012).[34] Where perceived negligence is at issue, CI operators are subject to public demands for accountability and increased regulatory oversight. Yet, at the same time, it is

[34] According to Renn's (2008) risk typology, the uncertainty associated with fracking may contribute to risks, perhaps in the form of civil unrest, stemming from public distrust or hesitation regarding its perceived hazards.

unclear whether the public would be willing to pay the full cost of improving the safety and security of the water supply.

Our interview data lends mixed support to the explanatory power of ORH. When asked about the influence of various factors on how they spend their time, interview participants identified 'citizen concern' as the most influential on average (see Figure 8). A water utility participant, for example, described the public as 'customers' and therefore critical from a business perspective (DCI 4). Yet the participant implied further that the public has little understanding of the complexity and additional costs involved in achieving safety and security. Industry representatives and fire fighters (DCI 5-6; DCI 11), by comparison, described the influence of the media in the context of its capacity to shape or influence the public's view of how the organization responds to disasters. For both industry representatives and fire fighters, in other words, the primary concern was how they might be portrayed following a major CI event. The media coverage of BP and its then CEO Tony Hayward following the Gulf oil spill arguably provides a recent example of "trial by media", which would no doubt concern most CEOs in the dangerous chemicals sector (Balmer, 2010; Smithson and Venette, 2013).

Figure 9: The perceived influence of various factors on security and safety practices



Source: DCI 1-7; DCI 8; DCI 10-11; DCI 13

Note on Figure 9: The small sample size precludes the use of any rigorous statistical analysis to support generalizations of the findings. We present the data as indicative of the relative importance of the contextual influences as assessed by these individual interview subjects and use it as a departure point for analysis and discussion. Please see the Methodology section (Appendix B) for further discussion on this approach.

Although not statistically significant, the data in Figure 9 suggests important differences between CI operators in the chemical sector and those in the transportation sector, for example. Quigley and Mills (2014), in a parallel study of the transportation risk regulation regime, report that CI operators in airports, for example, appear to view laws and legal concerns as the most significant influence on how they spend their time. In contrast, our interview subjects here seem to be characterized by sensitivity not only to laws and legal concerns but also to individual lay views, and therefore many of the risk psychology concepts described above may be useful in interpreting and anticipating potentially irrational reactions, as well as industry's interest in influencing the public's perception of the industry.

Yet while it is clear that CI regulators and operators in the chemical sector are cognizant of public opinion and the media, it is less clear whether these factors shape regulatory outcomes. It seems that there is a subtle but important difference between, on the one hand, striving to avoid controversy and, on the other, tailoring risk regulations to public preferences, which in any event may not be stable. Equally, it is not clear that industry or government is making sufficient effort to ensure public opinion is adequately represented on decision-making and advisory boards or informed about the true nature of chemical risks. Recall from Figure 2 that relatively few information-gathering fora include citizen participation. Recall also that there appears to be no centralized database or website that citizens can access at their convenience for even minimal site-specific risk information.[35]

Instead, it may be more accurate to think about ORH as a latent force, shaping the chemical industry's preference to avoid negative media coverage. Here, industry outreach efforts, such as the RC requirement that member companies undertake proactive community awareness and dialogue processes (CSCE, 2012; DCI 11), may be understood as a stratagem to shift public opinion rather than as a product of increased demands for transparency. Empirical data suggests that these types of efforts can be successful in improving public perceptions of the chemical industry (Heath and Abel, 1996). At the same time, Canadian right-to-know legislation has not kept pace with the U.S. laws (Wordsworth *et al.*, 2006). ORH is thus more useful in explaining gaps between public expectations and regulatory content – and, by extension, efforts by government and regulators to shape public opinion – than as a straightforward account of the chemical regime; as Hood *et al.* emphasize, "Gallup-style opinion-responsive government [is] not typical in the government of risk" (2001: 103).

ORH perhaps offers a more convincing account for regulatory changes in the immediate aftermath of a major incident as governments and industry scramble to reassure a potentially volatile public by promising new and more stringent safeguards and

[35] A related concern is the need to balance trade-offs between safety and security. The potential benefit of improving public awareness must be weighed against the risk of inadvertently providing to malicious actors sensitive details about critical infrastructure. Concern about this issue was prominent after 9/11, when it was determined that the previous decade's push for online transparency had made available on the Internet "details about public utilities and nuclear plants, blueprints for public buildings, and the design structures of bridges and tunnels, as well as storage of chemical and hazardous materials" (Feinberg, 2002: 272).

reporting requirements. Lac-Mégantic, for example, has already produced several announcements regarding new federal regulations. In these instances the regime's normal standards and manners of operating are subject to intense scrutiny by a hungry media in search of a culprit and a public that is fascinated and outraged by disasters.

It is unclear, however, whether the announcement of new standards translates into improved regulatory outcomes over the long term. This is particularly true when an incident is not reviewed by a formal, public inquiry or commission. The absence of an inquiry limits the potential for organizational learning. The value of a public inquiry is illustrated by comparing the response to the 2008 Sunrise Propane explosion in Toronto with the 2005 explosion at the Buncefield oil storage depot in Hertfordshire, England. In both cases, the insurance and legal issues took several years to resolve. Yet after Buncefield, the UK promptly initiated an independent investigation into the cause of the failure. The investigation maintained a comprehensive website with detailed information about its activities and its findings, including numerous interim reports (Buncefield Investigation, 2006). In comparison, the Ontario Office of the Fire Marshal prepared what it described as a "technically complex" (Ontario, 2010) internal report that was made available to citizens only upon request and in redacted form. The former response provided immediate transparency and an opportunity for benchmarking and learning. In Canada, the absence of a public inquiry means there is a comparatively higher degree of opacity with respect to how organizations incorporate lessons from previous failures. It also restricts opportunities for democratic oversight of the regulatory regime and holding those responsible to account.

In any case, our research confirms that in Canada, public opinion becomes much more influential in the aftermath of major incidents. The re-surfacing of the ORH thus represents a disruptive moment for the regime, which can displace temporarily the normal state of affairs and produce progress towards a regime that better reflects the interests and concerns of civil society. Major incidents do not necessarily generate these results, however; when there is little transparency, for example, organized interests can use failures to consolidate their power and exert greater influence on the regulatory

regime for their benefit.[36] Indeed, we found evidence that organized interests regularly play a significant role in the manner in which the regime operates, a point we explore further in the third hypothesis.

5.3 Interest Group Hypothesis

The third hypothesis presented by Hood *et al.* attributes regime content to interest group pressures. As Hood *et al.* note, "various components and elements of regimes can be shaped by different organized interests" (2001: 131). Political pressure of this sort can be difficult to study, given that public campaigns to influence policy are often complemented by informal, subtle or otherwise discreet lobbying efforts. The *Interest Group Hypothesis* (IGH) thus necessitates an inferential approach, in which the preferences of relevant interest groups are assumed to be revealed by their function and observable behaviour. In the context of regulatory analysis, IGH directs our attention to the degree of alignment between these preferences and regime content, and where clear alignment *is* detected, interest group pressure can be said to explain the regime. This is particularly true where regulatory policy is contested by multiple organized interests; here, alignment between content and preferences suggests that one group was 'victorious' and therefore better organized and more powerful than others.

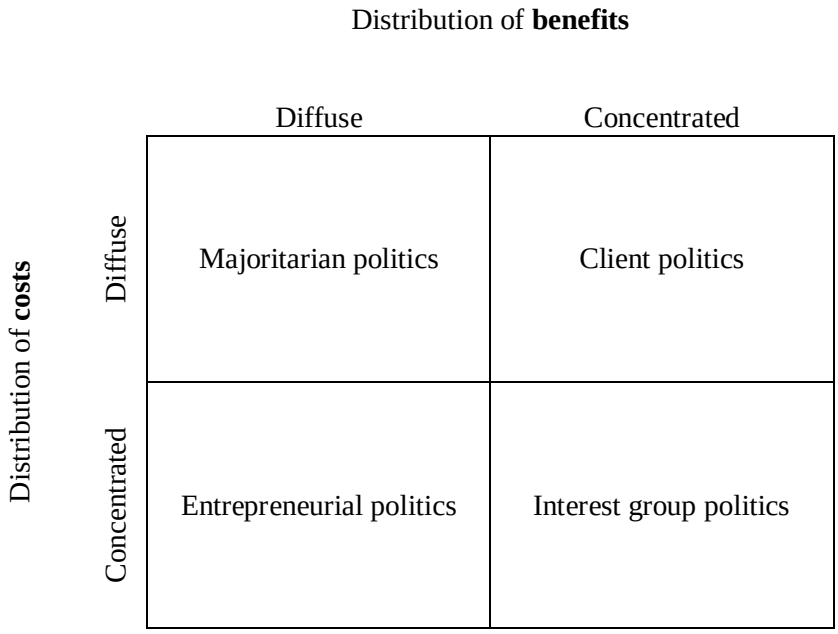
Another way to conceptualize interests is to study the benefits and costs of regulation. Put differently, IGH suggests that the concentration or diffusion of costs and benefits will affect the desire by an interest group to influence policy. According to the Stiglerian, or Chicago School perspective, business interests are often "the best-organized group in the policy domain" because their "fortunes could be affected by price control or restrictions on entry to their markets" (Hood *et al.*, 2001: 65). Regulatory capture occurs when these interests are successful in shaping the behaviour and decisions of regulators. Yet non-business groups also attempt to influence government. Environmental organizations, for example, lobby governments to strengthen pollution standards. As well, Hood *et al.*

[36] In interviews with agriculture specialists, for example, we were told that the imposition of new standards is often followed by consolidation in the industry, as large firms purchase small producers who find themselves unable to afford the costs of compliance. This arguably introduces new vulnerabilities by increasing the sector's single points of failure.

contend that regulators themselves may be understood as an organized interest group. Although financial profit is not at issue, the economics and public administration literature highlights several other benefits that regulators may seek to maximize, such as their departmental budget (Niskanen, 1971), job satisfaction (Dunleavy, 1991) or fulfillment from seeing personal preferences reflected in policy (Downs, 1967). In any case, the IGH approach posits that the presence of well-organized interest groups in a policy area may be understood by examining how regulation affects the benefits and costs accrued by those groups.

Drawing on James Wilson's seminal book, *The Politics of Regulation* (1980), Hood *et al*. illustrate the IGH using a two-dimensional matrix, reproduced in Figure 10.

Figure 10: Interest group explanation of regime content



Source: Hood *et al*. (2001: 122).

Each quadrant in the matrix corresponds to a specific case, or type of regulatory politics. When both benefits and costs are diffuse, the matrix predicts the presence of what Wilson (1980) calls majoritarian politics. The wide distribution of both benefits and costs means no group stands to gain from regulation and no group stands to lose. As an example, Wilson highlights the Sherman Antitrust Act, which affected every business

operating under U.S. jurisdiction and was sufficiently vague that "any given firm could imagine ways in which these laws might help them" (1980: 368). But since no specific *sector* stood to benefit, the Act received little organized business support. IGH overlaps with ORH in this situation, since the absence of organized interests means legislators craft regulatory content in light of prevailing public opinion.

The opposite situation, where both benefits and costs are highly concentrated, produces interest group politics. This situation tends to arise when a proposed regulation threatens to benefit one set of business interests at the expense of others. Hood *et al.* use as an example the imposition of vehicle safety-enhancements, which may benefit "vehicle manufacturers whose markets may be protected or enhanced by such measures" while harming others, such as "vehicle fleet operators or truckers whose costs may be raised" (2001: 114). Where competition over regulatory outcomes involves multiple groups – including civil society actors, such as vehicle safety activists – with roughly equal access to decision-makers, the policy space reflects the archetypal pluralist model of democracy (for example, Truman, 1951). The uneven distribution of resources, however, means regulatory politics often resemble a polyarchy, in which the scales are weighted in favour of the expertise and resource capacity of large, well-organized business interests (Dahl, 1971). Ultimately, the key feature of interest group politics is that "whatever risk regulators do is liable to advance some business interests at the expense of others" (Hood *et al.*, 2001: 114). The concentration of benefits and costs means some groups must win and others lose.

The top right quadrant in Wilson's matrix – client politics – occurs in the presence of regulatory capture. This situation differs from interest group politics because the diffusion of costs means no group perceives itself as losing. "[T]he costs of the [regulation] are distributed at a low per capita rate over a large number of people," writes Wilson, "and hence they have little incentive to organize in opposition – if, indeed, they even hear of the policy" (1980: 369). Examples of client politics include the provision of subsidies by government to an industry or occupation (Wilson, 1980: 369) and the decision by government to limit the stringency of a regulatory regime, even when market failure or public opinion points to the opposite course of action (Hood *et al.*, 2001: 118).

The final type, entrepreneurial politics, exists when a widely dispersed and loosely organized group (the public, usually) benefits from regulation that incurs a significant cost on a much smaller set of interests, such as a specific industry sector. Hood *et al.* call this the 'defeated Goliath' pattern (2001: 116). Wilson suggests that the passage by Congress of the 1966 *Auto Safety Act*, due in large part to the entrepreneurial efforts of Ralph Nader, is illustrative of this type of regulatory politics. As with the majoritarian quadrant, entrepreneurialism in risk regulation blurs the distinction between IGH and ORH, since its success is often bolstered by industrial failure. As Wilson emphasizes, "the work of a policy entrepreneur is made easier by a scandal or crisis [and] … such crises are most important when the regulated industry is associated in the popular mind with positive values, such as free enterprise, the accomplishments of technology, or the virtues of limited government" (1980: 371). This reflects our earlier point regarding ORH as a latent force, emerging out of major crises to disrupt 'normal' patterns of control, thereby creating the conditions for regulatory change.

5.3.1 Applying the Wilson Typology

Our interview data and literature review indicate that the dangerous chemical regime tends towards *Client politics*. The existing relationship between industry and government provides concentrated benefits to industry while producing diffuse costs. A brief consideration of the structure of the Canadian chemical industry highlights why this is the case. In terms of companies and products, the Canadian chemical industry is diverse. In 2010 there were about 2,730 chemical establishments in Canada, concentrated primarily in Ontario, Quebec and Alberta (IC, 2011). The industry is the fifth largest in Canada, measured according to value of shipments (IC, 2011). Exports account for 57% of the industry's revenue (CTCS, 2013). Although the industry as a whole employs over 77,000 people, nearly 90% of chemical companies in Canada employ fewer than 100 employees (CBOC, 2013; IC, 2011). In this way, the Canadian chemical industry exhibits the characteristics of a powerful, if loosely organized lobby.[37] In terms of market structure

[37] In the US and Europe, major chemical firms have long exerted influence over regulatory policy. Following 9/11, for example, the American chemical industry was successful in preventing the passage of

the industry is, to an extent, oligopolistic. As Figure 11 illustrates, in 2010, the ten largest firms earned over half of the industry's revenue.

Figure 11: Ten largest Canadian chemical companies, by revenue (2010)

Company	**Revenue ($ millions)**	**% of Industry Revenue**
Agrium	$10,836	17.76%
PotashCorp	$6,233	10.22%
NOVA Chemicals	$4,576	7.50%
Canpotex	$3,200	5.25%
Methanex	$2,026	3.32%
BASF Canada	$1,135	1.86%
E.I. du Pont Canada	$935	1.53%
Air Liquide Canada	$649	1.06%
Chemtrade Logistics Income Fund	$558	0.91%
CEDA International	$533	0.87%
Total:	$30,681	50.28%

Calculations based on data from CBOC (2012); CTCS (2013)

Market power (financial and know-how) is thus concentrated in a handful of large, multinational firms. Their position is protected by barriers to entry for small firms, including high energy costs, low profit margins (and therefore the need for economies of scale) and a high degree of fluctuation over the business cycle (OECD, 2001). Compliance costs for regulation, which tend to be relatively low for larger companies (Mahdi *et al.*, 2002), represent an additional barrier. By retaining regulatory control through Responsible Care and other schemes, these major industry players are able to influence the level and nature of competition in the market, thereby preserving crucial structural advantages. The benefits of regulation, in other words, are concentrated in this small group of firms.

Self-regulation also enables industry to maintain compliance with U.S. standards. Given the importance of the U.S. market to the Canadian chemical industry (75% of

legislation forcing stricter security standards on chemical producers (Karruthers and Hild, 2004). As we note below, subsequent regulatory changes in the US, including development of the CFATS program, have occurred following consultation and collaboration with industry.

Canada's chemicals exports are to the U.S. (IC, 2013)), minimizing border restrictions on Canadian products is a key priority. Through self-regulation, industry is able to relax or tighten safety and security practices as necessary to ensure maximum efficiency and competitiveness. As well, in cases where the U.S. has requested more stringent government standards – the E2 regulations, for example – industry has been an active and enthusiastic participant (DCI 9) in drafting new policy.

The costs of self-regulation, on the other hand, are spread across consumers who face higher prices due to the costs associated with Responsible Care compliance. SMEs also face higher costs in the form of barriers to market entry, although these firms are numerous, geographically dispersed and often quite small, making them difficult to organize. Other users of chemicals, such as water utilities, may also face increased costs. Yet, as with SMEs, these organizations are numerous – a 2000 report by the World Health Organization estimates that there are 9,000 public water and wastewater treatment systems in the country (WHO, 2000). In addition, as public entities, the cost of investing in safety and security at water utilities would ultimately be borne by taxpayers.[38]

In sum, then, the distribution of benefits associated with self-regulation provides an incentive for large chemical companies to organize and lobby government through their industry associations. At the same, the diffusion of costs de-incentivizes consumers and competitors from organizing to achieve alternative regulatory arrangements. Together, these factors help explain why the Canadian dangerous chemical regime reflects, in many ways, the preferences of industry. Water utilities, by comparison, generally operate in non-competitive environments and therefore have limited incentive or capacity to influence regulatory standards. As well, their geographic disparity and varying sizes precludes their easy organization into an effective interest group. The absence of lobbying by fire fighters is surprising from this perspective, and is addressed in further detail below.

Our interview data and literature review are generally consistent with this account of the government-industry relationship. One chemical industry participant said that

[38] Most water utilities in Canada are public, operated by municipalities, the provinces or, on federal land, by Ottawa. A discussion paper prepared for the federal government's Policy Research Initiative indicates that private water provision is limited to very small, rural communities, typically "serving fewer than 50 customers in trailer parks, resort areas, subdivisions, or isolated communities" (Brubaker, 2003: 5, cited in Ouyahia, 2006: 16).

initiatives such as MIACC are the standard approach for regulating industry in Canada (DCI 8), while a second described how an industry association contributed to the drafting of the E2 regulations (DCI 9). The participant explained that in general, regulations in Canada emerge from compromise and ongoing discussions between government and industry (DCI 9).[39] A third industry participant stated that the Canadian government views RC as a suitable alternative to traditional regulatory models (DCI 11). Further evidence is offered by the regulatory and policy changes that followed the 9/11 terrorist attacks. Rather than develop new standards or behaviour modification programs, government introduced additional information-sharing mechanisms such as the E2 regulations and the SIR program, leaving CI operators with considerable flexibility with respect to addressing risks related to terrorism.

Since the 1970s and 1980s, environmental groups have played an increasingly significant role in industry self-regulation initiatives. As noted above, the RC National Advisory Panel includes several prominent scholars, consultants and activists with expertise in areas such as corporate social responsibility, environmental protection, sustainable development and human health. Ostensibly, this signals a willingness by large chemical firms to improve their safety and environmental records. It is unclear, however, whether advisory committees are able to provide anything beyond high-level guidance to industry associations. In other words, in the case of RC, individual firms seem to retain discretion with respect to the practices best suited to their particular circumstances. Moreover, our analysis indicates that the prioritization of safety and environmental issues has not coincided with a similar emphasis on improving security practices. In the RC verification audit reports we reviewed, security issues received only modest attention compared to safety and environmental ones.

As noted above, client politics are often associated with regulatory capture, in which regulators prioritize industry objectives over the public interest. We are hesitant to depict the chemical regime in these terms. Instead, our interview data and literature review suggest numerous reasons why the public interest may in fact be served by a regime that incorporates the expertise and resources of chemical producers and that promotes a close

[39] Similar evidence was provided by a U.S. regulator, who explained that the Chemical Facility Anti-Terrorism Standards (CFATS) were developed in collaboration with American chemical industry associations (DCI 18).

relationship between industry and government. Indeed, regulators (DCI 10; DCI 13; DCI 18) described how working collaboratively with industry produces mutually beneficial outcomes. Further, both regulatory agencies and large companies are hierarchical organizations, structured according to rules and clear lines of accountability. These shared organizational characteristics mean they both act within bureaucratic frameworks. For multinational corporations, the preferred approach to risk management involves negotiated, stable and predictable regulation in a collegial context rather than limited and restricted access to regulators in a wide-open and competitive one. The federal government may see in this arrangement the opportunity to influence the regulation of chemical risks more discreetly without overstepping its constitutional authority. As Macza emphasizes, the constitutional division of powers explains "to a great degree why Canada has relied so much on industry to adopt best practices initiatives like [Responsible Care]" (2008: 12/8-12/9). From this perspective, one can see how the existing regulatory model provides benefits not only to industry, but to the public as well.

This style of regulation is neither inevitable nor necessarily permanent. As noted above, major incidents involving dangerous chemicals often correspond with the displacement of interest group pressures by public opinion. In these cases, the regime, which typically operates according to the logic of client politics, is disrupted by intense media coverage and public scrutiny.

Our application of the Wilson typology allows us to make an important addition to this analysis. Specifically, the typology highlights that the effect of public opinion is not limited solely to major incidents. Instead, it can be deployed as a tool by interest groups to mobilize latent public opinion even in the absence of a pre-existing scandal or disaster. Recall from above the entrepreneurial pattern of politics, in which activists lobby for the imposition of stricter regulations on industry. The success of these campaigns often relies on the existence of widespread public support: Wilson, for example, points to the passage in the United States of the 1906 Food and Drug Act, which "was powerfully aided by the publication of Upton Sinclair's *The Jungle* in 1905" (1980: 370).

An unexpected result of our interviews and literature review was the absence of evidence of organized lobbying by fire fighters. Despite the stated preference among our interview participants for improved standards for chemical storage (DCI 6) and enhanced

capabilities-based planning among emergency services (DCI 5; DCI 6), it seems that fire fighters have to date refrained from organizing public campaigns in pursuit of these objectives. It may be that the preferred route is to influence government through organizations such as the International Association of Fire Fighters and the Canadian Association of Fire Chiefs, both of which use conventional lobbying techniques, such as formal meetings with MPs and presentations before parliamentary committees. As well, fire fighters may be hesitant to antagonize large industry partners, with whom they often share positive relationships in terms of information sharing and preparedness training. The relatively small number of major chemical incidents in Canada may also mean that chemical storage standards are a lower priority than other objectives, such as higher wages or improved benefits. At some future point, however, fire fighters may choose to galvanize public opinion in support of more stringent standards for chemical storage facilities. Should that occur, we would expect the dynamics of the regime to shift to the interest group quadrant of the Wilson typology, with ORH also assuming greater explanatory power. Similarly, an event such as West, Texas, in which several fire fighters were killed, could galvanize public support around this issue in Canada.

6.0 Conclusion

The three hypotheses advanced by Hood *et al.* explain to varying degrees the regime for controlling major chemical incidents; no one hypothesis provides a fully satisfying explanation of the regime. The market failure hypothesis explains government efforts to facilitate information sharing given the high cost of obtaining information about chemical risks. On the other hand, the comparative absence of regulatory action on addressing opt-out costs is at odds with the predictions of MFH. With respect to ORH, while we have seen in recent years increased sensitivity by the chemical sector to public opinion – particularly on issues concerning environmental protection and sustainability – it is unclear whether this has led to meaningful behaviour change as opposed to more concerted efforts at public relations. The interest group hypothesis appears to possess the strongest explanatory power with respect to the content of the dangerous chemicals regime, notwithstanding the apparent absence of concerted lobbying by fire fighters on issues related to the storage of chemicals. The persuasiveness of IGH in this context is perhaps not surprising: large firms have the benefit of resources, expertise and an institutional design that is conducive to influencing government, and government regulators benefit from maintaining stable and predictable relationships with those they regulate. In sum, although the equilibrium of the regime is punctuated from time to time by major incidents – and, consequently, the need to respond to negative media attention and unfavourable public opinion – the regime's increasing preference for information sharing and industry-generated standards reflects the interests of large industry. This is particularly instructive for those concerned about the resilience of the chemical sector, since the interest group hypothesis highlights the regime's loci of influence, which represent sources of potential resistance to regulatory changes.

Examining the sector's interest groups underscores the extent to which safety continues to be prioritized over security. Our analysis reveals that across the chemical sector, CI operators who have the resources and capacity to engage seriously in risk management tend to focus more on safety risks, including those related to environmental protection, than security risks, including those related to terrorism. Among industry

associations, for instance, more effort has been put into controlling major incidents stemming from natural disasters and industrial accidents than malicious acts.

Adopting an interest group focus also emphasizes the importance of export markets, and especially the U.S. market, for major chemical firms. This fact, in turn, speaks to the potential feasibility of a pan-North American approach to regulating major chemical incidents. For regulators, the benefits of a collaborative, multi-level mechanism for controlling chemical risks seem self-evident given the cross-border nature of the chemical industry, and the continental (if not global) perspective of chemical firms. In practice, many Canadian firms already operate on this basis, adhering to American standards such as C-TPAT. By advocating for a formalized institutional arrangement, Canadian regulators could establish for themselves an avenue for influencing the direction of future chemical standards in North America. As well, such an arrangement may address the market risks associated with border closures following major incidents.

In addition, IGH draws attention to the effect of organizational differences between interest groups. A main theme of this paper has been the risk management implications of resource and expertise gaps between large and small organizations, be they chemical firms, water utilities, emergency management offices or regulatory agencies. Beyond these differences are structural factors that influence organizational preferences, such as regulation, integration, size and whether an organization operates for-profit. Institutional arrangements make a difference with respect to how people perceive and respond to risk (Hood, 1998). Regulatory policy is improved to the extent that it acknowledges and reflects these varying preferences and capacities. In short, a key lesson of our research is that information-gathering, standard setting and behaviour modification ought to occur in a manner that is sensitive to organizational context. Further research and analysis on determining which organizational strategies are appropriate for which organizational contexts would be useful.

In closing, we wish to reiterate that this paper has focused primarily on the regime in a stable state. Less attention has been paid to how the regime responds to disruptions. Although we consider the importance of public opinion in the wake of failures, we do not articulate principles for emergency managers to consider when responding to such failures. Doing so would involve addressing the various types of risks posed by chemicals,

and the implications each type has for decision-making. The quality of information varies by risk type, from those involving complex causal variables (a process failure at a chemical plant, for instance) to those where there is insufficient data to predict risk probabilities (the use of a chemical weapon by terrorists, for example). Each type requires a unique approach to risk management, meaning different levels of engagement with experts, stakeholders and the public and varying degrees of adaptive capacity. Coming to terms with these issues is crucial for effective planning and rapid reaction and, as we note above, represents an interesting and potentially rewarding avenue of future research.

Appendix A: Interview Participants

Figure 12: Interview participants by role, sector and location

Code	Role	Sector	Location	Date
DCI 1	Manager/Operator	Water Utility	International	July 2011
DCI 2	Manager/Operator	Water Utility	Canada	July 2011
DCI 3	Manager/Operator	Water Utility	Canada	July 2011
DCI 4	Manager/Operator	Water Utility	Canada	June 2011
DCI 5	First Responder	Emergency Management	Canada	June 2011
DCI 6	First Responder	Emergency Management	Canada	June 2011
DCI 7	Government Regulator/Official	Regulatory Agency	International	November 2011
DCI 8	Expert	Chemical Industry	Canada	July 2013
DCI 9	Industry Association	Chemical Industry	Canada	July 2013
DCI 10	Government Regulator/Official	Emergency Management	Canada	July 2013
DCI 11	Industry Association	Chemical Industry	Canada	August 2013
DCI 12	Expert	Emergency Management	Canada	August 2013
DCI 13	Government Regulator/Official	Regulatory Agency	Canada	August 2013
DCI 14	Government Regulator/Official	Law Enforcement	Canada	August 2013
DCI 15	Government Regulator/Official	Law Enforcement	Canada	August 2013
DCI 16	Industry Association	Chemical Industry	International	August 2013
DCI 17	Industry Association	Chemical Industry	International	August 2013
DCI 18	Government Regulator/Official	Regulatory Agency	International	October 2013

As noted in Appendix B, for analytical purposes we often refer in this paper to participants as belonging to one of four broad groups, or sectors: (1) water utility operators (i.e. DCI 1-4); (2) emergency managers and law enforcement personnel (i.e. DCI 5-6; DCI 10; DCI 12; DCI 14-15); (3) government regulators (i.e. DCI 7; DCI 13; DCI 18); and (4) chemical industry experts and representatives (i.e. DCI 8-9; DCI 11; DCI 16-17).

Appendix B: Methodology

In 2011 and 2012 we conducted semi-structured interviews with 55 CI regulators, owners and operators. The Hood *et al.* framework was used to develop the questions for the interviews and later, for extracting data from the transcripts. Seven interview subjects had professional responsibilities related to dangerous chemicals: four interview participants were employed by water utilities, which use chemicals for treatment purposes; two were fire fighters with expertise in hazardous materials; and one was employed by a nuclear regulatory agency. In 2013, under the agreement of support from the Kanishka Project, we conducted an additional 11 semi-structured interviews with chemical industry experts, industry association representatives, emergency management professionals, law enforcement officials and government regulators. The names of all interview subjects and the transcripts are confidential. We committed to the Ethics Board and to our interview subjects that we would not use direct quotations from our transcripts without the explicit consent of our interview subjects.

A mixed method analysis was conducted on the interview data, employing both quantitative and qualitative methods. The quantitative analysis consists of descriptive statistics, including simple means and response percentages. The small sample size of interview subjects in any one subsector would preclude the use of any rigorous statistical analysis to support generalizations of the findings. At the same time, we have found it useful when conducting semi-structured interviews to ask interview subjects to score contextual pressures that influence how they spend their time, for example. While not generalizable, the scoring allows interview subjects to distinguish more succinctly the impact of the different pressures. It also allows us to rank and compare how individuals perceived the different pressures. We present the data as indicative of the relative importance of the contextual influences as assessed by these individual interview subjects and use it as a departure for analysis and discussion.

We used a grounded theory-based approach to extract and organize additional themes. We supplemented this work with a comprehensive literature review of academic literature related to the regulation of dangerous chemical risks.

For the media analysis presented in Section 5.2, we reviewed 1857 newspaper articles from four different newspapers; 1199 were about H1N1 in particular, which were

removed from our analysis here. We accessed the coverage of these events by using the Factiva database to search a leading national newspaper in each country: the *Australian*, the *Globe and Mail*, the *Daily Telegraph* and the *New York Times*. These are all high-distribution newspapers and opinion leaders in each of the respective countries. We identified our sample by drawing on all articles that appeared during the year following the date each event began and that included the term(s) most commonly used to refer to the event. We eliminated any articles that were clearly not principally about the event. These types of events tend to appear in large numbers of articles during the year in which they occurred, but the references to the events are often 'asides' in articles that are principally about something else.

To analyze the content of the articles, we counted the number of articles that referred to various key terms. The key search terms were selected based on conventional items that were relevant to public administration and risk management. We also determined whether key actors – such as government and owners and operators in critical sectors – were assessed positively, negatively or neutrally. (N/A was also an option.) To summarize the performance data, a value of + 1 was assigned to each article that was on balance a positive assessment for each key sector and a value of -1 to each article that was on balance a negative assessment (neutral assessments were given 0.) We then calculated the total net sum, adding the number of positive and negative assessments together. When assessing government performance, each order of government was assessed separately. In other words, if one article has a negative assessment of both the federal and provincial government, then it is assessed -2.

All non-H1N1 articles were analyzed during February and March 2010. We reduced the impact of the bias in assessments by using several strategies. As noted, we assessed all the articles during a short and fixed period of time. We also developed a standard template and applied it to all articles. All results were stored in a Microsoft Access database that we developed and maintain. One research assistant classified all non-H1N1 articles in the *Australian*; one classified all non-H1N1 articles in the *G&M*; one classified all non-H1N1 articles in the *Daily Telegraph*; and one classified the *NYT*. The group also met at the start and periodically to review articles together to introduce some level of consistency.

To test the inter-rater reliability of all aspects of coding, 10% (n=186) of the 1857 articles were double-coded independently of the original coders. Using Cohen's kappa coefficient we found an inter-rater reliability agreement of k = .66 for government performance assessment. This corresponds to a substantial level of agreement.

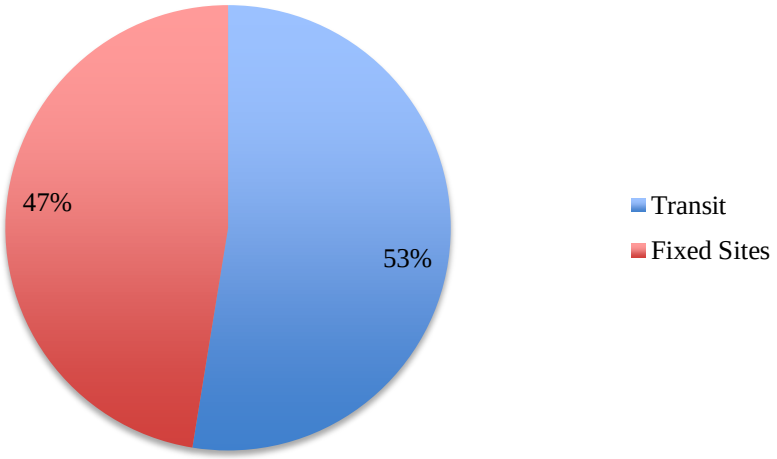
Appendix C: Analysis of Chemical Incidents in the Canadian Disaster Database

Public Safety Canada maintains the Canadian Disaster Database, which contains "detailed disaster information on more than 1000 natural, technological and conflict events (excluding war) that have happened since 1900 at home or abroad and that have directly affected Canadians" (PSC, 2014). Incidents included in the database conform to the Canadian Emergency Management Framework's definition of a disaster as a hazard that "intersects with a vulnerable community in a way that exceeds or overwhelms the community's ability to cope" (Canada, 2011: 14). Incidents must also meet at least one of several criteria related to severity, measured according to fatalities, injuries, evacuations, assistance required and so on.

We analyzed the data to obtain a sense of the quantity and quality of major chemical incidents in Canada. We queried the database for the following incident types: fire (non-residential), hazardous chemical (non-residential and vehicles), transportation accident (derailment release, fire, leak/spill release, marine release and vehicle release) and explosion (air, marine, rail and vehicle). Of the results produced by the query, only those containing sufficient data to identify their location and type, either transit or fixed site, were retained for the analysis. After filtering the results, 78 incidents remained.

Next, we sorted the incidents according to type. The result, illustrated in Figure 13, shows a fairly even split between transit and fixed sites. This is in line with our interview data, which indicates that fixed sites pose similar risks to transportation systems, despite the recent public and media attention on the latter over the former (DCI 5-6; DCI 10).

Figure 13: Number of chemical incidents at fixed sites vs. in transit

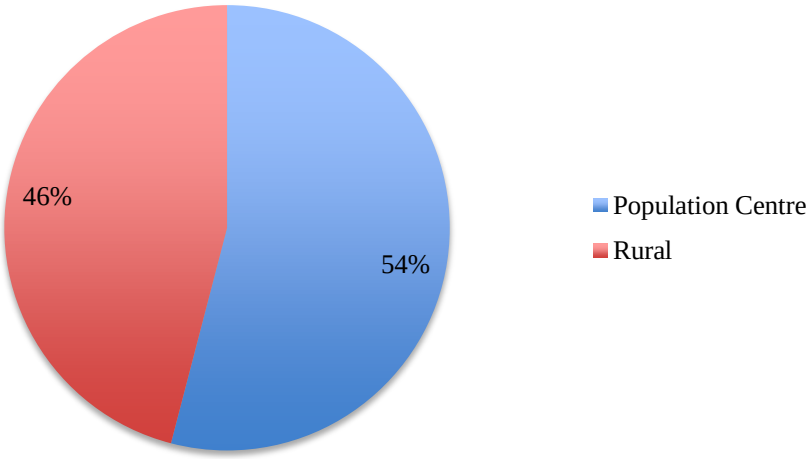


Calculations based on data from PSC (2014)

In light of the issues our research identified with respect to land-use planning and the proximity of fixed chemical sites to residential areas, we investigated the number of fixed site incidents that occurred in populated areas. To do so, we used Statistics Canada's population centre concept, which classifies areas that have a minimum population of 1,000 and a minimum population density of 400 persons per square kilometre into one of three population centre categories: small (areas with populations between 1,000 and 29,999), medium (populations between 30,000 and 99,999) and large (populations greater than 100,000). All other areas are classified as rural.

Figure 14 illustrates the results of this categorization. Again, a fairly even split is evident. In other words, since 1900, chemical incidents at fixed sites have occurred approximately as often in population centres as in rural areas. We see in this data additional impetus for the adoption of our recommendations regarding capacity-building and improved coordination among jurisdictions with respect to land-use planning. As well, it reaffirms the importance of ensuring that rural communities have timely access to the resources and capacity necessary to respond to major chemical incidents.

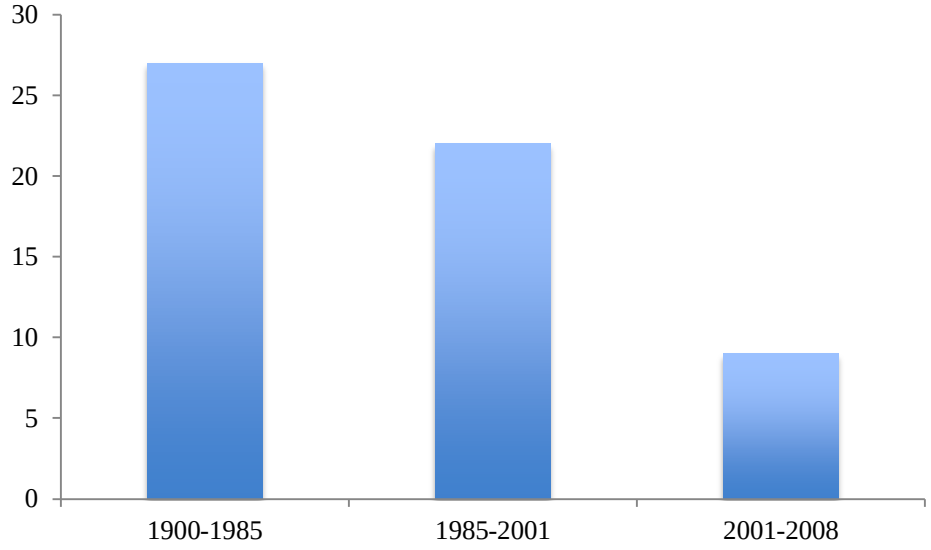
Figure 14: Number of chemical incidents in rural areas vs. population centres



Calculations based on data from PSC (2014)

Finally, in recording the date of each incident, the Canadian Disaster Database enables an investigation of the rate of accidents during a given period. Since our research highlights the importance of industry self-regulation initiatives, and in particular the significance of the Bhopal disaster on influencing chemical regulation, as well as the policy changes implemented in the wake of 9/11, we divided the fixed site incidents into three periods: pre-Bhopal (1900 to 1985), post-Bhopal (1985-2001) and post-9/11 (2001 to 2008). The results are presented in Figure 15.

Figure 15: Fixed site chemical incidents by period: 1900-1985, 1985-2001 and 2001-2008



Calculations based on data from PSC (2014)

Figure 15 must be interpreted cautiously. At first glance, the data implies an increase in the rate of incidents during the period immediately following the Bhopal disaster (the middle column is associated with a shorter period than the first). Yet in the absence of contextual data regarding trends in the chemical industry – whether it grew rapidly in the late 1980s and 1990s, whether the cost of spills is increasing, if response time is improving and so on – one should refrain from making inferences about the success of the regulatory regime. It may be, in other words, that during this period the volume of chemicals stored at fixed sites grew exponentially, in which case the number of accidents between 1985 and 2001 represents a decline in the *relative* rate of failure. Still, at the very least, the absolute rise in the number of incidents per year in the wake of Bhopal – and the uninterrupted continuation of that rate even after the 9/11 terrorist attacks – suggests additional research in this area is warranted, particularly since the literature on American self-regulation schemes remains inconclusive about their success (see Finger and Gamper-Rabindran, 2013; Gamper-Rabindran and Finger, 2013; Gunningham, 1995; King and Lenox, 2000; Prakash 2000).

Appendix D: Responsible Care Codes

The Responsible Care program has three sets of codes to which members must adhere. In general, the codes articulate guiding management principles while maintaining flexibility for individual members to implement practices appropriate to their particular circumstances. Although the specific contents of the codes are not widely publicized, the Responsible Care website (CIAC, n.d.) provides a short description of their purpose. This material is reproduced below.

"The Responsible Care® **Operations**, **Stewardship** and **Accountability Codes** influence the decisions that CIAC member-companies make every day – decisions that are key to creating more sustainable products and processes.

The **Operations Code** outlines how Responsible Care® companies should manage their facilities and equipment to ensure that they're operated in a safe and responsible way. Companies must work to continuously improve the environmental performance of their facilities and processes, and reduce their resource consumption.

Under the **Stewardship Code**, companies must regularly review the value, impact and safety of the products that they make, and the services and technologies that they use. They must also work with their business partners – suppliers, distributors and customers – to ensure the stewardship and security of their products over their entire life cycle.

Finally, the **Accountability Code** requires companies to communicate the risks and benefits of their operations to those who live beside their plants, or in communities along transportation corridors, as well as to other stakeholders, and to work to address any concerns that they may have."

Appendix E: Note about the Authors

Kevin Quigley is an Associate Professor and Director of the School of Public Administration at Dalhousie University. He is also the Principal Investigator to the CIP Initiative at Dalhousie (http://cip.management.dal.ca).

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