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Performance-Based Regulation and Regulatory Regimes

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ABSTRACT

This research addresses the policy implications of performance-based approaches to regulation. Differences in the form of performance-based regulation arise in thinking about how to characterize performance outcomes, what constitutes desired achievements, and how to measure the level of performance that is obtained. Implementing performance-based regulation is as much about changes in regulatory regimes as it is about introduction of performance-based standards.

Four sets of experiences with performance-based regulatory regimes are examined: (1) the "leaky building crisis" in New Zealand that illustrates shortfalls in accountability; (2) food-safety regulatory reforms that illustrate difficulties in linking standards and causes; (3) performance-based approaches to fire safety that illustrate implementation issues more generally; and (4) nuclear power plant safety that illustrates the difficulty of measuring safety outcomes. The research is based on documentation from governmental and other secondary sources of the experiences with the selected performance-based regulatory regimes.

The contrast between these cases indicates that any performance-based regulatory regime must confront a fundamental issue of how tight controls should be in promoting consistency and accountability versus how much discretion should be granted in promoting flexibility and innovation. Given this, accountability for results can legitimately be considered the Achilles' heel of performance-based regulation.

Keywords: performance-based regulation, regulatory implementation, regulatory policy

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1.1 INTRODUCTION

The notion that regulations should be based on achievement of specified results rather than on adherence to particular technologies or prescribed means has been widely accepted as a basis for improving social and environmental regulations. The concept of performance-based regulation has been endorsed by the Clinton and current Bush administrations, by a variety of business and environmental groups providing consensus proposals for reform of environmental regulations, and by various groups recommending regulatory reforms in other areas of regulation. Variants of performance-based regulation have been adopted in the United States as well as a number of other countries for regulation of aspects of air and water quality, building and fire safety, consumer product safety, energy efficiency, food safety, forest practices, nuclear power plants, pipeline safety, and worker safety.

To be sure, performance-based regulation has not fully supplanted more traditional forms of protective regulation. Many regulations in the U.S. are still highly prescriptive in telling regulated entities what to do and how to do it. And, when the performance-based approach is offered, it is usually simply presented as an alternative to existing prescriptive regulation. Despite the enthusiasm for results-based regulation in governmental circles, the merits and feasibility of the approach are open to debate [see Coglianese and Lazar 2003; Coglianese, Nash, and Olmstead 2003; Office of Technology Assessment 1995; Steinzor 2001]. This research contributes to this debate by discussing the implications of a shift to performance-based regulation and by drawing insights from efforts to employ the approach in several regulatory arenas.

What constitutes performance-based regulation is complicated by the fact that the concept has been, and can be, applied in a variety of ways and with different degrees of regulatory comprehensiveness. Regardless of the form that it takes, performance-based regulation cannot be considered as separate from the broader regulatory system. Indeed, the appeal of performance-based regulation is as much about introduction of a new regulatory regime as it is about regulating for results. As such, understanding performance-based regulation requires thinking about expectations for regulatory regimes.

1.2 VARIETIES OF PERFORMANCE-BASED REGULATION

Performance-based regulation is easy to describe in concept but hard to define in the particulars. The key concept is regulating for results rather than adherence to prescribed means under prescriptive regulations or adherence to specified technologies under "best available technology" regulations. That regulations should be defined with respect to desired outcomes, rather than prescribed means or technologies, is disarmingly simple and in many respects unarguable. Differences arise in thinking about how to characterize those outcomes, what constitutes desired achievements with respect to the outcomes, and how to measure the level of performance that is obtained.

Given these differences, it is perhaps best to think of performance-based regulation as a class of regulations that vary with respect to characterization of outcomes, standards for desired levels of achievement, and assessment procedures for gauging the level of performance that is obtained. Table 1 summarizes these dimensions and illustrates variation along each.

The characterization of outcomes addresses the goals or intent of a regulation as would normally be specified in legislation or the regulation itself. These can be stated with varying degrees of comprehensiveness in referring to a broad or narrow spatial distribution (e.g., air quality attainment area), a system as a whole or parts of it (e.g., a building or building component), or a broad or narrow target group (e.g., all workers or particular classes of workers). There can be a singular goal, for example, of avoiding adverse health impacts. Or, there can be multiple goals of protecting life and property from harm. Each of the performance goals can be stated with differing levels of specificity. Gunningham and Johnstone [1999: 25–27] discuss the use of "general duties of care" in the UK Health and Safety Work Act of 1974 as general statements of performance objectives. For example, one duty is that employers ensure the health, safety, and welfare of workers. This duty is further specified in language defining sub-goals that include "the provision and maintenance of plants and systems of work that are, so far as reasonably practicable, safe and without risks to health." [Gunningham and Johnstone 1999: 26].

The characterization of desired level of achievement is the standard against which compliance is gauged. Identifying relevant measures of performance and standards for desired levels of performance are much more difficult than stating performance objectives. Numerous examples exist of the difficulties of translating vague performance objectives for regulations into meaningful standards. One example, which perhaps is the first quantitative performance standard in U.S., is the creation in 1914 of a voluntary federal drinking water quality standard that specified maximum coliform bacteria levels for municipal water supplies [see Gurian and Tarr 2001].

As was the case for the original drinking water quality standard, the establishment of desired performance standards has engendered controversy within a variety of regulatory arenas. For example, Landy et al. [1999: 49–88; also see Powell 1999: 267–284] discuss the difficulties in 1979 of revising the ozone standard to meet the legislative requirement under the Clean Air Act of protecting the public health with an adequate margin of safety. At issue were what constituted public health (and relevant "sensitive populations" in particular), what constituted an adequate margin of safety, and how any particular standard could be defended against likely legal challenges.

Table 1. Dimensions of performance-based regulation

Dimension	Variation	Examples
Characterization of Outcome	**Comprehensive (high level)** ◆	• Area-wide air quality goals for prevention of unhealthy conditions (regional air quality regulation) • Building regulation goals for protection of life-safety and economic value of a structure and its functions
	❖ **Less Comprehensive (lower level)**	• Facility-specific goals for prevention of unhealthy air emissions • Building regulation goals for performance of individual components (a wall, a stairwell, or products used to construct these) with respect to life-safety or other goals
Characterization of desired level of achievement	**Quantitative performance characterization** ◆	• Ambient air-quality threshold based on documented health effects • Force loading of that a building can withstand for a specified amount of time based on understanding of building collapse
	❖ **Qualitative performance characterization**	• Equivalency requirement = Demonstration that performance for life safety is at least equivalent to that obtained by prescriptive standards • Qualitative statement that a building shall remain stable and not collapse during construction or throughout the life of the building
Performance Assessment	**Observed Measurement of Performance**	• Physical measurement of air quality, or of emissions • Physical tests of performance of building materials or elements
	Predicted Performance	• Model-based predictions of performance of a building system for collapse prevention or fire resistance

Source: Author with some examples drawn from U.S. Regulatory Council [1981] and Office of Technology Assessment [1995].

Standards can be expressed in quantitative or qualitative terms. The ozone standard illustrates use of a quantitative measure in that it specifies exposure levels for particular duration of time at particular measurement sites. The establishment of the standard engendered debate over the relevant metric for measuring exposure, the level at which exposure is harmful to health, and the duration of that exposure that would be harmful allowing for the legislatively mandated "margin of safety." An example of a qualitative expression of a standard is the International Code Council's performance-based fire-safety objective. The objective of preventing unwanted ignition by building equipment and systems is one of several performance requirements for which relevant equipment "shall be installed so that they will not become a source of ignition" [provision 601.3.2, International Code Council 2001: 21]. The obvious difficulty with such qualitative characterization of performance is the vagueness with which performance is characterized.

Another qualitative way of specifying a performance standard is by simply saying that performance should be at least the equivalent of that obtained with existing prescriptive (design) requirements and specifications. This is an "alternative performance" provision that is common in building-code provisions. The burden is upon the regulated entity to show that the proposed alternative is at least as good as the original, prescriptive regulation. Codes of practice, which have quasi-legal status in the U.K., provide a similar "acceptable alternative" approach. As discussed by Gunningham and Johnston [1999: 27–28] for worker health and safety, the codes specify an acceptable path for complying with general duties, but the regulations do not mandate that the acceptable path be followed.

A third set of considerations for performance-based regulations is the way that performance is assessed. The basic distinction is whether performance can be directly observed and measured, or whether it requires other forms of assessment. Direct observation requires actual measurement of performance to gauge adherence to a given performance standard. This is common practice for assessing potential contamination of drinking water, air quality emissions, and water quality effluents. Challenges concerning such measures have been raised in the U.S. through lawsuits that challenge the reliability of the testing and the degree to which the tests indicate presence of a health threat.

For many instances it is not possible to undertake direct assessment of outcomes. The systems may be too complex or the outcomes to be prevented are unobservable. The safety of a nuclear power plant cannot be directly observed nor can the safety of a building with respect to earthquakes, fire, or other potential harms. One means for assessing performance involving a probabilistic risk assessment is to conduct tests or assessments of elements of the facility with particular attention to those elements that are most critical. A related means, if sufficient information is known about the performance characteristics of the system in question, is to use computer models to simulate the performance of the system for varied situations. Notarianni and Fischbeck [2001] discuss how such modeling might be used to assess performance of structures for fire safety. The obvious issues for any prediction are the uncertainty associated with the prediction and the validity of the prediction method.

1.3 EXPECTATIONS FOR REGULATORY REGIMES

One can think of a regulatory regime as the system for achieving regulatory goals [see Hood et al. 2001, May 2002]. That system comprises an institutional structure as well as the actions taken by regulatory authorities. The institutional structure is made up of three key elements: (1) rules that govern expected behaviors or outcomes, (2) standards that serve as benchmarks for compliance, and, (3) sanctions for non-compliance with the rules. By altering any of these elements, the nature of the regime can be changed. For example, a highly prescriptive regulation specifies particular materials to be used and particular grades of the material that are acceptable for different conditions. A performance-based regulation specifies a threshold of acceptable performance and a means for verifying that the threshold has been met. Management-based regulatory approaches address a mandated process that can be either highly prescribed or defined in terms of desired outcomes of that process [see Coglianese and Lazar 2003].

Regulatory regimes also entail implementation roles and actions. Regulatory agencies and inspectors in the field make choices about the frequency and nature of reviews and inspections, the style of interaction of inspectors and regulated entities, the way in which sanctions are used, and the willingness of regulators to accept alternative approaches to accomplishing the same end. Although these issues are seemingly mundane in comparison to the bigger issues of regulatory reform, they are essential aspects of regulatory practice. Sparrow discusses these aspects in commenting about the craft of regulation: "[t]he nature and quality of regulatory practice hinges on which laws regulators choose to enforce, and when; on how they focus their efforts and structure their use of discretion; on their choice of methods for procuring compliance. Yet the vogue prescriptions for the reinvention or reform of government, which have been swirling around regulatory executives for close to ten years, say little about these issues and sometimes ignore them altogether" [2000: 2].

1.4 REGULATORY CRITICISM AND REFORM

Any reform is at least in part a reaction to perceived failures of what preceded the reform. As such, the expectations for performance-based regulatory regimes are shaped as much by prior shortcomings as they are by conceptualizations of what constitutes "good" regulation. With this in mind, it is useful to consider performance-based approaches to regulation as a reaction to criticisms of existing regulatory regimes.

One line of attack has been the rules and standards themselves that constitute the basic regulatory structure. These criticisms have been popularized in Philip Howard's book *The Death of Common Sense* [1994]. These critics argue that many rules and standards are unreasonable, narrowly defined, and overly prescriptive. For example, Howard cites the case of Amoco spending $31 million to comply with requirements for installing a smokestack filter to reduce emissions of benzene. Compared to other facility components that were not addressed, the smokestack was a minor source of emissions [Howard 1994: 7].

A second related line of attack on unreasonable regulations addresses the way that the front lines of regulatory agencies enforced regulations. As noted by Bardach and Kagan: "Site-level unreasonableness explains much of the present political and social discontent with protective regulation….[T]he present discontent with protective regulation, as expressed in most complaints about it, has almost nothing to do with aggregate costs and almost everything to do with particular costs and aggravations imposed by particular enforcement officials on particular institutions and businesses" [1982: 7].

Critics argue that unreasonable regulations and capricious enforcement practices impose unneeded burdens on regulated entities. For example, the National Association of Homebuilders found in a 1998 survey of association members that 10 percent of the cost of building a typical new home is attributable to unnecessary regulation, regulatory delays, and fees [U.S. House Committee on Small Business 2000: 42]. Critics also argue that the inflexibility of prescriptive regulations limit innovation [Oster and Quigley 1977] or constrain international competitiveness [Porter and van der Linde 1995]. Key themes for those regulatory reforms are reducing these burdens and promoting innovative solutions. Regulatory relief became a major initiative in the U.S. beginning in the early 1980s under actions taken by the Reagan administration to roll back regulations. This push evolved with different presidential administrations to later emphasis by the Clinton administration on "common sense" regulation. Within the context of these reforms, performance-based regulation can be viewed as part of an evolution in regulatory design and another step in regulatory reform.

Beginning with the Reagan administration in the early 1980s, there has been a series of regulatory reforms in the U.S. aimed a lessening the rigidity of regulations and compliance burdens, while also promoting innovation and allowing for lower compliance costs. One statement of the multiple objectives of regulatory reform is contained in the principles of regulation set forth in Executive Order 12866, the primary federal regulatory planning and review directive adopted by the Clinton administration and subsequently reaffirmed by the Bush administration. Federal agencies are directed to take into account in regulatory design the need for and effectiveness of regulations along with "incentives for innovation, consistency, predictability, the costs of enforcement and compliance (to the government, regulated entities, and the public), flexibility, distributive impacts, and equity" [section (b)(5)]. A more precise statement of expectations for performance-based approaches is contained in the Clinton administration's strategy for reinventing environmental regulation in stating as a key principle that "[e]nvironmental regulations must be performance-based, providing maximum flexibility in the means of achieving our environmental goals, but requiring accountability for results" [National Performance Review 1995: 6].

Two realities must be recognized regarding such statements about regulatory objectives. One is the obvious incompatibilities of the differing objectives. Among other conflicts, the objectives of consistency, equity, and predictability are at odds—or at least in tension—with the objectives of flexibility and innovation. Similarly, there is a basic tension between flexibility and accountability. Accountability requires an ability to observe outcomes, while flexibility frustrates that ability by permitting a variety of ways of achieving outcomes. Underlying these potential conflicts is a fundamental tension between discretion and control that regulatory authorities must confront when carrying out regulations. This tension is aptly summarized by Sparrow:

> Some say that the answer to regulatory unreasonableness is to give regulators more discretion. Others say that the regulators themselves are the problem and that the solution is to take away their discretion by exerting tighter legislative control. The dilemma is familiar and ages old. Too little discretion provides legalistic, nitpicky behavior and denies regulators the means to tailor their responses to local or particular circumstances. Too much discretion creates opportunities for corruption and discrimination and opens a regulatory agency to capture by the regulated community. [2000: 238].

Under performance-based regulation, the pendulum is clearly swinging away from tight controls and toward increased discretion and flexibility.

A second reality, also reflected in Sparrow's remarks, is that the design of a regulation is only part of the equation. While a regulation may be designed to promote innovation, encourage flexibility, or minimize compliance costs, the reality of that regulation rests on what regulatory agents do in the field when enforcing the regulation and monitoring performance [also see Bardach & Kagan 1982: 34–35]. Here is where the potential for inequities and inconsistencies arise and where regulated entities form their impressions about a given set of regulations. Here, as well, the informal aspects of law as played out with the style of interactions between regulators and those regulated become paramount. These shape the trust that regulated entities place in regulators, the legitimacy that regulated entities attach to regulations, and ultimately the acceptance and adherence to regulations by regulated entities [see Tyler 1990, 1994; Winter and May 2001]. As found by May and Wood [2003] in studying homebuilders, regulated entities will react negatively to the lack of predictability if performance-based regulations are inconsistently interpreted. Similarly, regulated entities will see little improvement over the prior more prescriptive regulations if performance-based regulations are interpreted too narrowly in allowing for a limited range of solutions.

1.5 EXPECTATIONS FOR PERFORMANCE-BASED REGIMES

Given the above discussion, performance-based regulation is best viewed as part of broader trends in regulatory reform. As such, the expectations about performance-based regulation are shaped by criticisms of existing regulations and practices. Table 2 summarizes what the literature suggests about performance-based regulatory regimes relative to more prescriptive approaches. The potential benefits are greater effectiveness in reaching specific regulatory objectives, flexibility in means of adhering to the regulation, increased incentives for innovation, and reduced costs of compliance for regulated entities. The potential drawbacks are inconsistencies in application of rules, decreased predictability in regulatory expectations, increased costs to governmental regulators, and uncertain equity and distributive impacts. Many of these expectations have been framed in the literature in very general terms. Given the caveats that apply in generalizing from this literature, it is perhaps best to think of the entries in Table 2 as a set of hypotheses about expected effects.

Table 2. Expectations for performance-based regulatory regimes

Criterion	Expectation [a]
• *Effectiveness* in reaching regulatory objectives	• *Increased*, but limited incentive to go beyond minimum performance objectives [Coglianese and Lazar 2003; Gunningham and Johnstone 1999].
• *Flexibility* in means of adhering to regulation	• *Increased*, given ability to use alternate means to reach objectives [U.S. Regulatory Council 1981 among many others].
• *Innovation* potential	• *Increased* incentives for innovation, but depends on industry structure and cost of innovation compared with current approaches [Office of Technology Assessment 1995].
• *Consistency* in application of rules	• *Potential for inconsistencies* in interpretation of what is acceptable for which the standards and skills of inspectors are important [Gunningham and Johnstone 1999].
• *Predictabilit*y in regulatory expectations	• *May decrease* due to lack of understanding of what is a workable means for achieving desired ends; code of practice guidelines are useful in this respect [Foliente 2000; Gunningham and Johnstone 1999].
• *Cost* to:	
• *Government regulators*	• *Uncertain* — Greater costs of developing rules and enforcement [Office of Technology Assessment 1995, US Regulatory Council 1981], but not necessarily so for costs of developing rules [Gunningham and Johnstone 1999].
• *Regulated entities*	• *Decreased or no change* in compliance costs [U.S. Regulatory Council 1981], but some entities may choose to develop more costly alternative approaches [Coglianese, Nash, Olmstead 2003].
• *Public beneficiaries of regulation*	• *Decreased or no change* — not explicitly addressed in the literature; presumably benefit from lower costs to regulated entities and innovations spurred by performance-based approach.
• *Distributive impacts* in addressing regulated harms	• *Mixed* — Focuses attention on a given harm no matter where it is, but leaves potential for gaps in coverage of attention to that harm if performance is gauged on an area-wide basis through “hot spots” [Office of Technology Assessment 1995].
• *Equity* in treatment of regulated entities	• *Uncertain* — Competitive differences may emerge due to large firms having advantage in developing alternative approaches [U.S. Regulatory Council 1981] for heterogeneous industry. How rules are enforced will also affect equity.

Notes:

[a] Expectations provided by sources noted in parentheses about performance-based regulation when compared to prescriptive-based regulatory approaches.

Three sets of uncertainties stand out in Table 2. One is the cost to government of developing and enforcing performance-based regulations. Gunningham and Johnstone [1999: 28] suggest performance-based regulations are less costly to develop because they do not require detailed understandings of relevant technologies but may be more costly to enforce because of the vagueness of performance standards and lack of expertise on the part of enforcers. The Office of Technology Assessment [1995: 43] argues that it can be costly, and sometimes prohibitively so, to develop accurate monitoring technology for gauging performance. Ironically, a second uncertainty stems from the fact that none of the studies reviewed address the costs to public beneficiaries of performance-based regulations.[1] The presumption is that public benefits accrue from greater effectiveness in reaching regulatory objectives and productivity gains by regulated entities. The potential for increased governmental costs also implies potential increased costs to the public. A third uncertainty is the potential inequities derived from some firms having greater abilities to take advantage of alternative approaches than others leading to competitive differences. Whether this constitutes a legitimate harm to other firms is, of course, a normative matter for which arguments can be made on both sides.

The bottom line for this discussion of expectations is that some aspects—increased flexibility and potential for reduced compliance costs by firms—are relatively predictable while many others depend on the specifics of the design and implementation of the performance-based regulatory regime. Figuring this out, therefore, requires attention to specific applications of these regulatory regimes.

[1] The OMB regulatory guidance under Executive Order 12866 suggests that if regulations are to be adopted as justified by benefit-cost analyses, performance-based regulations are generally preferred [U.S. Office of Management and Budget 2003]. Coglianese and Lazur [2002: 17] argue that performance-based regulation is generally preferable over technology and management-based approaches when there is adequate capacity to assess firm outputs and when firms differ greatly in their size and operations.

2 Case Studies of Performance-Based Regulation

Four sets of experiences with variants of performance-based regulation are examined in what follows. These provide a basis for considering implementation issues and the strengths and weaknesses of the performance-based approach. The cases have been selected to draw contrasts in different ways of regulating by results and in different degrees of development of the regulatory regimes. The four cases are:

- Building regulation in New Zealand
- Food-safety regulation in the United States
- Fire-safety regulation in the United States
- Nuclear power plant safety regulation in the United States

The first two cases constitute reasonably well-developed regulatory regimes at least in the sense that they have been adopted and fully implemented. The last two represent regulatory regimes for which aspects have been adopted and implemented, but further refinements and broader application are still being developed. The building and fire-safety cases embody the performance-based approach with attention to specification of desired results and enforcing compliance with those results. The food and nuclear power plant safety cases embody a mix of performance-based and management-based regulatory approaches. As elaborated on in the discussion of each of these cases, these regulatory regimes require regulated entities to establish management systems for identifying and rectifying potential performance issues [see Coglianese and Lazar 2003] along with performance-related evaluations.

2.1 BUILDING SAFETY: LEAKY BUILDINGS AND LEAKY REGULATION IN NEW ZEALAND[2]

The reform of New Zealand's approach to building regulation took place within a set of sweeping governmental reforms across a number of sectors. The broader reforms were brought about by a reform-minded government that was elected in 1984 on the heels of a crippled economy and over-extended central government.[3] The reformers sought to reduce the business of government while instilling business principles into what remained, to reduce central government meddling in local problems while increasing local governmental attention to relevant concerns, and to reduce cradle-to-grave dependency of citizens on the state and replace it with user-pays reliance on a free market. The reforms enacted between 1985 and 1991 included restructuring of regional and local governments, selling off of state assets, contracting of key state services and corporatizing others, and major reform of environmental and resource management.

The reform of New Zealand's approach to building regulation reflected a number of these changes. A review of building regulation that was undertaken in 1986 prior to the reforms found a "multi-leveled, disparate and inefficient" system of building that imposed high compliance costs and provided "little scope for builders and developers to use cost-effective alternatives" [Hunn Report 2002a: 5]. New provisions, enacted with the *Building Act 1991*, incorporated the performance-based approach to regulating buildings. As with other performance-based building regulations, New Zealand's Act provided broad objectives of protecting people, their health and safety, and the environment with sub-objectives relating to averting potential injuries, protection from the spread of fire, preventing injuries from hazardous materials, protecting other property from damage, providing means of access for disabled people, and promotion of efficient use of energy [Yates Report 2003: 13]. The Act also created the Building Industry Authority as a Crown agency charged with devising the details for verifying compliance with the new performance provisions and establishing acceptable solutions with the performance standards (as one basis for compliance). The Authority was funded from fees that developers paid when seeking building approvals.

[2] Portions of this section appear in May [2003].
[3] This description of the New Zealand reforms draws from May et al. [1986: 43–68].

The new provisions embraced the general philosophy of New Zealand's other reforms in several respects.[4] Consistent with the devolution of governmental responsibilities from central to local government, the major responsibility for building regulation was delegated to local authorities with limited central government oversight. The relevant application materials for approval of building permits were specifically left to be determined by local authorities. Market-like mechanisms were introduced by allowing certification of compliance with code provisions to be undertaken either by private certifiers or by local authorities. Local authorities retained overall responsibility and ability to issue waivers for specific buildings from requirements, but the local authorities were also required to accept building certificates of code compliance issued by private certifiers.[5] (The private entities were to be certified by the Building Industry Authority.)

In stark contrast to building regulatory practices in many settings, the Act did not specify requirements for inspections of buildings during construction. Consistent with the philosophy of reducing the dependency of citizens on the state, the Act introduced a strong dose of "buyer beware" provisions in requiring owners to acknowledge the presence of buildings in sites that may be vulnerable to natural hazards, in putting the responsibility of choosing building certifiers onto owners, and in not providing owners specific legal protections for building deficiencies.

In short, the reforms in New Zealand of building regulation embraced the New Right faith in the market and limited governmental intervention. This is aptly summarized in the governmental commentary about the building reforms issued at the time of the reforms: "The new building control system is designed to allow market forces to be combined with regulatory controls to ensure that the statutory purposes and principles of building control can be achieved, with minimal compliance costs" [Hunn Report 2002a: 11].

As summarized in the Hunn Report [2002b: 8], the market for building construction in New Zealand was changing as well during the 1990s. After a substantial downturn in the commercial and housing markets in the 1980s, the 1990s brought a substantial demand for condominium living with many property developers shifting from commercial buildings to multi-unit condominiums. At the same time, consumer preferences for single family homes in

[4] The provisions discussed in this paragraph are documented in the two main governmental reports that were issued as part of investigation of the leaky buildings crisis, known as the "Hunn Report" [2002a, 2002b] and the "Yates Report" [2003].
[5] The Yates Report [2003: 56] estimates that 34 percent of all building approvals in New Zealand were undertaken by private certifiers with considerable variation in that percentage among different jurisdictions.

New Zealand increased for “Mediterranean style” homes with plaster and adobe finishes. The marketplace responded to these dual demands with what the building industry generally viewed as cost-efficient and low-maintenance building materials in what was an ever-increasingly competitive market. It is the confluence of the changing market and the new building regulatory environment that contributed to problems with the weathertightness of buildings.

The Leaky Building Crisis, as the problem of weathertightness was labeled in a series of two dozen articles appearing in 2002 and 2003 in the *New Zealand Herald*, was not the typical story of shoddy construction or localized building inspection failures that move the mundane aspects of building regulation into the public consciousness. Rather, the problems were pervasive leading to a crisis for the central government, the building industry, and others. The source of the crisis is a common challenge for building in wet climates in that buildings must be designed and constructed so that the outer shell of the buildings resists or otherwise addresses moisture creeping into the membrane. If not addressed, moisture can undermine the durability the structure or parts of it such as joints, decks, railings, and exterior cladding leading to cracking and eventually partial or total collapse of the building. The symptoms of the crisis in New Zealand, which began to appear in the mid 1990s, were most apparent for condominiums built with a particular type of exterior cladding (“monolithic cladding panels”) and for high-priced residences built with similar types of synthetic stucco sheathing. The extent of the problem is unknown, with various reports and newspaper coverage suggesting up to 18,000 homes and numerous multi-unit buildings being affected particularly in the Auckland area. The Hunn Report investigating the issues simply states that “the Overview Group is convinced of the significance of the problem and that urgent action is required and must not be delayed while the extent is investigated further” [2002b: 13].

The fallout of the publicity surrounding the crisis was noteworthy. The central government was deeply involved in responding to the issue with active involvement of the Deputy Prime Minister, the Minister for Internal Affairs, and the Minister for Commerce along with a parliamentary investigation. The Prime Minister made a commitment in her annual address to the nation to that the crisis would be addressed by the government, and legislation was introduced by the Commerce Minister in August 2003 to revise the Building Act. The Building Industry Authority took the brunt of criticism while also sponsoring one of the major reviews of the issues that became known as the Hunn Report [2002a, b]. Other fallout is documented in the

New Zealand Herald's series of articles about the crisis. A number of major construction and homebuilding firms in the Auckland area were forced into receivership because of the anticipated costs of repairing damage to structures they built. The insurance market for building certifiers involved in that type of inspection dried up, effectively putting many certifiers out of work including the second largest firm in Auckland. (Insurance availability is a mandatory requirement for governmental authorization to do business.) Numerous lawsuits were brought against local councils by owners of damaged buildings for which the initial substantial out-of-court settlement by one council was labeled "a precedent for future legal settlements." Local authorities were particularly concerned because of unique provisions of New Zealand law that make them potentially responsible for faulty building occupancy certificates even if issued by a private building certifier. In hopes of alleviating these legal actions, the central government established a Weathertight Homes Resolution Service as a clearinghouse for mediating claims by homeowners about leaky buildings.

The ways in which the changing market and the building regulatory regime contributed to the crisis are of more relevance to this discussion than are the details of the crisis. The two reports that were undertaken labeled the problems as systemic ones for the industry and for the regulatory regime while supporting the basic concepts of performance-based regulation. As stated in the parliamentary inquiry:

> Changes to the building control regime brought about by the Building Act, and too greater reliance of market competitiveness have, we believe, contributed to the systemic failure of the building industry. It is a systemic failure in the sense that, although the framework for building work in New Zealand may, in part, be adequately designed, a wide range of participants have not complied with it. The system of procedural and technical controls also appears, in part, to be faulty in design and therefore inadequate in preventing undesirable outcomes such as the leaky buildings crisis. [Yates Report 2003: 15].

The Hunn Report summarizes the situation as follows:

> The Building Act has clearly succeeded in providing the building industry with the scope to develop innovate and cheaper building solutions. However, hand-in-hand with the service or product provider being given the ability to

> determine and provide design and construction solutions must go a responsibility and accountability to guarantee their performance against the Building Code's requirements. This has not happened. [2002b: 11].

Despite these criticisms, both reports and subsequent central governmental reviews endorsed the performance-based approach and expressed no desire to return to the prior prescriptive approach.

The investigations point to a number of problems that contributed to these systemic failures. Among other issues raised about the regulatory regime, the Hunn Report [2002a: 9–14] cites the lack of a performance objective concerning the provision of shelter, lack of detail concerning the functional requirements relating to external moisture, an inadequate system for certifying the performance of propriety products like wall cladding systems, the lack of approved methods for addressing weathertightness, and deficiencies in inspection process by local councils and private certifiers. The use of third-party certifies was particularly problematic as subsequent findings suggested they were not well trained or adequately certified by the Building Industry Authority.

The more basic problems outlined in the Yates Report [2003: 38–40] stemmed from the interaction of the prevailing industry conditions and the regulatory regime. The performance-based regime provided latitude to the industry to innovate with low-cost building solutions for which there was limited information about their performance and durability. Local authorities and private certifiers of building performance were incapable of gauging performance when builders used alternative methods like the cladding systems. And, little guidance existed from above for certifying such alternative methods.

Differences in how jurisdictions approached approval of alternative methods for acceptable performance like that presented by the cladding systems created gaps and inconsistencies. This contributed to a dysfunctional system of accountability for performance of non-standard building systems that were not specifically included as acceptable methods. Local authorities often resisted exercising a heavy hand in regulation of buildings in order to encourage development. Developers could game the system in choosing where to build (i.e., a favorable local regulatory climate) and in further choosing whether to seek a building certificate from the local authority or a private certifier. The end result was a race to the bottom in building approval standards especially as they related to alternative designs.

The investigations in New Zealand provided a number of recommendations that served as the basis for subsequent action. Among other responses, the policy and regulatory functions of the Building Industry Authority were transferred in January 2003 from the Ministry of Internal Affairs to the Ministry for Economic Development in a move that was labeled by the Deputy Prime Minister as designed to strengthen oversight of the Authority. The chief executive of the Building Industry Authority resigned in March 2003 after stinging criticism from the opposition in New Zealand's parliament. Among other criticisms, outrage was expressed about $65,000 (NZD) that the Building Industry Authority paid a public relations firm to help manage the crisis.

The Ministry for Economic Development issued a discussion paper in March 2003, "Better Regulation of the Building Industry in New Zealand," that solicited responses to options being considered for improving controls on the design and construction of all buildings. Responses to that document were used to help guide development of amendments to the Building Act. A bill to revamp the Act was introduced into the parliament in August 2003. As stated in the Cabinet white paper on the subject the revisions were aimed at creating "a much more responsive and better managed regulatory system" [New Zealand Cabinet Policy Committee, 2003: 5]. Key reforms included: increased oversight responsibilities for central government; clearer definition of performance standards in the Building Code; development of mechanisms for monitoring performance of building products and for warnings (and potential ban) about defective products; enhanced certification of council-employed and third-party inspectors; licensing of contractors; and, additional consumer protections. In short, the amendments call for a general tightening of the regulatory regime with emphasis on greater specification of performance standards and stronger monitoring of building inspection practices.

The most obvious question about the leaky building crisis is whether it would have occurred with the prior prescriptive regime. Although answering this requires knowing a counterfactual, other experience suggests that the problems would still have arisen but very likely would have been identified and addressed before becoming a crisis. Problems with new building materials and moisture have arisen in a number of other settings. The Hunn Report [2002b: 10–11] cites problems with a particular form of exterior cladding that were encountered in Vancouver, B.C., Canada, and in parts of the U.S. The regulatory response in Vancouver was to issue a moratorium on use of that approach until code requirements in Canada were updated to address the problems. The problems in the U.S. led to a number of class action lawsuits against the manufacturers of the products with one manufacturer settling out of court. Recognition of the problems in the U.S. also led to revisions in prescriptive requirements as part of the model building code provisions.

Given that similar problems arose in other settings under more prescriptive regulations, the decision to use a performance-based regulatory approach is not the origin of the problem of leaky buildings per se. Regardless of the type of standard employed, problems with moisture affecting durability of buildings are endemic to wet climates. Typically the problems stem from a combination of use of faulty materials, builders who were not competent in application of the materials, and inspectors who fail to identify problems at the time the materials are first used. Experimentation with new materials and approaches, which was a key contributor to the New Zealand leaky building crisis, also occurs under both prescriptive and performance-based regimes. What differs, and what became the key source of the problem in New Zealand, is the extent to which the problem festered until it became a crisis. As discussed in the above reviews of the crisis in New Zealand, this is the fault of the particulars of the regulatory regime that was employed more than it is the consequence of performance-based regulations per se.

2.2 FOOD SAFETY: CHANGED ROLES IN A NEW REGULATORY SYSTEM

The issue of food safety was propelled onto the American governmental agenda with the 1993 *E. coli* bacterial outbreak in Jack-in-the-Box restaurants in the state of Washington. Four children died and another four hundred people became ill. This was not an isolated case relating to food safety as the issue has been prominent in recent years with publicity over major recalls of contaminated meats in the U.S., the temporary ban by European countries on the import of British beef over fear of "mad cow" disease, similar bans on importing suspected tainted beef from Alberta, Canada, and a temporary ban on import of poultry from Belgium because of dioxin-contaminated feed. That these problems could arise in countries with well-developed systems for regulating food safety is all the more shocking to an unaware public.

Largely in response to the sensation created by the *E. coli* scare, the Clinton administration initiated an overhaul of the way in which meats and poultry are inspected in the U.S. This resulted in a new state-of-the-art, science-based inspection system. This new regulatory approach, deemed HACCP for Hazard Analysis and Critical Control Point, requires meat and poultry processors to identify potential sources of contamination within processing plants, to monitor those critical control points, to institute additional controls that are aimed at preventing contamination, and to inspect for two specific types of pathogens (*E. coli* and *Salmonella*). (Separate procedures govern regulation of ready-to-eat processed meat products and testing for *Listeria monocytogenes).* Similar HACCP regulatory approaches have been adopted by the U.S. Food and Drug Administration for regulating the processing of seafood; by Canada, France, the United Kingdom, and New Zealand for regulating meat safety; by the European Union as (part of E.U. food-safety directives; and by the World Health Organization and the United Nations' Food and Agriculture Organization in guidance materials about food safety [see Brown 2000]).

The HACCP regulatory approach transforms the burden of demonstrating adequate performance to plant operators and radically changes the role of inspectors. The implications of these changes in accountability structures and inspector roles are central to the discussion of this case of performance-based regulation. To understand them, it is useful to consider in more detail the changes that were involved in moving from the older "poke and sniff" regulation of meat and poultry to the HACCP approach. The regulation of safety of meat in the U.S. dates to the enactment in 1906 of the Meat Inspection Act that followed the sensation created by the publication of Upton Sinclair's book, *The Jungle*. Sinclair provided a scathing indictment of Chicago's meat processing industry that led to a regulatory system that existed nearly a decade with little change until the HACCP system was adopted.

As discussed by Crutchfield et al. [1997: 6–7], the "poke and sniff" regulatory approach provided for mandatory inspection of carcasses after slaughter to ensure that they were "sound, healthful, wholesome, and fit for human food" and inspection of meat products to assure that they were "sound, healthful and wholesome, and contain no dyes, chemicals, preservatives, or ingredients which render such meat or food products unsound, unhealthful, unwholesome, or unfit for human use." Each carcass was examined, as it is today, by U.S. Food Safety and Inspection Service (FSIS) on-site inspectors. If the lymph nodes were normal and there were no other signs of disease, the "animal was considered suitable for human consumption." The poke and sniff inspection did not adequately target and reduce microbial pathogens on raw meat and poultry, and as a consequence was literally hit or miss. FSIS also inspected processing plants, but unlike slaughter inspection, not all processed products were inspected.

The HACCP regulatory system recognized the inability of inspectors to identify pathogens by these methods and the need for a more scientific approach to testing. After several years of rule-making and commentary, the Hazard Analysis and Critical Control Point regulatory system was introduced in 1997 for meat and poultry. The FSIS characterizes this set of regulatory changes as follows:

> These regulations represent a fundamental shift in FSIS's regulatory philosophy from, "command and control," to performance standards, which allow for more industry flexibility. Industry is being required by the regulation to develop plans for controlling food safety hazards that can affect their products. If the plans they design are effective in eliminating health and safety hazards, and if the establishment executes the plan's design properly, then the resulting product should be safe for consumers. Instead of FSIS determining the means by which establishments will meet their responsibility to produce safe, wholesome, and properly labeled products, FSIS will set performance standards that establishments must meet. This means that FSIS will no longer be attempting to, "inspect quality into a product." Inspection's role has become one of regulatory oversight. FSIS will rely less on after-the-fact detection of product and process defects and more on verifying the effectiveness of processes and process controls designed to ensure food safety. [U.S. Food Safety and Inspection Service 1998: 2].

According to the U.S. General Accounting Office [2002], the FSIS, through its 15 district offices across the country, oversees the activities of about 7,500 federal inspectors who review the operations of about 5,000 plants subject to the HACCP requirements. About 3,400 inspectors are stationed in plants along slaughter lines to provide traditional carcass-by-carcass inspections using sight, touch, and smell. The remaining 4,100 FSIS inspectors oversee HACCP systems in plants.

As discussed by Coglianese and Lazar [2003], the HACCP systems approach is best characterized as a management-based approach to regulation rather than as performance-based regulation per se. Under the management-based approach, regulated entities devise management processes for identifying and correcting deficiencies. The cornerstone of this for HACCP is the identification by firms of potential food-safety hazards and critical control points in their production and processing. A critical control point is a point, step, or procedure whereby controls can be used to prevent, reduce to an acceptable level, or eliminate food-safety hazards. As part of the HACCP plan, the plants must establish critical limits, or maximum or minimum levels, of a hazard for each critical control point. These criteria are not enforceable regulatory standards, but they are intended to provide an objective point of reference that will help slaughter plants and FSIS ensure that plants are preventing and reducing fecal contamination of meat and poultry products.

The HACCP management-based system includes aspects of traditional regulation as a backstop and performance-based standards as an overall assessment of HACCP systems. As a backstop to the HACCP controls, FSIS inspectors still inspect individual carcasses using poke-and-sniff methods for fecal contamination under a "zero tolerance" policy. Inspectors are empowered to require corrective actions. Testing for the presence of *Salmonella* against performance-based standards provides the primary mechanism "to show that HACCP-based process control systems are achieving acceptable food safety levels" [U.S. Food Safety and Inspection Service 1998: 73]. FSIS inspectors collect samples for designated products that are evaluated for the presence of *Salmonella* by FSIS laboratories according to standards expressed as the maximum number of *Salmonella*-positive samples that are allowed per sample set. (These vary by type of product.) Stephen Crutchfield [1999] notes that *Salmonella* was selected for testing because it was the most prominent cause of U.S. foodborne illnesses associated with livestock and poultry at the time the regulations were developed.

The testing for presence of *E. coli* bacteria provides another performance-like basis for assessing the adequacy of HACCP-controls, but the procedures and role of such testing differs substantially from the *Salmonella* in testing [see U.S. FSIS 1998: 26–30]. In particular, plants are required to have a written program of testing that are conducted by plant personnel (not FSIS inspectors) for which results are compared with FSIS-established performance criteria or other process-control methods. The *E. coli* performance criteria are <u>not</u> enforceable regulatory standards, and thus their regulatory status differs substantially from the *Salmonella* standards. In essence, FSIS personnel monitor for the testing rather than for the testing results per se.

Several issues of broader relevance to performance-based regulation are raised in considering the experience with the HACCP-systems regulatory approach. One central issue is the role of performance standards in evaluating outcomes. Two issues have been raised in this regard. One issue is the scientific basis for establishing and defending standards of performance. The difference between the enforceable *Salmonella* testing and the non-enforceable *E. coli* testing illustrate this. The former is based on rigorous scientific studies of the pathogen that permit the establishment of relevant standards for different types of food. Corresponding data regarding *E. coli* have as yet not been developed, and thus there is not a parallel, scientific basis for establishing *E. coli* performance standards.

A second issue regarding performance standards is whether failure to meet a given standard is in fact an indicator of performance problems. Challenges about the reliability of performance testing and the degree to which the tests indicate presence of a health threat have been raised in noteworthy lawsuits. For one recent case, *Supreme Beef Proc v. United States Department of Agriculture*, addressing *Salmonella* testing under the HACCP system, the 5th U.S. Circuit Court of Appeals ruled that performance testing for the presence of *Salmonella* bacteria in raw meat could not be used to close plants that fail *Salmonella* tests. The court found that such testing did not necessarily assess plant conditions or performance. As a consequence, the USDA could not use these test results as a basis for enforcement actions against meat producers. However, the USDA could — and does — use inadequacies in carrying out tests for *Salmonella* as indicators of defects in the HACCP control system and as a potential basis for shutting down production. (Agriculture Secretary Ann Veneman issued a press release shortly after the court ruling, stating that if a plant failed two or more tests of relevant samples that an in-depth review of the plant's food-safety systems would be undertaken. Failure of a plant to take corrective actions based on that review would constitute a basis for withdrawing USDA inspection, thereby effectively closing the plant.) In short, the scientific basis for standards of performance, the reliability of performance testing, and the link between performance standards and actual performance are all critical issues to be considered in devising performance standards.

A second set of issues that the HACCP system raises for performance-based regulatory regimes concerns the change in regulatory roles of inspectors and their supervisors. With the exception of front-line inspectors of carcasses, the change in roles is more than cosmetic. The philosophical shift is from regulation to regulatory oversight. As stated by the Food Safety and Inspection Service in planning the HACCP system: "Inspection roles and responsibilities [would] shift from DETECTING facility and production problems to VALIDATING and VERIFYING that plants and producing safe meat and poultry products that meet the newly established requirements" [U.S. FSIS, 2002: 3; emphasis in original]. Stated differently, inspectors now monitor for compliance with the approved HACCP system for a given facility rather than monitoring plant or food conditions.

Not surprisingly, the shift in roles has engendered problems. Many FSIS inspectors do not have the technical training in microbiological aspects of food safety to assess HACCP system compliance. In addition, front-line inspectors and their supervisors can no longer serve as consultants for advice about resolving health-related production problems. The issues of technical abilities and role of FSIS field inspectors have been particularly acute in fostering confusion over responsibilities in approving versus verifying compliance with plans. This confusion was evident with the remarks made by the FSIS administration in a 1998 memorandum to field in-plant personnel:

> Because of an apparent misunderstanding among some industry representatives and inspection personnel [however], it is necessary to re-emphasize the respective responsibilities of industry and in-plant inspectors in meat and poultry plants operating under HACCP. It is the responsibility of industry to identify potential hazards, to develop a HACCP plan containing controls to prevent, eliminate, or reduce hazards to an acceptable level, to monitor the performance of controls, and to maintain required records. The primary responsibility of in-plant inspectors is to evaluate the implementation and maintenance of a HACCP plan's process controls. It is not the responsibility of in-plant inspectors to determine whether the form and content of a HACCP plan is adequate…. [Memorandum dated 13 February 1998].

2.3 FIRE SAFETY: ENGINEERING A NEW REGULATORY APPROACH

The regulation of structures for fire safety has historically evolved in response to devastating fires. As noted by Bukowski [1997] in reviewing the history of fire-safety regulation, saving lives from fires became prominent concerns after fires that included among other similar events, the 1903 Iroquois Theater fire in Chicago (602 deaths), the 1911 Triangle Shirtwaist Factory fire in New York City (150 deaths), and the 1942 Coconut Grove nightclub fire in Boston (492 deaths). Each of these events led to new thinking about potential harms and new provisions of building codes concerning fire safety. Although the code provisions were highly prescriptive in specifying such things as location and size of exits, design of stairways, location of exit signs, and specification of fire-resistant materials, the basic philosophy of protecting life safety from fires became the focal objective of fire regulations.

Perhaps no other discipline has embraced performance-based regulation in the U.S. as strongly as have key groups addressing the regulation of fire safety. A major impetus has come from the efforts of the Society of Fire Protection Engineers (SFPE), a professional association of engineering specialists in fire safety. Beginning in 1991, SFPE sponsored a series of workshops around the themes of performance-based fire and building safety that became important forums for identifying relevant issues and advocating for regulatory changes. Closely related were the efforts of the National Fire Protection Association (NFPA), an international non-profit association dedicated to fire prevention, in incorporating the performance-based concepts into the development of a new set of consensus code documents published in 2000 as the *NFPA 101: Life Safety Code* and in 2002 as the *NFPA 5000, Building Construction and Safety Code*. These documents provide for the use of performance-based evaluation of buildings as an alternative to parallel prescriptive methods. Also highly relevant were a research and technical-scoping effort under the auspices of the National Institute of Standards and Technology in conjunction with efforts of the Society of Fire Protection Engineers that entailed consideration of a framework for performance-based fire-safety design, engineering tools for addressing fire safety, the desired content of engineering guidance documents, and regulatory issues [see in particular NIST 1998].

The details of the performance-based provisions promulgated by the NFPA are less relevant to this discussion than are the intent of the regulatory changes and the issues that have been debated in introducing the new regulatory approach. The rationale for a performance-based approach to fire protection is provided in a primer issued by the NFPA:

> A performance-based code, standard, or similar document is one that specifically states its fire safety goals and desired level of safety, and then references approved methods which can be used to demonstrate a design's ability to meet these specified goals. Instead of specifying exact construction materials or protection systems to be used in a prescriptive code, a performance-based code or standard allows the use of any and all solutions that demonstrate compliance with the stated goals. This system allows the stakeholders in a building design the flexibility to design new and innovative

> structures, while maintaining a specified level of safety. [National Fire Protection Association, 1999: 8].

While codes had traditionally allowed for designs that provided "equivalent" protection to that of prescriptive provisions, neither the standards nor the procedures for documenting and verifying equivalency were well specified. Nonetheless, fire-protection specialists and other engineers involved in non-traditional structures had to demonstrate this, while regulators faced with such designs found that they had to evaluate the proposed designs for equivalency. Moving to a more systematic approach to performance-based design and regulation would address these problems, and as such it became both a basis for the evolution of performance-based design and new regulatory standards.

Several challenges for the performance-based approach were identified through the various forums and technical reports before it would be possible "to reach the full potential of innovative, safe, cost-effective, and sustainable buildings made available through the application of performance-based analysis and design concepts within a performance-based regulatory structure…." [Meacham 1998: 2]. In drawing from these reports and other documentation, three different challenges are addressed here: establishing goals and standards; developing predictive models that address uncertainties in fire protection; and implementing regulatory changes.

The establishment of goals and standards for fire safety confronts the same challenges as any effort to establish performance-based objectives in deciding how specific or general the goals or standards should be and in deciding whether they should be in expressed in qualitative terms, quantitative terms, or both [see Beller et al. 2001]. The resolution in development of the National Fire Protection Association performance-based code is a hierarchy of goals and objectives that consist of broad goals, more specific objectives, qualitative performance objectives, and scenario-based evaluation of the ability of a given structure and fire protective systems to reach those objectives. Thus, the fire-safety goal is specified as providing an environment that "is reasonably safe from fire" and that provides "reasonable safety" for firefighters and other emergency personnel [section 4.1.3.1.1]. The fire-safety objectives are expressed as design and construction to protect the safety of occupants and firefighters. And performance criteria for fire safety are expressed as the design and construction of buildings to "reasonably prevent the ignition of construction materials and building contents" [5.2.2.1], "to reasonably prevent the spread of fire beyond the compartment of fire origin" [5.2.2.2], and "To reasonably prevent structural failure under fire conditions for a time sufficient to protect the occupants" [5.2.2.3], among other criteria.

These goals and objectives clearly emphasize protection of life. Left unaddressed are the thorny questions of how much loss of life can be tolerated and at what expenditure for achieving that level? Building and fire officials, as with public officials more generally, are clearly very uncomfortable in quantifying potential loss of life or in stating that any loss of life is acceptable [see May 2002]. Thus, for example, in a survey of those code officials who are involved in preparing consensus-based codes, Van Rickley [1996] found that only 20 percent of the officials were "comfortable specifying a number for acceptable life loss as part of a risk-based analysis for building construction." Inevitably, such issues must be addressed as a comparative evaluation of the potential loss of life under different designs and protective systems. Yet, even such comparative evaluation leaves room for interpretation of what constitutes "reasonable" prevention of fire ignition or spread.

A second key challenge for performance-based fire-safety regulation is the development of reliable methods for predicting the performance of structures and protective systems for different potential fire situations. Stated differently, the evaluation of performance of a given structure of design with respect to fire-safety necessitates predictions about rather than observations of that performance. Although there are a number of computer programs for modeling the ignition and spread of fire, and guidelines have been produced by the Society of Fire Protection Engineers for carrying out such evaluations, much of the commentary about predictive modeling underscores the difficulties involved and the inherent limits. Vincent Brannigan, a fire-protection engineering academic who has been a consistent critic of fire models, calls attention in a series of papers to the difficulties of developing reliable fire prediction models and the inherent uncertainties in predicting outcomes [see Brannigan et al. 2001; Brannigan and Smidts 1996]. The prediction difficulties, in part, stem from the complexity of potential ignition sources, spread, and other physical and engineering factors. Brannigan and his co-authors also highlight the fact that an important variable in the loss of life from fires is human behavior itself, which may be largely unpredictable.

How different fire situations enter into the predictions has also been a matter of debate. The accepted practice in fire engineering is to use fire scenarios that represent particular classes of events as a basis for evaluating performance. This is an explicit component of the NFPA performance-based approach that specifies eight different scenarios to be evaluated. Notarianni and Fischbeck [2001] discuss the alternative of probabilistic fire modeling that takes into account a wider array of potential events and evaluates performance with respect to different probabilistic outcomes. The combined challenges of adequately conveying performance criteria and predicting performance are highlighted by Meacham's [2002] discussion of risk characterizations and data needs.

Much of the discussion of performance-based fire-safety regulation has focused on the engineering requirements and challenges. Less attention has been paid to the regulatory systems' implications particularly as they relate to shifting roles and accountability structures. The shifts are more matters of emphasis than they are wholesale changes. Experts, particularly fire-protection engineers, have always been involved in analyzing and evaluating fire protection for non-traditional structures. The performance-based approach brings their role to the forefront by placing the onus of accountability on them for demonstrating "reasonable" protection.

2.4 NUCLEAR SAFETY: SEEKING A SAFETY CULTURE

The 1979 nuclear power plant accident at the Three Mile Island Unit-2 reactor near Harrisburg, Pennsylvania, brought the issue of safety of nuclear power plants onto the public and policy agenda. These were not new issues as the Nuclear Regulatory Commission (NRC) was specifically created in 1974 in order to provide a greater focus on safety and regulatory issues than was the case under the predecessor agency, the Atomic Agency Commission. Since it began operations in 1975, the NRC has confronted a number of issues in the design and implementation of an effective regulatory approach. The complexity of nuclear power plants and their operations present daunting challenges. Further complicating safety actions are the twin economic forces of increased consolidation of ownership of facilities in the nuclear industry and the deregulation of the market for energy.

The NRC's primary mission, as stated on their website, is "to protect the public health and safety, and the environment from the effects of radiation from nuclear reactors, materials, and waste facilities." This requires attention to 103 commercial nuclear power plants operated at 64 sites in 31 states, 10 facilities that produce nuclear fuels, and an additional 21,000 entities that use nuclear materials and are jointly regulated in some states [U.S. GAO 2001: 1]. The traditional regulatory approach has been the use of prescriptive regulations governing licensing and operation of nuclear power plants and handling of nuclear materials. That approach is being transformed with two overlapping regulatory reform initiatives that are subjects of this brief case study. One, which officially began in 1999, is a shift to the extent that it is feasible and justifiable to regulating on the basis of performance outcomes. The second initiative, which is an outgrowth of efforts since the 1970s and was endorsed in a series of steps in the mid-1990s, is labeled "risk-informed" regulation as a basis for setting priorities for regulatory standards and activities.

These two initiatives can be put into context by considering what preceded them. As described by Golay, a nuclear engineering professor at MIT, the prior prescriptive regulations and their guidelines:

> …effectively constitute a long, fragmented checklist of requirements that safety-related systems in a plant must satisfy. The consistency of this checklist and its ability to promote uniform levels of safety among different power stations is questionable. Furthermore, since these requirements are so pervasive in determining the acceptability of a plant's design and operation, they inhibit innovation and improvement. Because the workload of satisfying the sum of such requirements is so great, owners of nuclear power plants commonly treat satisfaction of the USNRC's requirements as being a sufficient effort for accident prevention and mitigation. When this occurs, the responsibility for safety has become de facto that of the USNRC rather than solely that of the licensee. [Golay 2000: 221].

These safety regulations were developed over time, with some dating to the early days of reactor development, and largely on the basis of expert opinion and determinist analyses of what could go wrong and of the consequences of the designated failures.

Historically, the NRC employed performance criteria in limited ways for such things as test-based reliability standards for emergency diesel generator starting and assessment of reactor survival durations for blackout periods [Golay 2001: 222]. Beginning in the late 1990s, the Commission undertook a series of steps to consider the relevance of performance-based regulation to nuclear safety standards[6]. In 1997, the Nuclear Regulatory Commission requested

[6] This history is drawn from the Nuclear Regulatory Commission's 2002 guidance document for performance-based regulation [NRC 2002: 1–2].

commission staff to propose a plan for developing performance-based regulations. That directive was further clarified in 1999 with specific direction to Commission staff to "develop high-level guidelines to identify and assess the viability of candidate performance-based activities," which was followed with the development of a white paper on the topic [NRC 2000a], and in January 2000 with the publication in the Federal Register of the proposed guidelines [NRC 2000b]. The intent of pursuing the performance-based approach for appropriate safety standards is characterized in NRC guidance as an effort to ". . . improve the objectivity and transparency of NRC decision making, promote flexibility that can reduce licensee burden, and promote safety by focusing on safety-successful outcomes" [NRC 2002: iii].

The regulatory rule and NRC guidelines set forth a process for "considering" the performance-based approach with attention to the applicability of the approach to different regulatory tasks and standards. As stated in the September 2000 information briefing about the performance-based approach, the performance-based approach for a given task or standard would be appropriate if the performance-based approach were deemed to be "viable" and an assessment showed that the approach would result in "opportunities for regulatory improvement." Viability is defined in terms of the ability to devise a performance-based standard for the given regulatory situation for which: "(1) failure to meet the standard will not result in an immediate safety concern; (2) measurable or calculatable parameters can be constructed; (3) the performance standard is based on objective criteria; and (4) the licensee or the NRC has flexibility in the method used to achieve the desired performance level" [NRC 2000a].

The "opportunities for regulatory improvement" to be used to gauge the value of a performance-based standard are defined as follows:

> A. Maintain safety, protect the environment and the common defense and security…;
>
> B. Increase public confidence…;
>
> C. Increase effectiveness, efficiency and realism of the NRC activities and decision-making…;
>
> D. Reduce unnecessary regulatory burden…;

E. The expected result of using a performance-based approach shows an overall net benefit…;

F. The performance-based approach can be incorporated into the regulatory framework…; and

G. The performance-based approach would accommodate new technology. [NRC 2000a].

Concerns about the approach in response to the *Federal Register* submittal, as also summarized in the 2000 memorandum to the Commission, revolved around the feasibility of establishing performance standards, the degree to which efforts to reduce regulatory burdens would compromise safety, the specific activities that would be affected, and the establishment of performance parameters.

The "risk-informed" approach to regulation overshadowed, and in some respects encompassed, the performance-based approach. The approach evolved from the efforts to develop and employ probability-based risk analyses (PRA) in setting standards and evaluating nuclear power plant performance, beginning with the Rasmussen report in 1975, obtaining formal endorsement of the use of PRA in a 1995 Commission policy statement, and in 1998 with the endorsement of the risk-informed approach:

> …as an approach to regulatory decision-making that uses risk insights as well as traditional considerations to focus regulatory and licensee attention on design and operational issues commensurate with their importance to health and safety. A risk-informed approach enhances the traditional approach by: (a) explicitly considering a broader range of safety challenges; (b) prioritizing these challenges on the basis of risk significance, operating experience, and/or engineering judgment; (c) considering a broader range of counter measures against these challenges; (d) explicitly identifying and quantifying uncertainties in analyses; and (e) testing the sensitivity of the results to key assumptions. A risk-informed regulatory approach can also be sued to identify insufficient conservatism and provide a basis for additional requirements or regulatory actions. [NRC 2001: Part 1-1].

Dr. Richard Meserve, Chairman of the NRC, characterized the approach in a speech to the Convention on Nuclear Safety held in Vienna, Austria, in 2002 as "perhaps the most significant change occurring at the NRC today and [is] a theme central to the NRC's activities. This effort represents a significant shift away from our traditional approach" [Meserve 2002]. He went on to state that the risk-informed approach should be viewed as a complement to the existing deterministic approach, and for that reason the NRC actions should be considered "risk informed" rather than "risk based."

The relationship between the performance-based and risk-informed regulatory initiatives is somewhat confusing with the latter clearly having higher visibility within the NRC. The 2002 NRC guidance document concerning performance-based regulation states:

> Risk-informed and performance-based approaches to regulation complement one another. Risk information, when a probabilistic risk assessment (PRA) is available, can be useful in finding the most safety-significant functions and systems. If a PRA is not available, operational experience may provide enough information. Safety would be best served by demanding the highest (i.e., the most aggregated) levels of performance from the most safety-significant structures, systems, and components. [NRC 2002: 9].

The NRC 2001 update on the risk-informed plan states "[t]o the extent possible, staff activities to risk-inform regulations should also incorporate the performance-based approach to regulations. The corollary is also true: performance-based regulations should be risk-informed when possible" [NRC 2001: Part 1-10]. Nuclear engineer Golay depicts the two as inter-related in referring to "risk-informed performance-based regulation" (RIPBR) in writing that RIPBR entails probabilistic risk analysis and "also involves combined use of deterministic decision rules, performance test results and subjective evaluations, with each decision element being used where it has the greatest advantage" [2000: 222].

The performance-based approach and the risk-informed approach have been subjects of several background papers, much commentary by industry and other stakeholders in response to regulatory notifications, and many Commission hearings. Although the emphasis for each initiative to date has been largely on development of relevant frameworks and strategies for implementing the reforms, the NRC has undertaken efforts to learn more about the viability of the reforms. As discussed by Golay [2000], the NRC initiated performance-based changes in maintenance rules and for requirements for testing of containment leaks. The 2000 NRC staff discussion of performance-based regulation contains discussion of the applicability of the approach to the control of combustible gases and controls to restrict radiological exposure in restricted areas [NRC 2000a]. The risk-informed approach was also employed in a revision to the maintenance rule that, among other things, requires risk assessments before conducting maintenance activities.

As described by Commission Chair Meserve [2002], one of the more visible aspects of the risk-informed regulatory reform is the change in the reactor oversight process (ROP). This relates to the NRC's role in inspecting nuclear power plants for which a risk-informed safety oversight process was first implemented in 2000. Meserve comments that the impetus for the change came from realization that "our inspection, assessment, and enforcement processes did not always focus on the most important safety issues. In some situations, our inspection activities were inefficient and, at times, they were overly subjective. In addition, our regulatory actions were not always sufficiently understood or predictable to either the public or the regulated industry" [2002: 7]. Under the risk-informed approach, the reactor oversight process is being transformed to focus on the greatest potential risks, on facilities with track records of problems, and the establishment of objective indicators of performance (e.g., number of unplanned reactor scams, safety system unavailability, effluent releases). As stated by Meserve: "The key features of the ROP are new methods for assessing and reporting performance and for conducting inspections to ensure safe operation. The process also clearly spells out what licensees can expect if they achieve good performance, as well as what actions the agency will take if performance declines" [2002: 7].

The difficulty of bringing about this change in oversight is underscored by the complexity of monitoring reactor safety [Meserve 2002: 8]. Inspectors spent a total of some 5,000 hours per year for a typical two-unit nuclear power plant conducting baseline inspections that address the systems that plant operators have in place for identifying and rectifying problems. Additional inspections are triggered by deficiencies in these systems and by reactor systems events or other safety-related events.

The bottom line is a goal of preventing harm through fostering nuclear power plant safety. The risk-informed, performance-based approach seeks to enhance this by focusing attention on those regulatory and operational aspects that present the greatest risks to safety. The ability to successfully bring this about has been subject of discussion by NRC officials and General Accounting Office testimony to Congress. The GAO 2001 testimony stated:

> NRC's challenge has been to demonstrate that the new approach meets its goal of maintaining the same level of safety as the old approach, while being more predictable and consistent. The nuclear industry, states, public interest groups, and NRC staff have raised questions about various aspects of the process. For example, the industry has raised questions about some of the performance indicators selected. Some NRC staff are concerned that the process does not track all inspection issues and NRC will not have the information available, should the public later demand accountability from the agency. Furthermore, it is very difficult under the new process to assess those activities that cut across all aspects of plant operations—problem identification and resolution, human performance, and safety conscious work environment [GAO 2001: 4].

The 2000 GAO testimony noted that 60 percent of NRC staff responding to questions about the oversight process thought that the risk-informed approach would "reduce the margins of safety" at nuclear power plants [GAO 2000: 2].

Although the NRC has made adjustments to the reactor oversight program in response to the GAO testimony and other criticisms, the basic challenge remains one of instilling a safety culture among plant operators and NRC staff. NRC Commissioner Meserve comments:

> I believe that the United States explicitly or implicitly addresses most of the elements of safety culture in the NRC's regulatory process, despite the fact that we do not directly regulate safety culture. We believe that it is unnecessary to assess a licensee's safety culture as a distinct component because the concept of safety culture is similar, if not integral, to the licensee's more specific responsibilities. If a licensee has a poor safety culture, problems and events will continue to occur at that facility either causing various performance indicators to exceed their thresholds, or surfacing during the NRC's baseline inspection activities. [Meserve 2002: 9].

Yet, some aspects of safety are extremely difficult to assess using probabilistic and risk-informed methods. In particular, the adequacy of security and emergency preparedness programs are extremely difficult to gauge and, as a consequence, have been major points of contention in licensing of some nuclear power plants.

3 Challenges for Performance-Based Regulation

Any regulatory regime must confront a fundamental issue of how tight controls should be in promoting consistency and accountability versus how much discretion should be granted in promoting flexibility and innovation. The prescriptive approach emphasizes control and accountability. The performance-based approach desires to promote flexibility with accountability for results. Although the particulars of the cases of performance-based regulatory regimes that are discussed here differ, they share a common set of challenges in obtaining this accountability. Given this, accountability for results can legitimately be considered the Achilles' heel of performance-based regulation.

3.1 ACCOUNTABILITY FOR RESULTS: THE ACHILLES' HEEL OF PERFORMANCE-BASED REGULATION

Accountability is a fundamental and thorny issue for performance-based regulation that presents challenges that differ from traditional, prescriptive-based regulation (more generally, see Behn 2001]. Prescriptive-based regulatory programs attempt to achieve accountability by mandating adherence to the rules and are biased toward monitoring adherence to rules that are easy to observe. As a consequence, accountability under such systems can be haphazard and misplaced with little attention to the end result [Bardach and Kagan 1982; Sparrow 2000]. Performance-based approaches seek accountability for results, but as is clear from the cases reviewed here, observing or predicting results can be costly or even infeasible.

In the New Zealand case, flexibility was achieved without sufficient accountability for performance of the particular building systems in question. The problem was less a question of feasibility and more one of not wanting to invest the necessary resources given the twin desires to reduce the scope of government and to lessen enforcement burdens for regulated entities.

These forces contributed to over-reliance on poorly trained third-party certifiers and to lax review of alternative building products. In short, there was a naïve faith that "the market" would help correct deficiencies in building practices. As stated by one of the reviews of the performance-based regulatory regime: "the Act is very much the product of its time and the laissez faire philosophy that prevailed in the 1980s and early 1990s. Opinions on light-handed regulation, the concept on which the Act is based, have changed. There is now a greater consciousness of the need to manage the balance between flexibility and intervention" [Hunn Report 2002a: 4].

The HACCP system for the regulation of food safety raises issues about process accountability and the role of regulated entities in overseeing management-based regulatory systems. The HACCP management-based regulatory approach shifts accountability to industry. Unlike a purely performance-based regime where accountability rests on results, accountability under the management-based regime rests mainly on the adequacy and adherence to the process controls. The accountability issue is partly what the accountability is for (results versus process), but more importantly whether industry can indeed be held accountable to relevant standards. That, in turn, rests on the motivations of regulated entities to do a good job, on the quality of the standards, and on the effectiveness of the regulatory regime in monitoring accountability.

Performance-based fire-safety regulations also entail shifting roles and accountability structures. The shifts are more matters of emphasis than they are wholesale changes. Experts, particularly fire-protection engineers, have always been involved in analyzing and evaluating fire protection for non-traditional structures. The performance-based approach brings their role to the forefront by placing the onus of accountability on them for demonstrating "reasonable" protection. As such, the de facto standards of performance are established through the expertise of the fire-protection engineers and their understanding of existing state of practice.

Ultimately, the question of the safety of nuclear power plants is intertwined with the question of accountability. Nuclear power plant owners and operators need to be held accountable not only when lapses in safety occur, but also for demonstrating that facilities operate within tolerable bounds of safety. The prescriptive system sought such accountability by assessing whether the parts of the power plant system were adequate to the job as augmented with deterministic studies. The performance-based approach seeks to alter this equation by establishing operating and safety performance goals and measuring performance toward those goals.

3.2 ACCOUNTABILITY TO WHOM? REGULATORY CAPTURE REVISITED

The issue of accountability is closely related to the traditional regulatory concern about potential for regulatory capture. As discussed by Wilson [1980], regulatory capture refers to situations for which regulations benefit particular private interests rather than provide the broader public benefit that the regulations are intended to promote. Prescriptive regulatory provisions are open to forms of localized capture by promoting particular products or technologies and to a more global form of capture if regulated entities gain from exclusionary practices. The local forms of regulatory have lesser consequences, but can lead to the type of inefficiencies and burdens that are the focal points of criticisms of prescriptive regulations.

The performance-based approach to regulation avoids the localized form of capture by not prescribing particular methods or materials. As a consequence, particular producers of the prescribed materials or methods are not favored over others or at the expense of the public interest. Indeed, as reviewed here, performance-based regulation is aimed at promoting competition to provide better and more cost-effective ways of complying with regulations. The cases considered here show that the more global form of regulatory capture does not necessarily disappear under a performance-based regulatory regime. It simply appears in a more subtle form. At issue is how accountability for performance is determined.

In the New Zealand case, de facto standards for performance of cladding systems were established by the marketplace, with those standards falling short of what was intended by the performance-based code. This could be characterized as a form of global capture in that the public interest was not well served and the building industry gained, at least in the short term, in the process by having inexpensive construction methods. The problems that arose were not a result of a conspiracy or of unscrupulous behaviors. Rather, the problems were systemic ones related to a regulatory regime that placed too much faith on self-correction of the marketplace as a means of control. That, in turn, gave undue power to the building industry leading to what is arguably a form of global regulatory capture.

The issue of the power of the industry to determine accountability also arises in the case of the HACCP system for food safety. There is little question that industry favors the approach and the flexibility in process controls that it permits. At the same time, there have been spectacular lapses in the quality of meat production leading to massive recalls since the HACCP system has been implemented. One notable case was the failure of U.S. FSIS inspectors to take action against a ConAgra ground beef plant that had repeated problems from January 2001 until summer 2002, at which point ConAgra issued a recall notice for 19 million pounds of meat linked to an *E. coli* outbreak. This and other notable lapses have led critics to suggest that there are serious weaknesses in the accountability for food safety under the new system [see Nestor and Lovera 2002; Petersen and Drew 2003].

Performance verification under the performance-based approach to fire safety, as discussed above, rests on the expertise of the fire-protection engineers and their understanding of existing state of practice. Yet, their findings are based on the information provided by (or on behalf of) building owners who are subject to fire-safety regulations. Unless there is strong review of the findings for a given structure by fire-protection and other engineers, the accountability for verifying performance shifts from the regulator to the regulated. This leaves open the potential for the global form of regulatory capture.

3.3 STRENGTHENING ACCOUNTABILITY STRUCTURES

The concerns raised here about accountability structures suggest a more fundamental issue of how adequate accountability for performance can be guaranteed. One approach, which seems to be the preferred one at present, is an educational approach of improving the knowledge of relevant parties: regulated industries, professional engineers, and regulatory inspectors. The logic is one of ensuring that these individuals have knowledge of relevant standards and ways of assessing results, and that they understand their respective responsibilities under a performance-based regulatory regime. These are fundamental to effective regulation under this approach and, as such, educational efforts are important. But, two issues loom greatly. One is the variability in skills and knowledge among relevant individuals that makes the educational challenges noteworthy. A second is the basic fact that education alone is insufficient to overcome incentives to cut corners in demonstrating adequacy of results. Stated differently, under any regulatory regime there will always be “bad apples.”

A second approach for enhancing accountability structures, advocated more generally by Bardach and Kagan [1982], is to place greater emphasis on the legal system and assignment of liability. This is an explicit means of protection against the "bad apples" who deliberately falsify statements of adequate performance. This could take several forms. One is to make owners or plant managers, depending on the regulatory context, potentially liable for falsified statements about performance or falsified testing. This is similar to having corporate executives sign off on accounting reports to the Securities and Exchange Commission in the wake of reforms over accounting practices. A second form is to make engineers or other third-party professionals who sign off on performance documents liable for subsequent failures or lapses in performance. Use of liability mechanisms looks better on paper than in practice. Legal issues arise concerning the ability to assign responsibility and the relevant legal jurisdiction in that many regulatory actions are governed according to differing states' laws. Financial issues arise concerning the affordability of liability insurance and the ability of engineering or other professionals to offer their services at a price that clients are willing to pay. Most importantly, such liability schemes are based on the premise that it is possible to accurately gauge performance under a results-based regulatory regime.

A third approach to enhancing accountability structures is involvement of third-parties in peer review or external review as consultants to regulatory authorities. These are mechanisms for enhancing the capacity and expertise of regulatory agencies. The use of such peer review is clearly common practice for building and fire regulation when larger projects or ones involving non-conventional designs are involved. Such review provides a backstop to regulatory officials. How effective that backstop is clearly depends on the quality of the peer review and the ability and willingness of those involved in that process to raise questions about performance goals and achievement.

The basic point is that effective performance-based regulatory regimes need workable accountability structures. That entails clear assignment of responsibilities for providing information about performance and review of that information. It also entails clear standards for demonstrating performance and of what constitutes adequate performance. The difficulty of demonstrating performance is likely to be the weakest link in any accountability structure for which a key aspect is development of credible means of assessing performance.

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