13th World Conference on Earthquake Engineering
Vancouver, B.C., Canada
August 1-6, 2004
Paper No. 3254

PERFORMANCE-BASED REGULATION AND REGULATORY REGIMES

Peter J. MAY[1]

SUMMARY

This paper 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 with respect to the outcomes, and how to measure the level of performance that is obtained. Regardless of the form that performance-based regulation takes, it cannot be considered as separate from the broader regulatory system. As such, 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 in illustrating shortfalls in accountability; (2) food safety regulatory reforms in illustrating difficulties in linking standards and causes; (3) performance-based approaches to fire safety in illustrating implementation issues more generally; and (4) nuclear power plant safety in illustrating 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 provides important lessons about the challenges and limits to performance-based regulation as it applies to the field of earthquake engineering.

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 Bush and Clinton 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 United States 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 performance-based regulation in governmental circles, the merits and feasibility of the approach are open to debate

among regulatory scholars. This research contributes to this debate by discussing the broader implications of a shift to performance-based regulation.

What constitutes performance-based regulation is complicated by the fact that the concept can be, and has been, 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.

EXPECTATIONS FOR REGULATORY REGIMES

One can think of a regulatory regime as the system for achieving regulatory goals (see Hood et al. [1], May [2]). That system is comprised of 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 [3]).

Regulatory regimes also entail implementation roles and actions. Regulatory agencies and inspectors in the field make choices about the frequency of inspections, the style of inspection, the use of sanctions, and the willingness to accept alternative approaches. Although these issues are seemingly mundane in comparison to the bigger issues of regulatory reform, they are essential aspects of regulatory practice.

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 [4]. These critics argue that many rules and standards are unreasonable, narrowly defined, and overly prescriptive. A second related line of attack on unreasonable regulations addresses the way that the front lines of regulatory agencies enforced regulations. 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 are attributable to unnecessary regulation, regulatory delays, and fees (see U.S. House Committee on Small Business [5], p. 42). Key themes for those advocating regulatory reform are reducing these burdens and promoting innovative solutions.

Beginning with the Carter administration in the late 1970s, a series of regulatory reforms were undertaken in the United States that were 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 [6], 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)).

Expectations for Performance-Based Regulatory Regimes

Performance-based regulation is best viewed within the context of the broader trends in regulatory reform. As such, the expectations about performance-based regulation are shaped by criticisms of existing regulations and practices. Table 1 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 1 as a set of hypotheses about expected effects.

Three sets of uncertainties stand out in Table 1. One is the cost to government of developing and enforcing performance-based regulations. Gunningham and Johnstone [7] 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 [8] 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. 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 requires attention to specific applications of these regulatory regimes.

Table 1. 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 [3], Gunningham and Johnstone [7]).
• *Flexibility* in means of adhering to regulation	• *Increased*, given ability to use alternate means to reach objectives (US Regulatory Council [9] 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 [8]).
• *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 [7]).
• *Predictability* 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 [10], Gunningham and Johnstone [7]).
• *Cost* to:	
• *Government regulators*	• *Uncertain* -- Greater costs of developing rules and enforcement (Office of Technology Assessment [8], US Regulatory Council [9]), but not necessarily so for costs of developing rules (Gunningham and Johnstone [7]).
• *Regulated entities*	• *Decreased or no change* in compliance costs (US Regulatory Council [9]), but some entities may choose to develop more costly alternative approaches (Coglianese, Nash, Olmstead [11]).
• *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 [8])
• *Equity* in treatment of regulated entities	• *Uncertain* -- Competitive differences may emerge due to large firms having advantage in developing alternative approaches (US Regulatory Council [9]) 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.

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 performance-based regulatory regimes and in different degree 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; and,
- Nuclear power plant safety regulation in the United States.

The first two cases constitute reasonably well-developed regulatory regimes in the sense that they have been fully implemented. The last two are regulatory regimes for which aspects have been implemented, but further refinements and broader applications 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 safety 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.

Building Safety: Leaky Buildings and Leaky Regulation in New Zealand

The reform of New Zealand's approach to building regulation in 1991 embodied both the principles of performance-based regulation and the precepts of broader reforms undertaken by reform-minded governments in New Zealand during that era. 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" [12], p. 5. New provisions, enacted with the *Building Act 1991*, incorporated the performance-based approach to regulating buildings. As with other performance-based building codes, 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 [13], p. 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.

The major responsibility for building regulation was delegated to local authorities with limited central government oversight. Determination of the relevant application materials for approval of building permits were specifically left to 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. (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 does 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.

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 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" [12], p. 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. 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 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." 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. [13], p. 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. [12], p. 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 [12] 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 [13] 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. Local authorities and private certifiers of building performance were incapable of gauging performance when builders used alternative methods like the cladding systems. Little guidance existed from above for certifying alternative methods. Differences in how jurisdictions approached approval of alternative methods for acceptable performance created gaps and inconsistencies. 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 obvious questions about the leaky building crisis are 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. Problems with exterior cladding were also encountered in Vancouver, British Columbia and in parts of the United States. 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 United States 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 United States 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. 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.

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. 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 United States. 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*.)

The HACCP regulatory approach transforms the burden of demonstrating adequate performance to plant operators and radically changes the role of inspectors. The regulation of safety of meat in the United States 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. The HACCP regulatory system recognized the inability of inspectors to identify pathogens by the "poke and sniff" 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.

As discussed by Coglianese and Lazar [3], the HACCP systems approach is best characterized as a management-based regulatory regime, rather than as a performance-based regulatory regime. 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 where 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 the adequacy 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" [14], p. 73. FSIS inspectors collect samples that are evaluated for the presence of *Salmonella* by FSIS laboratories. The testing for presence of *E. coli* bacteria provides another performance-like basis for assessing the adequacy of HACCP-controls, but the procedures and the role of such testing differs substantially from those for Salmonella testing. 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. The difference between the enforceable *Salmonella* testing and the non-enforceable *E. Coli* testing illustrate problems in establishing an adequate science base. 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. 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.

Changes in regulatory roles of inspectors and their supervisors under the HACCP system are also relevant to performance-based regulation. With the exception of front-line inspectors of carcasses, the change in roles is from that of regulation to that of providing 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" [15], p. 3; emphasis in original. 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 has been particularly acute in fostering confusion over responsibilities in approving versus verifying compliance with plans.

There is little question that industry favors the HACCP 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 US 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.

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 [16], saving lives from fires became prominent concerns after fires that included among other notable 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.

Perhaps no other discipline has embraced performance-based regulation in the United States 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, a professional association of engineering specialists in fire safety. Beginning in 1991, 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, 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 [17, 18]. These documents provide for the use of performance-based evaluation as an alternative to prescriptive methods.

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. [19]). The National Fire Protection Association performance-based code for fire-safety [17] provides 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. The goals and objectives emphasize protection of life. Left unaddressed are the thorny issues of the amount of loss of life that can be tolerated and the expenditure required 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 [20]). Thus, for example, in a survey of those code officials who are involved in preparing consensus-based codes, Van Rickley [21] 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."

A second key challenge for performance-based fire-safety regulation is development of reliable methods for predicting the performance of structures and protective systems for different potential fire situations. 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 [22, 23] to the difficulties of developing reliable fire prediction models and the inherent uncertainties in predicting outcomes. 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 [24] 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 [25] discussion of risk characterizations and data needs.

Nuclear Safety: Seeking a Safety Culture

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, according to the U.S. General Accounting Office [26], 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. 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 over-lapping regulatory reform initiatives. One is a shift to regulating on the basis of performance outcomes. The second is labeled "risk-informed" regulation as a basis for setting priorities for regulatory standards and activities.

NRC guidelines for the performance-based approach [27] set forth a process for evaluating the applicability of the approach to different regulatory tasks and standards. The performance-based approach for a given task or standard is considered appropriate if performance-based standards are deemed to be "viable" and the approach could result in "opportunities for regulatory improvement."

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 feasibility of the reforms. As described by Commission Chair Meserve [28], one of the more visible aspects of the risk-informed regulatory reform is the change in the reactor oversight process. 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. 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).

The difficulty of bringing about this change in oversight is underscored by the complexity of monitoring reactor safety. 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. In Congressional testimony, the GAO [26] 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.

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 commented:

> 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. [28], p. 9.

Yet, some aspects of safety are extremely 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.

CONCLUSIONS: 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. This is accomplished by mandating adherence to the rules for which accountability is biased towards compliance with rules that are easy to observe. As a consequence, accountability can be haphazard and misplaced. The performance-based approach desires to promote flexibility with accountability for results. But, obtaining the latter can be especially problematic since observing or predicting results can be costly or even infeasible. The cases considered here show different aspects of accountability challenges for performance-based regulation.

In the New Zealand case, flexibility was achieved without sufficient accountability for performance of the particular building systems in question. 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" [12], p. 4. The problem of accountability for the New Zealand "leaky building crisis" 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.

The HACCP system for the regulation of food safety raises issues about process accountability and the role of regulated entities in providing it. The HACCP management-based approach shifts accountability to industry. Unlike a purely performance-based regime where accountability rests on results, accountability under the management-based regime rests on the adequacy of 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.

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. 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.

The issue of nuclear power plant safety is also 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 for nuclear power plant safety sought 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.

Although the particulars of the cases of performance-based regulatory regimes that are discussed here differ, they share a common set of challenges of achieving the desired flexibility while also providing accountability for results. The cases underscore the difficulties of obtaining this type of accountability. Given this, accountability for results can legitimately be considered the Achilles' heel of performance-based regulation.

ACKNOWLEDGEMENTS

Invaluable assistance with this research was provided by Chris Koski and Andrew Goodrich. Revisions to earlier drafts were stimulated by comments provided by Cary Coglianese, Neil Gunningham, Brian Meacham, and Jon Traw. The discussion of the New Zealand experience draws from: May, PJ. "Performance-Based Regulation and Regulatory Regimes: The Saga of Leaky Buildings," Law and Policy 2003; 25(4): 381-401. Support of this work was provided with funding to the University of Washington by the Pacific Earthquake Engineering Research Center (PEER) as part of the Earthquake Engineering Research Centers Program of the National Science Foundation under award number EEC-9701568. The findings are not necessarily endorsed by the National Science Foundation, the PEER Center, or the University of Washington.

REFERENCES

1. Hood C, Rothstein H, Baldwin R. The Government of Risk, Understanding Risk Regulation Regimes. Oxford and New York: Oxford University Press, 2001.
2. May PJ. "Social Regulation" in Lester Salamon ed. Tools of Government: A Guide to the New Governance. Oxford and New York: Oxford University Press, 2002: 156-185.
3. Coglianese C, Lazar D. "Management-Based Regulation: Prescribing Private Management to Achieve Public Goals." Law and Society Review 2003; 37(4): 691-730.
4. Howard P. The Death of Common Sense, How Law is Suffocating America. New York: Random House, 1994.
5. U.S. House of Representatives. Committee on Small Business. Regulatory Reform Initiatives and Their Impact on Small Business. Hearing before the Committee, Serial No. 106-60. Washington DC: US Government Printing Office, 2000.
6. Executive Order 12866, "Regulatory Planning and Review," Federal Register issued October 4, 1993; 58 (190): 51735-51755.
7. Gunningham N, Johnstone R. Regulating Workplace Safety, Systems and Sanctions. Oxford: Oxford University Press, 1999.
8. Office of Technology Assessment, U.S. Congress. Environmental Policy Tools: A User's Guide. OTA-EVN-634. Washington DC: U.S. Government Printing Office, 1995.
9. U.S. Regulatory Council. Performance Standards, A Practical Guide to the Use of Performance Standards as a Regulatory Alternative. Report of the Project on Regulatory Alternatives. Washington DC: Administrative Conference of the United States, 1981.
10. Foliente, GC. "Developments in Performance-Based Building Codes and Standards." Forest Products Journal 2000; 50(7/8): 12-21.
11. Coglianese C, Nash J, Olmstead T. "Performance-Based Regulation: Prospects and Limitations in Health, Safety, and Environmental Protection." Administrative Law Review 2003; 55: 705-729.
12. Hunn Report. Report of the Overview Group on the Weathertightness of Buildings to the Building Industry Authority, Addendum: Section 3. Wellington, NZ: Building Industry Authority, Submission of 31 October 2002. Accessed at http://www.bia.govt.nz/publicat/pdf/sec_3_report.pdf on 2 April 2003.
13. Yates Report. Weathertightness of Buildings in New Zealand. Report of the Government Administration Committee's Inquiry into the Weathertightness of Buildings in New Zealand, dated March 2003. Wellington, NZ: House of Representatives, 2003.
14. Food Safety and Inspection Service, United States Department of Agriculture. "Supervisory Guideline for the Pathogen Reduction/HACCP Regulatory Requirements." Washington, DC: FSIS, 1998. Accessed 7 October 2003 from http://www.fsis.usda.gov/oa/haccp/oa/regreq98.pdf
15. Food Safety and Inspection Service, United States Department of Agriculture. "Inaccuracies in Statements and News Articles Concerning the HACCP-Based Inspection Models Project (HIMP)." Washington, DC: FSIS, 2002. Accessed 3 October 2003 from http://www.fsis.usda.gov/oa/news/2002/himpmyths.htm
16. Bukowski, RW. "Progress Toward a Performance-based Codes System for the United States." Applications of Fire Safety Engineering. Symposium for '97 FORUM. Proceedings. FORUM for International Cooperation on Fire Research, Tianjin Fire Research Inst. and Shanghai Yatai Fire Engineering Co., Ltd., 1997: 97-107.
17. National Fire Protection Association. NFPA 101: Life Safety Code. Quincy, MA: NFPA, 2000.
18. National Fire Protection Association. NFPA 5000, Building Construction and Safety Code. Quincy, MA: NFPA, 2002.
19. Beller D, Everall P, Foliente G, Meacham B. "Qualitative versus Quantitative Aspects of Performance-Based Regulations." Proceedings of the CIB World Building Congress: Performance in Product and Practice, Wellington, New Zealand, 2 - 6 April 2001. Rotterdam: International Council for Research and Innovation in Building and Construction: Paper 267, 2001.

20. May, PJ. "Societal Perspectives About Earthquake Risk: The Fallacy of 'Acceptable Risk'," Earthquake Spectra 2001; 17(4): 725-737.
21. Van Rickley C. "A Survey of Code Officials on Performance-based Codes and Risk-based Assessment." Codes Forum 1996; (January/February): 42-46.
22. Brannigan V, Kilpatrick A, Smidts C. "Human Behavior and Risk Based Fire Regulation." Proceedings, Human Behavior in Fire: Understanding Human Behavior for Better Fire Safety Design, 2nd International Symposium. London: Interscience Communications Ltd., 2001: 411-418.
23. Brannigan V, Smidts C. "Performance Based Fire Safety Regulation Under Intentional Uncertainty." Proceedings: The Human Behaviour in Fire the First International Symposium. Belfast, Northern Ireland: Textflow Ltd., 1996: 410-420.
24. Notarianni K, Fischbeck P. "Performance with Uncertainty, A Process for Implementing Performance-Based Fire Regulations." Fischbeck PS, Farrow RS, Editors. Improving Regulation: Cases in Environment, Health, and Safety. Washington DC: Resources for the Future, 2001: 233-256.
25. Meacham, BJ. "Risk and Data Needs for Performance-Based Codes." Workshop to Identify Innovative Research Needs to Foster to Foster Improved Fire Safety in the United States, National Research Council, Board on Infrastructure and the Constructed Environment, Washington DC, April 15-16, 2002.
26. United States General Accounting Office. "Nuclear Regulation: Challenges Confronting NRC in a Changing Regulatory Environment." GAO-01-707T, Testimony of Ms. Gary L. Jones before the Subcommittee on Clean Air, Wetlands, Private Property and Nuclear Safety, Committee on the Environment and Public Works, U.S. Senate, May 8, 2001.
27. Nuclear Regulatory Commission. "Guidance for Performance-Based Regulation." NUREG/BR-0303. Washington DC: Nuclear Regulatory Commission, 2002.
28. Meserve, R. "U.S. Presentation to the Convention on Nuclear Safety of the Second Review Meeting of the Convention on Nuclear Safety." Speech delivered on 18 April 2002; NRC News No. S-02-013. Washington DC: Nuclear Regulatory Commission, 2002.

---

[1] Professor of Political Science, Center for American Politics and Public Policy, University of Washington, Seattle WA, USA Email: pmay@u.washington.edu