Comments

Chemical Accident Prevention Regulation in California and New Jersey

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Chemical plant explosions, refinery explosions, and the killing winds of toxic gas releases are inevitable features of industrial society. Chemical accidents are as old as the chemical industry itself, yet large accidents continue to occur. They are, in the words of Charles Perrow, "normal accidents."

Although chemical accidents are not new, the nature of the associated public policy problem changed dramatically following the December 1984 toxic gas release in Bhopal, India. The images and consequences of Bhopal captured, and continue to capture, the attention and imagination of people all over the world. Bhopal and its kin have changed the way we respond to chemical hazards and, indeed, to technological hazards generally. The chemical industry argues, with strong statistical support, that it is comparatively safe, that few people have been killed or injured by accidental releases, and that the vast bulk of...
chemical accidents produce no fatalities and few injuries. The industry suggests that there is less of a problem than meets the eye. But accidents like Bhopal have taught communities to fear all chemical accidents. Now, every small, otherwise inconsequential accident adds to community dread and creates more demands for safety. Whether or not they think the public attitude is reasonable, industry and government have responded.

Chemical accident prevention programs enacted by the European Community, certain states, and now the federal government adopt the modern approach to process safety developed by industry groups. The regulations do not specify the particulars of operation. Rather they demand that each chemical plant have written operating procedures and precise operating parameters. The core of these regulatory programs is the requirement that each plant painstakingly assess its operations and identify outstanding hazards.

To regulate chemical plant safety successfully, however, agencies and companies must go further. Safety engineers and sociologists argue that chemical plants and other complex technologies should not be understood merely as large machines with a collection of operators, but rather as systems with organizational and technological subsystems. Traditionally, mistake-free operation was considered the main criterion of safe operation. In contrast, the emerging view of chemical plants as systems suggests a more complex set of criteria, drawn from the experiences of those high hazard systems that operate with high reliability. Those systems share several common characteristics: Operators have a full understanding of the system's operation; there is elaborate and facile communication and interaction within the organization; and management and workers throughout the organization share a commitment to safety. These hallmarks of reliable operation should be the goals of chemical process safety.

6. See infra notes 39-40 and accompanying text.
7. "After Bhopal, every incident—even much smaller ones—drew so much attention, creating a tremendous level of public concern and, in its wake, political concern." David Hunter, Managing the Way Toward Process Safety, CHEMICAL WK., July 17, 1991, at 24 (quoting Vincent E. Boyden, Director of Corporate Safety, Monsanto). The public's tendency to equate large and small accidents has a technical counterpart. Engineers regard a succession of small accidents as a signal of mismanagement that could produce a large accident. See infra notes 34-37 and accompanying text.
8. See infra notes 72-79 and accompanying text.
9. See infra part II.
11. See infra note 267 and part III.A.
The emerging systems view of chemical plant safety offers a means to address public concern about chemical accidents. Some commentators worry that the fear of chemical accidents is merely one more sign of a timid and joyless society. They suggest that the public reaction to hazards is a dangerous barrier to progress and accuse politicians who respond to such fears of being shortsighted and avaricious. However, ranking hazards by the number of people at physical risk, as these commentators do, unreasonably discounts the public’s response to the characteristics of a hazard. Strong public reactions to highly concentrated technological risks are a proper basis for public policy.

Moreover, the results of accident prevention programs further refute these commentators’ narrow viewpoint. New Jersey’s Toxic Catastrophe Prevention Act, the most aggressive of the regulatory programs discussed in this comment, is believed to have reduced the incidence of chemical accidents. On that basis, the U.S. Environmental Protection Agency (EPA) has determined that its proposed regulation, which is strikingly less stringent than New Jersey’s, is cost effective. But estimates of the benefits of accident prevention are inevitably conservative; the indirect costs of a large accident defy prediction and estimation. The breadth of the public response to chemical accidents and the extensive indirect costs of each accident create a powerful but open-ended incentive for regulation. Politicians, who must establish the parameters of a regulatory program, need some guiding principle.

This comment suggests that the systems view provides such a guiding principle. It argues that regulatory programs should be designed to foster effective organizational interactions within chemical plants as well as adherence to sound chemical engineering practices. It also argues that such regulatory programs can be designed so that they enhance, rather than obviate, a plant’s commitment to safety. Part I introduces chemical accidents and chemical accident prevention (CAP) regulation and engineering techniques. It also describes public attitudes toward chemical accident risk and the scope of the policy problem. Part II compares the evolution and operation of CAP regulation in two states: New Jersey and California. The comparison illustrates the wide range of choices avail-

12. See, e.g., Henry Fairlie, Fear of Living: America’s Morbid Aversion to Risk, NEW REPUBLIC, Jan. 23, 1989, at 14 (lamenting that such fears are “enfeebling the economy . . . and threatening to create an unbuoyant and uninventive society”).
14. See infra text accompanying note 212.
15. See infra text accompanying note 70 (discussing costs of the Three Mile Island accident).
CHEMICAL ACCIDENT PREVENTION

able to design CAP regulatory programs, as well as the potential for public fear to contribute to a comprehensive and well-regarded program. New Jersey embraced chemical accident prevention as a significant responsibility of the state. In contrast, California created only a shell of a program delegated to underfunded local agencies.

Part III of this comment presents the systems or organizational view of chemical plant safety. Following the Three Mile Island accident, Charles Perrow persuaded many observers that accidents are inevitable in complex, tightly coupled operations, a category that includes large chemical plants. Yet some such systems operate with a relatively low rate of accidents. Part III describes some characteristics of those high reliability systems, then returns to the differences between California and New Jersey to consider how regulatory programs can promote those characteristics.

CHEMICAL ACCIDENTS AND SAFETY

Public policy regarding chemical accident prevention is in a period of great transition, for two main reasons. First, the number of large accidents has increased in recent years, as the industry has grown, and the size (and therefore hazard) of individual plants has grown. Second, in the last decade, CAP regulatory programs have become prominent in Europe and the United States. This section describes these two developments and the public concerns that connect them. Finally, this section describes the chemical industry's emerging approach to process safety.

A. Chemical Accidents

Chemical accidents have occurred throughout the industrial age.\textsuperscript{17} Not until this century, however, did large accidents become regular occurrences.\textsuperscript{18} There are several possible reasons for the upsurge. First, the chemical industry grew dramatically following World War I.\textsuperscript{19} Sec-

\textsuperscript{17} The earliest chemical accidents occurred before the birth of the chemical processing industry. There are, for example, records of a toxic gas release in the biblical era and a 1759 chemical fire caused by a nitric acid release. V. C. MARSHALL, MAJOR CHEMICAL HAZARDS 4-5 (1987). Not surprisingly the explosives industry led to many unintended explosions. \textit{Id.} The chemical industry itself grew rapidly in the early nineteenth century in response to the needs of the soap, cotton, and glass industries and later to produce dyes. C.A. Heaton, \textit{The World's Major Chemical Industries, in An Introduction to Industrial Chemistry} 36-38 (C.A. Heaton ed., 1984).

\textsuperscript{18} See MARSHALL, supra note 17, at 6.

\textsuperscript{19} \textit{Id.} at 11. For example, United States production of sulfuric acid went from 1 million metric tons annually in 1910 to over 30 million metric tons in 1980; production of chlorine went from 100,000 metric tons annually in 1935 to 10 million metric tons in 1985. \textit{Id.}; see also Linda C. Durkee, \textit{Industries Managing Chemical Risk Undergoing Evolutionary Period: Conference on Chemical, Related Process Accidents Focuses on Prevention}, 11 Int'l Envtl. Rep. (BNA) 346 (June 8, 1988).
ond, the conversion from coal to oil as a major energy source increased the use of volatile, explosive gases.\textsuperscript{20} Third, individual chemical processing units have grown in size, creating the potential of even greater hazards.\textsuperscript{21} The accident at Bhopal, India, for example, illustrates the potential hazards of large, modern chemical facilities.

On December 4, 1984, the Union Carbide pesticide manufacturing plant in Bhopal, India, released a cloud of toxic gas from its methylisocyanate processing unit, killing over 4000 people.\textsuperscript{22} The accident was a horror.\textsuperscript{23} Bhopal’s gruesome image is invoked in virtually all discussions of chemical accident prevention policy.\textsuperscript{24} Less than a year later, Bhopal’s “sister” plant, in Institute, West Virginia, leaked toxic gases and sent 135 people to the hospital.\textsuperscript{25} Americans learned that it can happen here.

Bhopal is not our only signal of the gravity of modern chemical hazards. In 1947, in Texas City, Texas, freighters containing fertilizer caught fire and exploded, “igniting refinery tanks and most of downtown, 576 people were killed.”\textsuperscript{26} In 1974, in Flixborough, England, a refinery

\textsuperscript{20} MARSHALL, supra note 17, at 8.

\textsuperscript{21} Id. at 10-14; \textit{World Chemicals: The Challenge of Asia}, ECONOMIST, Mar. 13, 1993, at 27, 28 ("Since the 1950s, the size of typical chemicals plants has increased twenty-fold."). It is not obvious that larger units ultimately produce a greater number of injuries. Marshall suggests that the cost of safety monitoring per unit of production does not increase with plant size. Moreover, the owners of larger plants are more likely to be able to afford a safety program. MARSHALL, supra note 17, at 16-18. Only large plants, however, can produce the largest hazards. See Durkee, supra note 19, at 348.


\textsuperscript{23} The horror of the accident is described by the following:

In the next hours, as people staggered and drifted back to their homes, the full dimensions of the disaster began to be apparent. Bhopal looked like a battle zone in a chemical war. It was littered with the dead—lying in alleys, ditches, roadways, or still trapped in their huts, in the contorted positions of sudden death. They lay intermingled with the goats, cows, sheep, and other animals that had also perished. The gas cloud had devastated everything living in its path, even killing plants and turning leaves black. “People were just lying in the road like dogs and cats,” Ishmail Khan recalled. One paper noted that it was easy to locate the plant from afar—vultures were circling overhead.


\textsuperscript{25} Abrams & Ward, supra note 22, at 143.

exploded, killing twenty-eight people and forcing another 3000 to evacuate. In 1976, in Seveso, Italy, a pharmaceutical plant released a dioxin gas cloud, driving hundreds from their homes and permanently traumatizing the community. In 1989, in Pasadena, Texas, the Phillips 66 chemical complex exploded, killing twenty-three workers and injuring 314 others. Each of these accidents remains a symbol, none so powerful as Bhopal, but none forgotten.

How likely is another catastrophic accident? Even those who regard the chemical industry as particularly safe acknowledge that a major catastrophe remains possible. The relative rarity of major accidents in the United States does not justify the conclusion that another large accident is unlikely in the future. In 1985, a World Bank chemical engineer warned:

This country has been very lucky it has not had a major chemical accident killing a lot of people. . . . There have been many warnings. Those who try to minimize the hazards are totally wrong. And if there aren't many changes in the next couple of years, there probably will be a major accident here.

The element of luck was also illustrated by the EPA contractors who identified "17 [U.S.] events for which the ratio of quantity released to toxicity is at least as large as that for the release at Bhopal." They surmised that the seventeen events had not created a Bhopal-scale tragedy in this country only because of the differences in "attributes of the circumstances of the release, of the physical environment, or of the proximity to a population."

The persistence of near misses and small accidents also indicates the possibility of larger accidents. "There is a correlation between the more frequent minor accidents and the less frequent major accidents . . . ."
While there are few systematic records of large accidents, and even fewer for smaller accidents, there are poignant suggestions of a trend away from safety. Former Secretary of Labor Elizabeth Dole lamented the absence of care that gave rise to the large, fatal accident in Pasadena, Texas: OSHA’s investigation revealed “clear evidence that [the] explosion was avoidable had recognized safety procedures been followed.”

B. Why Regulate?

Toxic chemical accident risk requires strong regulation even though, compared to other industries, the chemical industry is relatively safe. The total number of workers killed in chemical accidents in this country each year, approximately 265, is dwarfed by the 10,000 workers killed in occupational accidents. Indeed, the available industrial accident statistics suggest the chemical industry is among the nation’s safest industries. Why, then, should governments regulate chemical accident risk?

35. "Before the disaster at Bhopal, India, last year, the United States had never systematically collected information on accidents involving toxic chemicals." Michael Wright & Caroline Rand Herron, Counting Up Some of the Toxic Accidents, N.Y. TIMES, Oct. 6, 1985, at D4. European governments were also remiss in this area. See, e.g., MARSHALL, supra note 17, at 19-23. Moreover, a recent European study noted that databases of large accidents are often inaccurate on details such as the cause and the description of the event. Palle Haastrup & Lars H. Brockhoff, Reliability of Accident Case Histories Concerning Hazardous Chemicals: An Analysis of Uncertainty and Quality Aspects, 27 J. HAZARDOUS MATERIALS 339 (1991).

36. "[I]t is virtually impossible to get statistics on accidents such as leaks from the companies." Charles Perrow, Risky Systems, The Habit of Courting Disaster: Bhopal, Chernobyl, and Challenger Accidents, 243 NATION 329 (1986); see also Steve Tombs, Deviant Workplaces and Dumb Managements? Understanding and Preventing Accidents in the Chemical Industry, 3 INDUS. CRISIS Q. 191, 191 (1989) ("Yet despite the fact that . . . the line between a minor accident and a disaster is often a narrow one, little attention has been paid to the succession of small-scale incidents that occur almost daily within particular industries.").


38. Stephen G. Minter, Avoiding the Big Bang, OCCUPATIONAL HAZARDS, July 1990, at 36, 36 (quoting then-Secretary Dole).


40. Randal Schumacher, The Chemical Industry Replies, Making America’s Safest Industry Safer, N.Y. TIMES, May 18, 1986, § 3 at 2. "For example, in 1983 the chemical industry reported the lowest accident rate among industrial sectors, accounting for 5.5 cases of fatalities, lost workdays, or injuries without lost workdays per 100 full-time employees—a figure
There are at least three major reasons for aggressive CAP regulation despite the relatively small number of people harmed by chemical accidents. First, persons and communities harmed by large accidents are unlikely to be adequately compensated for their injuries. Second, toxic accident risk is inequitably distributed. Third, there is a strong, widespread aversion to toxic chemical risk.

Victims of chemical accidents are unlikely to be adequately compensated for their financial losses.\textsuperscript{41} Particularly in large accidents with many victims, it is unlikely that each victim will be compensated for his or her injuries.\textsuperscript{42} Litigation concerning complex accidents involving many parties is fraught with many practical problems that reduce the likelihood of adequate compensation.\textsuperscript{43}

Moreover, monetary awards cannot make the accident victim completely "whole." Monetary awards attempt to compensate victims for psychic harms,\textsuperscript{44} but such awards cannot completely redress the harm. An accident creates a relationship between the injurer and the injured: "[T]he harms we suffer because of the acts of others carry special injury; we mourn the deaths from a natural flood but resent, deeply, the ones from a broken dam. We 'are concerned not simply with safety but with

\textsuperscript{41} One study estimated that chemical companies pay 70\% or less of the social costs of acute chemical injuries to innocent bystanders. Nicholas A. Ashford & Robert F. Stone, \textit{Liability, Innovation, and Safety in the Chemical Industry, in The Liability Maze: The Impact of Liability Law on Safety and Innovation} 367, 388-91 (Peter W. Huber & Robert E. Litan eds., 1991). The figure was calculated "grudgingly" assuming 100\% recovery for the victim's impairment and pain and suffering. The authors also cite studies showing that after fatal accidents, the victims' estates are compensated for less than 10\% of their costs. \textit{Id.}

\textsuperscript{42} Allan T. Slagel, Note, \textit{Medical Surveillance Damages: A Solution to the Inadequate Compensation of Toxic Tort Victims}, 63 \textit{IND. L.J.} 849, 849 (1988). Indeed, Judge Jack Weinstein, at the center of mass tort litigation, has called for caps on the amount of money that can be recovered in such suits. Jack B. Weinstein, \textit{The Role of the Court in Toxic Tort Litigation}, 73 \textit{GEO. L.J.} 1389, 1391 (1985). In his official capacity, Judge Weinstein has noted that the threshold for regulation is lower than the burden to receive compensation. The latter involves the risk of unfairly making someone pay for a third person's injuries. \textit{In re Agent Orange Litigation}, 597 F. Supp. 740, 785 (1984).


responsibility and guilt as well.'"45 Rather than healing the victim’s sense of injury, the litigation process and fights over money impose a distance, even a hostility, between the injurer and the injured, often exacerbating the victim’s injury.46

Inequities in harm from toxic exposure47 provide the second reason for strong CAP regulation. The community surrounding a chemical plant receives only limited benefit from the plant, yet bears a special harm. In the worst case, such as Bhopal, whole communities are destroyed because so many of their members are killed. Even in less dramatic circumstances, a sense of loss can pervade the affected community, weaken its basic bonds, and create a collective trauma.48 The community realizes that its most basic building block, the family, is at risk.49 Communities are also harmed by more complex responses to toxic accidents. As the community responds to the consequences of the accident and seeks compensation, it must relive the trauma and suffer the attention and designs of larger political forces.50 These community impacts are an

46. And so, from beginning to end, we become the victims though we were the ones that were poisoned. We are the ones that were chemically assaulted, but we are the ones whose human dignity was trampled on and who are criminalized and treated like we are some community of hustlers trying to get a quick buck out of General Chemical or Chevron somewhere.

The Community and Toxics: Accidents Involving Hazardous Materials: Hearing Before the Subcomm. on Oversight and Investigations of the House Comm. on Natural Resources, 103rd Cong., 1st Sess. 70 (1993) [hereinafter Hearing] (response of Henry Clark, Richmond, Cal.). A more appropriate response to the accident would be for the injurer to provide post-accident care in addition to whatever pre-accident care he or she provided. Bender, supra note 43, at 901-08. This also suggests that there must be some mechanism for identifying individuals, who in addition to the company, were responsible for the accident. See infra part III.C.3. (discussing management accountability).

48. Kai Erikson describes collective trauma in the following way:

By collective trauma... I mean a blow to the basic tissues of social life that damages the bonds attaching people together and impairs the prevailing sense of communality. The collective trauma works its way slowly and even insidiously into the awareness of those who suffer from it, so it does not have the quality of suddenness normally associated with “trauma.” But it is a form of shock all the same, a gradual realization that the community no longer exists as an effective source of support and that an important part of the self has disappeared.


49. One of the lasting images of Bhopal is of a mother who successfully runs from the fumes only to discover that the daughter in her arms is dead. PAUL SHRIVASTAVA, BOPAL: ANATOMY OF A CRISIS 1-2 (1987).
independent harm of chemical accidents and provide a strong basis for regulation.51

The inequity of chemical accident harm is compounded by the fact that poor and minority communities are most often at risk.52 Communities notable for high concentrations of chemical plants and refineries are primarily the home to high percentages of people of color and poor people. Three notable examples are Richmond, California, in Contra Costa County;53 Cancer Alley, Louisiana;54 and the port and central cities of Los Angeles.55 Indeed, the primary devastating impact of the Bhopal accident was on a poor Indian community.56 The disproportionate impact of chemical accident risk is but one instance of the disproportionate burden of environmental harm borne by poor communities and communities of color generally.57

Communities already disenfranchised from mainstream society should receive strong protection from chemical accident risk. CAP regulation presents an opportunity to help correct a longstanding inequality: addressing the disenfranchisement of poor and minority communities should be an affirmative goal of environmental law.58 Equity thus provides its own reasons for CAP regulation.

The third reason for strong CAP regulation is to provide assurances to the public. Chemical accidents capture the public's attention and imagination.59 Chemical accident risk is an example of a "dread risk," a risk that produces a response disproportionate to the physical harm it can cause:

51. Among the legal system's "most ancient and fundamental goals [is to preserve] a sense of community against the threat of chaos and disintegration." Rabin, supra note 43, at 282.

52. Justice Lewis Powell noted a study that found "[n]ot surprisingly, that the poor were clustered around commercial and industrial areas . . . ." San Antonio Indep. Sch. Dist. v. Rodriguez, 411 U.S. 1, 22 (1973) (citations omitted).

53. CITIZENS FOR A BETTER ENVIRONMENT, RICHMOND AT RISK: COMMUNITY DEMOGRAPHICS AND TOXIC HAZARDS FROM INDUSTRIAL POLLUTERS 18-45 (1989); Hearing, supra note 46.

54. Marcia Coyle, Saying 'No' to Cancer Alley, NAT'L L.J., Sept. 21, 1992, at S5; Luke W. Cole, Empowerment as the Key to Environmental Protection: The Need for Environmental Poverty Law, 19 ECOLOGY L.Q. 619, 622 (1992). Not surprisingly, the Times Picayune of New Orleans was singled out for its pre-Bhopal coverage of chemical accidents. CHARLES RIVER ASSOCIATES, INC., supra note 30, at 42.


56. EVEREST, supra note 23, at 58-64.

57. See Cole, supra note 54, at 619-34.

58. See generally id.

59. Consider the strength of the reaction to Bhopal. For two full weeks, the unfolding tragedy was described on the front page of the New York Times. SHRIVASTAVA, supra note 49, at 75; see also Marc Galanter, Bhopals Past and Present: The Changing Legal Response to Mass Disaster, 10 WINDSOR Y.B. OF ACCESS TO JUST. 151, 169 (1990) ("Within the first two weeks, there were 39 network news stories about Bhopal on the three American TV networks." (citing Lee Wilkins)).
The public is known to be concerned about risks that have catastrophic potential, that are unfamiliar, uncontrollable, or involuntary, that threaten future generations, that would concentrate fatalities in time or space, that are distinctively threatening as opposed to widespread and shared by the general population, that are manmade as opposed to natural.60

The fear of being a chemical accident victim is a reasonable and predictable response to the type of harm chemical accidents pose. Sociologist Kai Erikson suggests toxic substances evoke strong reactions because of their insidious character.61 Unlike most physical threats, toxic substances are:

especially ghostlike and terrifying. Moreover, they invert the process by which disasters normally inflict harm. They do not charge in from outside and batter like a gust of wind or a wall of water. They slink in without warning, do no immediate damage so far as one can tell, and begin their deadly work from within—the very embodiment, it would seem, of stealth and treachery.62

The catastrophic potential of chemical accidents is a second particularly potent characteristic of dread risk. The possibility of the sudden disruption of many lives weighs heavily on the public's imagination. The public reacts more strongly to an event that causes many deaths concentrated in a narrow region of space and time than it does to the same number of deaths spread out in time and space. In part, this attitude reflects a common aversion to the inequity present when there are designated victims.63

60. Gillette & Krier, supra note 45, at 1073 (citations omitted). More succinctly, "'dread risk' is defined . . . by perceived lack of control, dread, catastrophic potential, fatal consequences and the inequitable distribution of risks and benefits." Paul Slovic, Perception of Risk, 236 SCIENCE 280, 283 (1987); see also Perrow, supra note 3, at 325-26.

61. "Maybe we should understand radioactive and other toxic substances as naturally loathsome, inherently insidious—horrors, like poison gas, that draw on something deeper in the human mind.” Kai Erikson, Toxic Reckoning: Business Faces a New Kind of Fear, HARV. BUS. REV., Jan.-Feb. 1990, at 118, 121; see also Perrow, supra note 3, at 316.

62. Erikson, supra note 61, at 122. The "treachery" has a biological basis. Toxic chemicals create a latent harm that may not manifest itself for many years after exposure. Talbot Page, A Generic View of Toxic Chemicals and Similar Risks, 7 ECOLOGY L.Q. 207, 222 (1978). During the latency period, the exposed victim lives with horrible uncertainty. The fear and uncertainty are a legally and politically cognizable harm. The tort system, the nation's principal method for compensating accident victims, for example, is struggling to recognize that fear as a real harm. Donald F. Pierce, Recovery for Increased Risk of Developing a Future Injury from Exposure to a Toxic Substance, 19 Envtl. L. Rep. (Envtl. L. Inst.) 10,256, 10,261-63 (1989) (discussing elements of actions for future toxic harm); see also Potter v. Firestone Tire & Rubber Co., 863 P.2d 795 (1993).

63. Hornstein, supra note 16, at 595-96 (reporting studies that find when subjects are given a choice, they strongly prefer risks distributed over a large group of people). In various ways the law embraces the bias against concentrated harms. It has been suggested that this bias is part of the origin of strict liability for ultra-hazardous activities. K.S. Shraeder-Frechet, RISK AND RATIONALITY 94 (1991). At least one government has chosen to set safety standards that impose proportionally (linear indifference curve on a log-log scale plot) greater
Any large accident has a "signal potential," an ability to be "perceived as a harbinger of further and possibly catastrophic mishaps." One chemical company executive described the way Bhopal fundamentally changed the industry's image: [A recent film, *The Killing of Bhopal,*] dramatically showed . . . what we might call the public's answer to all of our sophisticated risk assessments, risk probabilities, risk quantifications and public education programs on how safe our industry is . . . .

It showed doctors and nurses frantically trying to learn what had happened, to know how to treat the victims. It showed a mother describing how her baby died in her arms, choking to death. It showed a young wife who watched her husband die. It showed a 12-year-old boy who was the only survivor of his large family. For all our talk about the safety of chemicals, . . . these scenes from Bhopal are the end point of chemical risk. 

The bottom line of dread risk is that each accident creates social obstacles to progress. "[W]e have many reasons to suppose that toxic emergencies simply nourish dread, that they are, by their very nature, a thing of darkness and foreboding, and thus that over time, the fear may grow rather than diminish." The victim is never sure that the worst is over. In the most extreme cases, "the whole world has been revealed as a place of danger and numbing uncertainty." In short, catastrophic accidents undercut our confidence in technology itself.

Dread risk also has enormous monetary costs. These effects are perhaps seen most clearly in the response to a single accident. For example, immediately after the release at the Three Mile Island (TMI) nuclear power plant, 200,000 people evacuated the area. Pennsylvania Governor

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64. Slovic, *supra* note 60, at 284.


67. *Id.* at 124.

68. Ten weeks after Bhopal, one observer described the "mesmerizing fascination":

What truly grips us in these accounts is not so much the numbers as the spectacle of suddenly vanishing competence, of men utterly routed by technology, of fail-safe systems failing with a logic as inexorable as it was once—indeed, right up until that very moment—unforeseeable. And the spectacle haunts us because it seems to carry allegorical import, like the whispery omen of a hovering future.

*The Talk of the Town,* NEW YORKER, Feb. 18, 1985, at 29, 29. Smaller accidents can produce the same effects. *[D]isaster victims need not be of mythic proportions to lay claim on our attention.* Rabin, *supra* note 43, at 281.
Richard Thornburgh, in contrast, had recommended that only 3500 people do so. The public response to that single accident has been estimated to have cost up to half of a trillion dollars.

In sum, diverse ethical considerations, equity, inadequate compensation, social costs, and other indirect costs provide strong justifications for regulation. Moreover, because the costs of chemical accidents are diverse and generally incalculable, no meaningful quantitative assessment of the costs and benefits of regulation is possible. Even if fine-tuned analyses were possible, the results would be secondary to the fundamental consideration that freedom from chemical accident risk is a widespread priority. Toxic chemical accident programs should be designed to conform to common social needs and values, not the other way around.

C. Chemical Accident Prevention Regulation

Chemical accident prevention regulatory programs first emerged in Europe. In 1975, in response to the Flixborough disaster, a British administrative agency formed an advisory committee on major hazards. The Flixborough accident produced the "political will" for action. Similarly, the 1976 accident in Seveso, Italy drove the European Community (EC) to create the 1982 Seveso Directive, requiring

69. Erikson, supra note 61, at 118.
71. Environmental law "must be able to reflect and define our values, and not simply count how many of us will suffer." Hornstein, supra note 16, at 593.
73. See supra text accompanying note 27.
74. A.C. Barrell & P.J.C. Scott, The Regulatory Position—United Kingdom and Elsewhere, in HIGH RISK SAFETY TECHNOLOGY 15, 18 (A.E. Green ed., 1982). The Agency, the Health and Safety Executive, was created by, and acts under the authority of, the Health and Safety at Work etc. Act, 1974, Ch. 37 (Eng.), itself enacted in response to a Committee of Inquiry report chaired by Lord Robens. That Act recommended that special attention be given to major hazards. Barrell & Scott, supra, at 18.
76. See supra note 28 and accompanying text.
all EC Member States to adopt some form of CAP regulation. On an even broader international scale, the World Bank responded to Bhopal by establishing procedures to "evaluate the hazard which a development might represent to the people and environment outside its boundaries." Developing countries have also developed accident prevention programs.

In the United States, individual states acted first. In December 1985, the New Jersey legislature enacted the Toxic Catastrophe Prevention Act (the TCPA); California followed suit the following September. Two other states, Delaware and Nevada, also adopted programs prior to the federal mandate.

The Federal Government took a circuitous route to CAP regulation. In 1985, EPA began a voluntary effort, entitled the Chemical Emergency Preparedness Program, inviting chemical companies to focus on safety. In 1986, Congress added right-to-know provisions to the amendments of the Superfund legislation. Finally, in this time period, OSHA began working on a process safety rule.
The Federal Government did not commit itself to process safety regulation until 1990. The Clean Air Act Amendments of 199085 contain three principal features regulating chemical accident risk. First, EPA and OSHA must establish separate national chemical accident prevention regulatory programs.86 Second, the amendments direct the President to create a Chemical Safety and Hazard Investigation Board—modelled after the National Transportation Safety Board.87 Finally, they impose a "general duty" on chemical plant operators to prevent accidents.88 Although a regulatory requirement rather than a liability rule, the duty has the character of a negligence standard.89


86. Pub. L. No. 101-549, §§ 301, 304. The accident prevention provisions began as separate legislation but became § 112(r) of the CAA. 42 U.S.C. § 7412(r). See S. 816, 101st Cong., 2nd Sess. (1990); H.R. 2585, 101st Cong., 2nd Sess. (1990). Congress also held several oversight hearings on chemical accidents and worker safety, particularly following the Pasadena Texas explosion. See, e.g., Adequacy of OSHA Protections for Chemical Workers: Hearing Before the Subcomm. on Employment and Housing of the House Comm. on Government Operations, 101st Cong., 1st Sess. (1989). In an uncodified portion of the bill, Congress directed OSHA to finalize the rule it had begun years earlier. Pub. Law 101-549, § 304, 104 Stat. 2576, (1990); see also OSHA Process Safety Management of Highly Hazardous Chemicals 29 C.F.R. § 1910.119 (1993). The provisions concerning EPA became 42 U.S.C. § 7412(r)(7). See Risk Management Programs for Chemical Accident Release Prevention, 58 Fed. Reg. 54,190 (1993) (to be codified at 40 C.F.R. pt. 68). Congress did not give any clear indication of how the EPA program was to differ from the OSHA program. The final programs are likely to be quite similar. This is a stunning missed opportunity. The programs should complement each other—where OSHA’s minimal program applies to a broad range of facilities, EPA should develop an intensive program for high hazard facilities. Such a program would not only provide greater assurances of safety where they are most needed, the program itself would be a source of education. See infra Conclusion.


88. The duty is modelled after the OSHA general duty.

[Regulated facilities] have a general duty in the same manner and to the same extent as section 654, title 29 of the United States Code, to identify hazards which may result from such releases, using appropriate hazard assessment techniques, to design and maintain a safe facility taking such steps as are necessary to prevent releases, and to minimize the consequences of accidental releases which do occur.


89. The D.C. Circuit has accepted the following as the elements of a violation:

In order to establish a section 5(a)(1) violation, the Secretary must prove: (1) the employer failed to render its workplace free of a hazard, (2) the hazard was recognized either by the cited employer or generally within the employer’s industry, (3) the hazard was causing or likely to cause death or serious physical harm, and (4) there was a feasible means by which the employer could have eliminated or materially reduced the hazard.

International Union v. General Dynamics Land Sys. Div., 815 F.2d 1570, 1577 (D.C. Cir. 1987). Requiring the hazard to have been recognized in the industry and have a feasible
D. The Industry's Response to Bhopal

The American chemical industry also quickly responded to Bhopal. Industry first offered new promises, such as "safety first," "continuous improvement," and "total safety effort." These promises imply, and hopefully reflect, a fundamental commitment to chemical plants' workers and the surrounding communities. Industry also responded by funding safety research and institutes. The major American petrochemical industry trade groups initiated accident prevention research and advocacy programs. The Chemical Manufacturer's Association (the CMA) went as far as requiring its members to participate in its safety programs. The American Institute of Chemical Engineers created the Center for Chemical Process Safety to conduct research. The American Petroleum Institute, long active in industry standard setting, established Recommended Practice 750 concerning chemical process safety.

I. Chemical Process Safety

Prior to Bhopal, both public and private chemical engineering safety standards concerned the design and operation of individual parts of a chemical plant, rather than overall chemical process safety. After remediation is similar to the negligence standard that a reasonable (firm) would have taken greater caution. The general duty puts the strongest emphasis on the knowledge element. "Scienter is the Key." Id.

90. Cf. David T. Buzzelli, Restoring Public Confidence in the Safety of Chemical Plants, 9 PLANT/OPERATIONS PROGRESS 145, 146 (1990) ("It forced us to re-examine everything we do, everything we think we understand. We reviewed our processes critically as if we were designing them from scratch. We scrutinized every aspect of our operations, our procedures and our manufacturing practices. No step in our handling of chemicals could be taken for granted."). Mr. Buzzelli was a Dow Chemical executive and Chairman of the Canadian Chemical Producers' Association. There is an impressive humility in a total re-examination—as if the industry was willing to admit that everything that it had done thus far might be wrong. See supra note 7.

91. See, e.g., WILLIAMS, supra note 65, at 281-82 (1991) (discussing new approaches to plant safety).


93. Buzzelli, supra note 90, at 146.

94. AMERICAN PETROLEUM INSTITUTE, MANAGEMENT OF PROCESS HAZARDS: API RECOMMENDED PRACTICE 750 (1990) [hereinafter RP-750].

95. "Chemical process industries" is the trade term for the chemical manufacturing industries.

96. For instance, the American Petroleum Institute, among other groups, published countless standards concerning the thickness of pipes and vessels and the design of control equipment. See, e.g., OFFICE OF PRODUCT STANDARDS POLICY, NATIONAL BUREAU OF STANDARDS, STANDARDS ACTIVITIES OF ORGANIZATIONS IN THE U.S. (1988).
Bhopal, as OSHA neared completion of its chemical process safety standards, industry groups published overarching process safety standards. Key elements of these overall safety standards are plant safety information, standard operating procedures, training plans, management of change provisions, and hazard assessment protocols. The first three elements, described below, form management's protocol for operating the plant.

The plant safety information element consists of formal descriptions of the physical plant and definitions of the chemical processes. It specifies the conditions, temperature, and pressure of the process chemicals during normal operation. This element also includes descriptions of equipment tolerances and the nature of the hazardous chemicals.

The standard operating procedures element is an extension of the process safety information. "Documentation of normal operating conditions involves the development of operating procedures.... Operating procedures describe the tasks to be performed by the operator, instrument readings, data to be collected, samples to be taken, and operating conditions... to be maintained." Although the distinction is sometimes unclear, operating procedures and safety information are separate components of most, if not all, safety programs.

The training program element provides the means of implementing operating procedures. Effective training programs train plant opera-

97. It is frequently contended that such specific standards tend to distract workers and employers from general safety considerations. See, e.g., Job Safety Inadequately Emphasized: Former N.C. Official Tells State Conference, 21 O.S.H. Rep. (BNA) No. 49, at 1643 (May 13, 1992). In contrast, process oriented standards provide more comprehensive safety. Of course, the only truly effective safety measures are the reduction and elimination of toxic chemical use because as long as toxic chemical facilities exist, accidents will happen.


99. According to the CCPS:

   Process safety documentation should include the basic process knowledge and design considerations that form the foundation for facility design and operation. The first aspect of this documentation is the process definition..... The process definition should include the fundamental process chemistry and conceptual process flow configuration, including major steps or unit operations to the extent known.

   CCPS GUIDELINES, supra note 98, at 36-37 (1989). The safety information includes the fundamental chemical engineering documentation. See RP-750, supra note 94, at § 2; 29 C.F.R. § 1910.109(d) (1993); see also infra notes 158-62 and accompanying text (describing New Jersey's process safety information). Maintenance of the process safety information can also serve as an investigation of the plant.

100. CCPS GUIDELINES, supra note 98, at 40; see also RP-750, supra note 94, at § 5; 29 C.F.R. § 1910.109(f).

101. "Training should be provided for all personnel responsible for operating the facility in accord with their duties and responsibilities. Training should address the operating procedures....." RP-750, supra note 94, § 7; see CCPS GUIDELINES, supra note 98, at 105-10; 29
tors to implement maintenance protocols as well as operating goals. Training plays a profound role, not only in preparing plant operators to conduct specific tasks, but also in helping operators understand the plant as a whole and fostering a sense of community among plant operators.102

The management of change provisions emerged from a history of chemical accidents caused by unauthorized and ill-considered changes to the plant or its operating protocols. The Flixborough accident symbolizes the consequences of careless plant changes; operators thoughtlessly installed a short, poorly constructed bypass pipe and ignored several danger signs. Two months later the plant exploded, demolishing three houses and damaging over 1800 others.103 Accordingly, effective safety programs specify that "[a]ppropriate process hazards management systems should be in place to help ensure that hazards associated with a change are identified and controlled."104 Such management of change provisions require operators to consider and fully assess hazardous changes in plant design or operation.

2. Hazard Identification

At the core of every chemical process safety program is a hazard identification technique, also known as a hazard assessment, through which chemical engineers identify otherwise hidden hazards.105 Hazard identification is particularly essential because unanticipated scenarios often cause chemical accidents. The designers and managers of Union Carbide's plant in Bhopal did not anticipate that operators would flush water through methyl-isocyanate (MIC) transfer pipes when no slip blind (a physical barrier) protected the MIC storage tanks. They also failed to anticipate that metallic impurities would accumulate at the bottom of the MIC tank, catalyzing the reaction, and that both the scrubber system and the flare would be inactive.106 Such interaction of simultaneous failures is common to large accidents.107 Similarly, the designers and managers of Hoffman-LaRoche's plant at Seveso anticipated neither that operators would cool down the pentachlorophenol manufacturing pro-

C.F.R. § 1910.109(g).

102. See infra notes 333-39 and accompanying text.

103. PERROW, supra note 3, at 108-12; see also Deieso et al., supra note 40, at 439.

104. RP-750, supra note 94, at § 4.1. See CCPS GUIDELINES, supra note 98, at 73-83. Such provisions should also help localize responsibility within the corporate hierarchy and, thus, help ensure corporate responsibility for safety. See infra part III.C.3.

105. "OSHA believes that a process hazard analysis is the cornerstone of any effective program for managing hazards." 55 Fed. Reg. 29,514 (1990) (preamble to proposed rule on Process Safety Management). In general, the terms "chemical process hazard assessment" and "hazard assessment" are used to encompass both the hazard identification process and the hazard quantification process. In this comment, unless otherwise mentioned, "hazard assessment" refers to the hazard identification process exclusively.


107. See infra part III.A.
cess before the reaction was completed, nor that the operators would leave the reactive mixture unattended for the weekend while the tank contained volatile solvent.108

The simplest hazard identification techniques apply a standard set of questions to the particular system. For example, simple processes may be reviewed with a standard checklist covering issues such as materials compatibility, flow adequacy, and equipment safety ratings.109 More sophisticated techniques do not rely on mere lists, but on direct assessors to perform a structured and open-ended investigation.

A prominent hazard assessment technique is the hazard and operability study (HAZOP).110 It is a demanding technique which, for a large plant, can take a team several weeks to complete.111 The HAZOP technique combines systematic deliberation, brainstorming, and problem solving. The team systematically identifies all potential deviations from normal operations. Working with plant diagrams, team members look for valves, tanks, intersecting pipes, and other "nodes." At each node, the team hypothesizes possible deviations by applying "guide words" to "parameters." The parameters are chemical engineering quantities, such as flow, pressure, and temperature. The guide words are adjectives, such as, too much, too little, too high, too low, none, etc. For each node, the team identifies every possible unintended condition.

After identifying possible deviations, the team identifies the possible causes and consequences of each unintended condition. For example, after identifying the possibility that a particular pipe may become too hot, the HAZOP team tries to identify all the possible causes and consequences of the temperature rise. There are few guidelines for this brainstorming other than for the team to apply its collective expertise. In the end, the HAZOP technique produces a thorough list of significant risks and recommendations for reducing those risks.112

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108. REICH, supra note 28, at 102-04.
110. Chemists at Imperial Chemical Industries in England developed this approach in their own safety program and first described it in 1974. H.G. Lawley, Operability Studies and Hazard Analysis, CHEMICAL ENGINEERING PROGRESS, Apr. 1974, at 45; see also Gressel & Gideon, supra note 109, at 161-62.
111. Some team members should be intimately familiar with the process under study and at least one should be expert in the HAZOP procedure. It is gruelling work. A consultant who leads HAZOP teams reported that team members are warned to expect headaches at the end of each day. Interview with Ken Axe in San Francisco, Cal. (Mar. 27, 1992).
112. The actual HAZOP working documents for a moderate plant may be hundreds of pages thick. The HAZOP for the Chevron refinery in Richmond, California, occupies ten filing cabinets. Hearing, supra note 46, at 195 (response of Dr. Wendell Brunner, Contra Costa County). HAZOP practitioners have recognized from the beginning that completeness is the goal. "It should also be comprehensive and thorough, consider the abnormal and force out the obscure." Lawley, supra note 110, at 46.
CHEMICAL ACCIDENT PREVENTION

Hazard assessments generate knowledge essential to a chemical process safety program. The assessment reveals hazards that the larger program attempts to prevent. In contrast to traditional individual safety standards, chemical process safety standards form an interlocking whole. One industry representative, endorsing OSHA's program, emphasized the interaction of the various elements of the plan:

The proposed standard incorporates a series of interlocking, or intertwined, checks and balances which insure that high hazard plants are kept in the safe operating condition as intended when the plant was designed and built. . . . The proposed standard is a management system, not a collection of stand-alone provisions.114

E. The Regulatory Approach

Although the chemical industry has done much to promote chemical process safety, the public demands government assurances of safety.115 In the traditional approach to environmental protection, the government regulates individual points of hazard.116 Such an approach to regulating overall process safety, given the variety and complexity of chemical plants, would be impractical at best.117 Regulators have instead followed the industry's approach to process safety. Individual actions at

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113. Traditional chemical engineering safety involved compliance with individual design standards relating to the capacity and construction of individual pieces of equipment. Modern process safety incorporates these requirements in a holistic framework.
114. Raymond L. Brandes, Jr., Director, Safety and Industrial Hygiene, Statement (on behalf of ICI Americas) at OSHA Process Safety Management Workshop (Nov. 29, 1990). Brandes appears to take a systems view of plant safety.
115. "While industry has improved, and continues to improve, its prevention programs, the stakes are too high for compliance to be voluntary." MAJORITY STAFF OF THE SUBCOMM. ON OVERSIGHT & INVESTIGATIONS OF THE HOUSE COMM. ON NATURAL RESOURCES, 103RD CONG., 1ST SESS., LIVING WITH RISK: COMMUNITIES AND THE HAZARD OF INDUSTRIAL CONTAMINATION 37 (Comm. Print 5); see also Hearing, supra note 46.
117. See BARDACH & KAGAN, supra note 116, at 100 ("[F]ormal rules usually cannot be detailed enough to cover all the diverse hazards that emerge from technological changes and the accompanying patterns of human interaction."). Nonetheless, command and control regulation to prevent chemical accidents is not unheard of and could become more common. Regulations such as maximum vessel size are one possibility. More dramatically, the nation's premier air pollution control agency has banned the use of hydrogen fluoride because of the acute accident risk it presents. South Coast Air Quality Management District, Rule 1410 (Apr. 5, 1991). See George Hatch, AQMD Tries to Cut Risk of Leaks, L.A. TIMES, June 10, 1991, at A3. There have been prominent calls for EPA to adopt a similar rule. Panel Says EPA Should Revise Draft Report on Hydrogen Fluoride to Include Better Data, 23 Env't Rep. (BNA) 766, 766 (July 10, 1992).
a facility are dictated by one or more elements of the facility's process safety program. The regulators' role is not to specify the individual action but to oversee the development of the process safety program.\textsuperscript{118} This approach, and in particular the hazard assessment requirements, may be seen as a private regulatory approach to accident prevention.\textsuperscript{119} The regulatory agency oversees implementation of the safety program, but safe design and operation are ultimately the responsibility of plant operators.\textsuperscript{120}

Chemical process safety regulation is relatively new and presents many practical and theoretical problems. Agencies must hire appropriately qualified staff who will set an appropriate level of detail for the mandatory program elements and for their own review of the hazard assessments. Designers of CAP regulatory programs must also conceptualize the relationship between the regulators and the regulated. Each regulatory design choice has a significant impact on the effectiveness of the program and its public and private costs. Such choices are particularly difficult because the benefits of CAP regulation, though broadly definable, are difficult to quantify.\textsuperscript{121} Part II of this comment compares the programs of New Jersey and California to illustrate two relatively divergent paths that can be taken in designing CAP regulatory programs.

II
CHEMICAL ACCIDENT PREVENTION IN TWO STATES

In 1986, New Jersey enacted the Toxic Catastrophe Prevention Act (the TCPA).\textsuperscript{122} One year later, California enacted its Risk Management

\footnotesize{\textsuperscript{118} OSHA's general duty requirement was a step toward this approach. OSHA, in addition to enforcing hundreds of specifically promulgated standards, can enforce the facility's general duty to keep the workplace free from recognized hazards. 29 U.S.C. § 654 (1988); see also supra note 88 and accompanying text. The general duty is a substantive standard but does not include a requirement to seek out potential hazards. Id.}

\footnotesize{Other examples of this approach include California's illness and injury prevention program, whereby a wide range of employers must survey their operations and remove discoverable hazards. CAL. LAB. CODE § 6401.7 (West 1989). Similarly, many states require hazardous waste generators to conduct a broad survey of waste generating processes to identify minimization opportunities. See, e.g., CAL. HEALTH & SAFETY CODE § 25244 (West 1992).}

\footnotesize{\textsuperscript{119} Private regulatory approaches are designed to exploit the regulated entities as the front-line enforcement tool. See BARDACH & KAGAN, supra note 116, at 217-42. The requirement to have standard operating procedures is not itself a private regulatory approach. Rather, affirmative requirements to identify and mitigate undiscovered hazards shift the regulatory burden to industry.}

\footnotesize{\textsuperscript{120} Private regulatory approaches have a political content. First, they clarify that the burden of reducing hazards is on the regulated entity, not the government. Second, in the case of CAP regulation, they may be the tool by which government redefines the concept of the chemical plant. See infra part III.}

\footnotesize{\textsuperscript{121} See supra part I.B.}

\footnotesize{\textsuperscript{122} 1985 N.J. Laws ch. 403 (codified at N.J. STAT. ANN. §§ 13:1K-19 to -35 (West 1991)). Throughout the enactment process, this bill was known as the Bhopal bill. See sources cited in part II.A.1. In the public signing ceremony, Governor Thomas Kean chose instead to}
and Prevention Program (the RMPP). This part compares the processes leading up to each bill and the product of each act. Although both states have an extensive petrochemical industry and a history of innovative environmental protection, California and New Jersey followed different political and legislative paths when adopting CAP regulation. This part highlights key differences between the two CAP programs.

From the start, New Jersey’s political actors recognized the seriousness of chemical accidents. New Jersey’s legislative leaders, the Governor’s office, and the lead environmental agency all understood that the law they were crafting would profoundly affect New Jersey’s industry. Nevertheless, they resisted industry’s objections. In California, by contrast, few political actors strongly supported the proposed CAP bill and the enactment process was principally a series of retrenchments and compromises.

The substantive differences between the two programs are no less profound. Four overarching differences are striking. First, New Jersey implemented a centralized program administered by a state agency, while California dispersed authority to approximately 140 local agencies. Second, New Jersey committed itself to hiring experienced chemical engineers. Local agencies in California may make the same choice, but are not required to do so under their decentralized system. Third, New Jersey promulgated detailed standards establishing minimum safety thresholds. California did not. Finally, New Jersey’s regulators, unlike California’s, have clear authority to reject or modify a safety program, as well as to require adoption of specific safety elements. This comment argues for the path New Jersey took in designing its CAP regulatory program because it more effectively promotes systematic safety. While both programs adopted similar risk assessment approaches, there are key differences in the technical and administrative aspects of the programs.

A. New Jersey’s Toxic Catastrophe Prevention Act

In response to Bhopal, New Jersey embraced responsibility for preventing chemical accidents. Politically, several occurrences facilitated this response: An innovative legislator conceived of and crusaded for the...
program; New Jersey's aggressive environmental regulatory agency worked for the program; and, finally, the general political climate favored environmental action. The strongest factor, however, was the widespread perception, in the wake of Bhopal, that chemical accident risk was a problem for the state itself. This perception was fueled by a recent rash of chemical accidents and by the proximity of so many residents to chemical plants.

I. Political and Legislative Process

Less than four months after Bhopal, Assemblyman Byron Baer of Bergen, New Jersey, announced his intention to introduce the TCPA. It was the nation's first chemical accident prevention law and is still the nation's strongest. The striking aspects of the TCPA's adoption were the widespread support for the bill and the ineffectiveness of the opposition.

In 1985, New Jersey had a moderate Republican Governor who generally supported environmental causes and a chemical industry that was reeling from a series of stinging legislative defeats. Governor Kean had already presided over the adoption of some of the nation's strongest toxic substances control laws. The chemical industry fought these bills bitterly, but lost. The Worker and Community Right to Know Act, in particular, helped establish the philosophical underpinnings of the TCPA, by letting regulators into plants and giving them access to the manufacturing process. When industry lost in the legislature, it took the battle to the courts and lost again.

There were two additional backdrops to the Governor's and other politicians' support for strong CAP regulation. First, public opinion strongly favored better chemical accident prevention. In late 1984 and


126. One of the notable bills was The Environmental Cleanup and Responsibility Act (ECRA). N.J. STAT. ANN. §§ 13:1K-6 to -18 (West 1991). ECRA is a powerful law that requires industrial property owners wishing to sell their land either to demonstrate that the land is clean or to prepare a cleanup plan. In the latter case, the owner cannot sell the land until the state approves the plan. Industry opposition to ECRA was muted in part because of the attention industry gave to the Right To Know Act. Dennis J. Krumholz, ECRA: A Drama in One Act, N.J. LAW., Spring 1986, at 40, 40-41.


128. Interview with Mark Connelly, Section Chief, Environmental Section, Office of Legislative Services, (July 31, 1992). While the Right to Know Act wasn't the nation's first such law, it was probably the strongest. Leo H. Carney, Environews, N.Y. TIMES, July 3, 1983, § 11, at 19.

129. See generally Sharon Treat, The New Jersey Right to Know Act, 38 RUTGERS L. REV. 755, 768-75 (1986). The challengers succeeded in scaling back the law slightly. Id.
early 1985, New Jersey experienced a rash of chemical accidents, particularly in the Arthur Kill area in the northern part of the state.\textsuperscript{130} These accidents raised concerns about the health threats of chemical accidents.\textsuperscript{131} The sensitivity created by these accidents magnified the response to the Bhopal tragedy. One newspaper editorial emphasized the particular threat to New Jerseyites: "What are the lawmakers waiting for? Another Bhopal? \textit{In New Jersey, virtually none of us are so far removed from chemical facilities that we can afford to play that game, even if it were not an unconscionable toying with human life.}"\textsuperscript{132}

Second, New Jersey's environmental regulatory agency, the Department of Environmental Protection and Energy (DEPE),\textsuperscript{133} had long been concerned about chemical accident risk. The Agency began collecting information about toxic releases in the state in 1980.\textsuperscript{134} After Bhopal, DEPE took strong action. It announced its support for a pending bill that increased the notification requirements for accidental releases and sharply penalized notification failures. The Department's Commissioner, Robert Hughey, then summoned executives from forty large chemical companies and unambiguously warned them of the extreme consequences of future accidental releases: "I made it clear that the Department would take a hard line against companies which experienced repeated incidents of accidental chemical discharges. The executives were warned that they would be well-served by taking precautionary measures at their plants to prevent further releases into the atmosphere."\textsuperscript{135} Commissioner Hughey ordered two facilities to undergo ex-

\begin{footnotesize}
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  \item \textbf{130.} \textit{BUREAU OF RELEASE PREVENTION, N.J. DEP'T OF ENVTL. PROTECTION, BASIS AND BACKGROUND DOCUMENT FOR PROPOSED NEW RULE N.J.A.C. 7:31, TOXIC CATASTROPHE PREVENTION ACT PROGRAM 19-21, 23 (1987) [hereinafter BASIS & BACKGROUND]; Deieso et al., supra note 40, at 437.}
  \item \textbf{131.} The state assembly issued a one-house resolution, A. Res. 108, which requested that New Jersey's environmental regulatory agency study the public health consequences of the releases in the Arthur Kill area. Letter from Robert E. Hughey, Commissioner of the Department of Environmental Protection, to Assemblyman Alan J. Karcher (Sept. 10, 1985) (on file with author).
  \item \textbf{132.} Editorial, \textit{A New Look at Chemicals: Bhopal Disaster Easily Could Happen Here}, \textit{Asbury Park Press}, Mar. 19, 1985, at A18 (emphasis added); see also Editorial, \textit{Averting More Chemical Tragedies}, \textit{N.Y. TIMES}, Dec. 4, 1985, at A30 ("All the ingredients for another Bhopal are present, and the chances are worst in Northern New Jersey, where a quarter of the industry is concentrated.").
  \item \textbf{133.} During part of the time period discussed in this comment, the Department of Environmental Protection and Energy was known as the Department of Environmental Protection (DEP). See 2 \textit{PATRICK F. MCANDREW & SYDNEY V. STOLDT, N.J. LAND USE & ENVIRONMENTAL LAW} § 13 (1992). In the 1970's DEPE was primarily a natural resources agency. In the 1980's it undertook pollution regulation as well, partly in response to the Reagan era cutbacks at EPA. Interview with Mark Connelly, supra note 128.
  \item \textbf{134.} \textit{BASIS & BACKGROUND, supra note 130, at 14.} Compare this with the national situation where, as late as 1991, federal agencies employed, among other resources, newspapers to survey recent accidents. \textit{See Wright & Herron, supra note 35, at D4.}
  \item \textbf{135.} Letter from Robert E. Hughey to Alan J. Karcher, \textit{supra} note 131, at 2.
\end{enumerate}
\end{footnotesize}
tensive risk assessments, and the companies complied. These orders, based on the narrowest of authority, illustrate the vigor of the Department’s commitment to chemical process safety.

Against this background and on his own initiative, Baer introduced his bill. As introduced, the bill required DEPE to prepare guidelines for companies to follow in preparing a risk assessment. In his announcement, Baer acknowledged that “the bill represents a significant intrusion into the operations of private facilities,” but pointed to Bhopal and stated that the public interest in preventing harm to the people and industry of New Jersey “warrants governmental scrutiny.” The bill moved rapidly through the legislature and was adopted into law within ten months.

The bill had the strong support of DEPE throughout the legislative process. In addition, Governor Kean’s office supported the bill while it moved through the legislature. Environmentalists and labor unions also lent their support to the bill, but neither initiated or spearheaded...

136. The Commissioner later wrote to a legislator: “Absent passage of the Baer legislation, the Department has no clear authority to order preventative programs.” Nonetheless, “[my] response was to order both companies to submit ‘environmental accident risk assessments’... [including] procedures for prevention and control of accidental release of chemicals... [and] remedial action plans...” Id. at 2-4 (emphasis added). The Governor’s counsel wrote, “[a]t this point, the DEPE is acting without authority... and if this DEPE action was challenged in the courts, it is likely that the DEPE would be ordered to desist.” Memorandum from W. Cary Edwards, Chief Counsel, et al., to Governor Thomas H. Kean 11 (Dec. 13, 1985) [hereinafter Edwards Memo]. Presumably, in the months following Bhopal and the local leaks, the companies did not relish the publicity of challenging an order that required them to demonstrate that they were operating safely.

137. Telephone Interview with Assemblyman Byron Baer (Apr. 1, 1992). Baer identifies himself more as an innovator than as an environmental specialist. He links the TCPA to his accomplishments in landlord-tenant law and antidiscrimination law. Baer had read a “good bit” about the Three Mile Island nuclear accident, and Bhopal struck him as a similar failure of communication. Id.


140. Department of Environmental Protection, Testimony on the Baer Legislation (Oct. 10, 1985) (the testimony script, as found in the state archives, is attached to a summary statement dated October 10, 1985; however there is no independent information that the DEPE gave this testimony on that day) (on file with the author); Memorandum from Jane F. Kelly, (Governor’s) Assistant Counsel & Janice E. Mitchell, Deputy Assistant Counsel, to Assembly Board List, at 6 (Sept. 9, 1985) [hereinafter Kelly Memo]; Letter from Robert E. Hughey to Alan J. Karcher, supra note 131, at 6. The executive office memos discuss DEPE’s role in negotiating amendments to the bill. Perhaps because the legislation was introduced as more than one bill, the memos refer to the Department’s role in drafting the legislation; however, the Department probably participated from the beginning.

141. Kelly Memo, supra note 140, at 7. Kean himself approved a $500,000 appropriation (sponsored by Baer) for DEPE’s accident prevention efforts while TCPA was pending in the legislature. 1985 N.J. Laws ch. 403, § 15(a).
Moreover, Baer maintained close contact with both supporters and opponents of the bill.\textsuperscript{142} At two key moments, Baer took dramatic actions to keep the bill moving. First, in August, as the bill came up for a vote in the state assembly, Baer held a press conference in front of a chemical warehouse in the Ironbound section of Newark. Baer suggested that the evacuation, should there be an accident, would displace 200,000 people. His announcement received predictable press coverage.\textsuperscript{144} Later, inside the legislature, when a Republican assembly member introduced a hostile amendment, Baer abandoned the bill and introduced it again under a different number.\textsuperscript{145}

The bill’s industry opponents were, in a word, steamrolled. Industry groups started out firmly opposed to the bill.\textsuperscript{146} They negotiated some concessions, including one that allowed companies to collaborate with DEPE in developing site-specific workplans,\textsuperscript{147} one that required DEPE to consider a company’s existing risk management program before ordering the company to prepare an entirely new risk management program,\textsuperscript{148} and another that granted facilities specific appeal rights in the event that DEPE rejected a company’s existing plan.\textsuperscript{149} On this basis, one trade organization adopted a neutral position on the bill. Others still opposed the bill in silence.\textsuperscript{150} On January 8, 1986, Governor

\textsuperscript{142} Telephone Interview with Assemblyman Byron Baer, supra note 137; Telephone Interview with Jim Lanard, former Director for New Jersey Environmental Lobby (Mar. 31, 1992).

\textsuperscript{143} Edwards Memo, supra note 136, at 8.

\textsuperscript{144} See, e.g., Lucy Schulte, Lawmaker Seeks Toxic-Catastrophe Bill Backing, STAR LEDGER, Aug. 28, 1985. Baer cited this press conference as the turning point in the bill’s fortunes. Telephone Interview with Assemblyman Byron Baer, supra note 137.

\textsuperscript{145} Kelly Memo, supra note 140, at 5-6. The original bill was AB 3660 (1985); the memo discusses AB 4000 (1985). It appears that Baer had to pull this maneuver a second time: the final bill was AB 4145 (1985).

\textsuperscript{146} Kelly Memo, supra note 140, at 6.

\textsuperscript{147} The workplan is the mechanism by which companies without a safety program develop a safety program. See infra part III.A.2. The original bill had DEPE prepare a “scope of work project” without the participation of the facility operators. AB 3660 § 5 (May 6, 1985).

\textsuperscript{148} For a general description of industry’s victories, see Letter from James E. Benton, Executive Director, New Jersey Petroleum Council, to Jane Kelly, Assistant Counsel to Governor Kean (Nov. 25, 1985). See also Sullivan, supra note 139, at B2 (quoting Hal Bozarth, Executive Director, Chemical Industry Council of New Jersey).

\textsuperscript{149} The May version had no provision for review of a facility’s existing risk management plan. The review provision became N.J. STAT. ANN. § 13:1K-23; see Sullivan, supra note 139, at B2.

\textsuperscript{150} The appeal provisions were added by the Assembly on September 12, 1985. AB 4145 § 5.b. (Sept. 12, 1985).

\textsuperscript{150} Edwards Memo, supra note 136, at 9. The Petroleum Council, “attempting to be realistic,” did not try to stop the bill. \textit{Id.}
Kean, with Assemblyman Baer at his side, held a public ceremony and signed the Toxic Catastrophe Prevention Act into law.151

The TCPA had several things going for it. First, it had a committed sponsor who received special gratification from developing new programs. Second, it had the favor of a moderate Republican Governor. It was particularly helpful that the Governor had appointed an aggressive commissioner to run DEPE, an aggressive agency. Third and perhaps most importantly, at the time of adoption, chemical accidents were a salient concern to New Jerseyites. Throughout the process, various actors and commentators reiterated that New Jersey is small, has the nation's highest population density, and has an intensive chemical industry.152 These factors gave the TCPA tremendous momentum that carried over into its language and implementation.

2. The Act and Implementation—DEPE's Choices

As adopted, the core of the TCPA is the risk management program (the RMP).153 The eight elements of the RMP can be seen as a three-tiered approach to promoting safely. The first tier requires that the operator thoroughly characterize and understand the plant and its hazards. The second tier is a series of mandatory safety programs to ensure that the plant is operated safely. The third tier mandates that the plant monitor its own compliance with the Act.154

The TCPA's first characterization element, the annual safety review, precedes the hazard assessment. The plant operator must certify that the physical design of the plant and the operational characteristics are within design criteria.155 The operator must verify that the paper representa-

152. See supra note 132 and accompanying text; Kelly Memo, supra note 140, at 6 (citing Assistant Commissioner George Tyler); Telephone Interview with Assemblyman Byron Baer, supra note 137; Deieso et al., supra note 40, at 435-36; Urgency of Density, supra note 82. These concerns no doubt also contributed to the passage of the toxic chemical legislation that preceded TCPA. A similar combination of high population density and a substantial concentration of industry contributed to the adoption of the strong Dutch law on chemical accident prevention. OECD, Risk Assessment, supra note 27, at 46.
N.J. STAT. ANN. § 13:1K-21(i) (numbering of the eight elements added).
154. The discussion excludes the emergency response planning element of the RMP, which is not a part of prevention per se. There is some ambiguity in my categories. For example, the safety programs include routine inspections, which arguably are characterization efforts.
155. N.J. ADMIN. Code tit. 7, § 31-3.4 (1993). Sections 31-3.4(a) & (b) specify the re-
TABLE 1
COMPONENTS OF RISK MANAGEMENT PLANS

<table>
<thead>
<tr>
<th>Characterization Efforts</th>
<th>Safety Programs</th>
<th>Compliance Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Safety Review</td>
<td>Standard Operating Procedures</td>
<td>Annual RMP audit procedures</td>
</tr>
<tr>
<td>Hazard Assessment</td>
<td>Preventative Maintenance Program</td>
<td></td>
</tr>
<tr>
<td>Accident Investigation</td>
<td>Operator Training</td>
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<tr>
<td></td>
<td>Management of Change</td>
<td></td>
</tr>
</tbody>
</table>

Tions of the plant—the piping and instrumentation diagrams (P&ID’s), the one line electrical diagrams and the process flow diagrams—are up-to-date and reflect actual conditions.\(^{156}\) The operator must also determine, based on recent inspections, that the safety equipment matches design documents and is in working order.\(^{157}\)

The TCPA’s annual safety review is particularly stringent.\(^{158}\) In several places it directs the plant operator either to remedy unauthorized deviations “immediately” or remove the relevant equipment from operation until the deviations are repaired. If the annual review reveals that the plant deviates from the diagrams, the plant must be shut down until the discrepancies are removed according to the TCPA’s modification protocol.\(^{159}\) The regulations also require the operator to review actual “flow, temperature and pressure, process chemistry and materials feeds and specifications . . . to determine whether the actual conditions are within the limits of the design criteria.”\(^{160}\) Notably, the regulations require the operators to be interviewed.\(^{161}\) Finally, a report summarizing the safety review and any deviations must be given to the responsible manager.\(^{162}\)

\(^{156}\) Id. § 31-3.4(a).

\(^{157}\) Id. § 31-3.4(d)1. The process flow diagram is a standard engineering document that describes the chemistry and operation of the plant. It shows the flow of materials, basic control loops, and discharges, and includes or references details of material balance and operating conditions. Id. § 31-1.5.

\(^{158}\) Id. § 31-3.4(d)2. The safety devices must be tested regularly. Id. § 31-3.6(a)4, (d)5, 7.

\(^{159}\) Under the TCPA, updating the diagrams is a self-standing task. In contrast, the American Petroleum Institute (API) program allows facilities to update their diagrams as they conduct hazard assessments. RP-750, supra note 94, § 2.2.3. RP-750 requires updating only when the hazard assessments are updated, every three to ten years, id. § 3.4, or when the plant conducts an overall audit, every three to five years. Id. § 12.1. Refineries, it should be noted, are a relatively homogeneous group of facilities. OSHA, after debate in the notice and comment process, followed the API. 57 Fed. Reg. 6354, 6374 (1992).

\(^{160}\) N.J. ADMIN. CODE tit. 7, § 31-3.4(d)1. Safety devices and systems are also inspected, and any inoperable systems or devices must be immediately returned to operational status. Id. § 31-3.4(d)2.

\(^{161}\) Id. § 31-3.4(d)3.

\(^{162}\) Id. § 31-3.4(d)7.
Facilities must perform a hazard assessment every five years.\textsuperscript{163} DEPE has taken specific steps to try to ensure that the hazard assessment is thorough and investigatory: the regulations impose minimum qualifications on the hazard assessment team and require the facility to use one of four specified techniques or to seek DEPE's approval of a “systematic” alternative.\textsuperscript{164} The 1993 re-adoption of the TCPA regulations, however, embedded the hazard assessment in an elaborate risk assessment. After the team has identified points of possible releases, it must perform a dispersion/consequence analysis for a variety of releases.\textsuperscript{165} If the analysis for a particular release shows that the concentration at the facility boundary will exceed a specified threshold, the facility must perform an evaluation of possible state of the art mitigation measures for that release and develop a risk reduction plan.\textsuperscript{166} If the dispersion analysis shows that the release concentration at the facility boundary will exceed five times the threshold, the team must also develop an implementation schedule.\textsuperscript{167}

The final provision of the characterization tier is the mandatory accident investigation, a practice strongly endorsed by the engineering community.\textsuperscript{168} Accident investigation identifies “basic and contributory causes, either direct or indirect [and whether] the accident was caused by human error, a procedural inadequacy or equipment failure.”\textsuperscript{169} Accidents can be a powerful, although occasionally tragic, way to learn about the system’s behavior.

The TCPA’s second tier includes the intertwined elements of standard operating procedures (SOP’s) and training requirements, as well as requirements for preventative maintenance and management of change. Together these elements comprise a requirement that the plant be operated and maintained safely. The SOP must also include descriptions of potential abnormal conditions, procedures to return the plant to normal conditions, a description of emergency conditions and control procedures, and the procedures for starting up and shutting down the plant.\textsuperscript{170}

\textsuperscript{163} Id. § 31-3.9(b), (c); see supra part I.D.2.  
\textsuperscript{164} Id. § 31-3.9(c). The four techniques include a HAZOP, a Failure Mode and Effect Analysis, and two less demanding techniques.  
\textsuperscript{165} Id. § 31-3.9(d).  
\textsuperscript{166} Id. § 31-3.9(f). If the release is less likely than one in ten thousand per year, then the team need not perform the alternatives analysis.  
\textsuperscript{167} Id. § 31-3.9(e). The original regulations had a less elaborate risk assessment. The new protocol appears to be an attempt to respond to DEPE’s statutory mandate to “establish criteria or quantitative standards for determining risk.” N.J. Stat. Ann. § 13:1K-26(a). Earlier, DEPE had acknowledged that it couldn’t implement that section. Response to Comments, supra note 34, at 37, 104. While the new program requires significant investigation and therefore should build understanding, it may not serve the team-building purposes of safety regulation. See infra note 320.  
\textsuperscript{168} RP-750, supra note 94, §11.  
\textsuperscript{169} N.J. Admin. Code tit. 7, § 31-3.8(b)(6).  
\textsuperscript{170} Id. § 31-3.5(c). The operating procedures must also include maintenance procedures,
Operating procedures are implemented through specific training requirements. For each operator, the plant's management must prepare a written job description, a statement of the minimum qualifications for that position, and the training required. The training must cover the relevant portions of the standard operating procedure and, presumably, for personnel with maintenance responsibilities, the maintenance requirements. To ensure that training is effective, supervisors are further required to evaluate the operator's on-the-job abilities.

The plant must have a preventative maintenance program that addresses all extremely hazardous substances (EHS) equipment. Maintenance frequencies are determined by the design or standard criteria. Where such criteria are not available, the regulation establishes a minimum frequency. The preventative maintenance requirement also includes a basic management of change provision. The management of change provision is an attempt to ensure that unauthorized modifications are not made.

Once a year the facility must verify its compliance with all elements of the RMP. From the safety program perspective, this requirement seems redundant. As a regulatory requirement, however, it appropriately removes any ambiguity about the facility's obligation to monitor its safety provisions and again require the involvement of the responsible managers.

3. **DEPE's Regulatory Choices**

DEPE had the support it needed to make the critical regulatory choices essential to the TCPA's success. DEPE drafted the TCPA regulations with confidence because the legislature had passed the bill with near unanimous majorities and the Governor had publicly supported and signed it. Indeed, instead of rebuking DEPE for its earlier exercise of ungrounded regulatory authority, the Governor and legislature appropri-

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171. *Id.* § 31-3.7
172. *Id.* § 31-3.6. The program must include: "[l]dentification of all EHS equipment to be included in the preventative maintenance program." *Id.* § 31-3.6(a)1. Operators must inspect the inside as well as the outside of equipment. *Id.* § 31-3.6(a)3.
173. *Id.* § 31-3.6(a)4.
174. *Id.* § 31-3.6(a)4, 5, 7.
175. "[T]here shall be a written procedure insuring that only modifications approved and authorized by the responsible manager are made and that communications are maintained between the maintenance, production, safety and engineering departments." *Id.* § 31-3.6(a)2. The 1993 amendments to the regulations added written, more comprehensive, management of change requirements. *Id.* § 31-3.15.
176. *Id.* § 31-3.11. This provision includes a requirement that the elements are "updated . . . in compliance with the Act," although for several of the elements the regulation lacks specific update requirements.
177. *See supra* part II.A.1.
ated one million dollars so that the Agency could act in earnest. This was a strong endorsement for DEPE's approach and it acted accordingly.

Perhaps DEPE's most important regulatory choice was its approach to staffing. Recognizing the extreme complexity of its task, the Agency created a new civil service classification, which allowed it to hire experienced chemical engineers. This choice is widely regarded as the reason for the TCPA's positive reputation in New Jersey. Experienced chemical engineers wrote the TCPA regulations. Many of those regulations were taken from the practices of leading engineering firms and recast as regulatory requirements. Thus, the TCPA program in many ways resembles the industry programs it predated. Because of the engineers' experience and commitment, the RMP is a state of the art process safety plan.

The DEPE's second important regulatory choice was to assign itself a major role in reviewing facility safety programs. The statute clearly lays out two different regulatory tracts: One for facilities with an established (pre-existing) risk management plan; and one for facilities without an existing risk management plan. (See Figure 1.) As industry commentators read the statute, DEPE's role in the first category was to identify individual deficiencies, not to require wholesale revisions of the existing safety plans. DEPE narrowly read the statutory provisions recognizing existing safety programs. Instead of allowing cursory certification of existing safety programs, DEPE's regulations mandate that new and existing programs conform to its comprehensive program model.

179. One of the most common objections to environmental regulatory programs is that regulators are inexperienced. See, e.g., Marianne La Velle, Survey: General Counsel Face Environmental Toll, NAT'L J., Mar. 16, 1992, at S2, S4.
181. "The Bureau of Release Prevention has the best people in DEPE." Telephone Interview with Carla Israel, New Jersey Chemical Industry Council (Feb. 3, 1992); see also Telephone Interview with Gerry Poje, National Wildlife Federation (Feb. 5, 1992); Interviews with Reginald Baldini, Acting Chief, Bureau of Release Prevention, DEPE (series of conversations held between April 1992 and July 1993). See infra part III.C.2. for a more general discussion of the importance of this choice.
182. See Interviews with Reginald Baldini, supra note 181.
183. See supra part I.D.1-2 (describing industry safety programs).
186. The first listed comment to DEPE's regulations contends that the framers of the TCPA intended for "[c]ompanies already employing sound practices... to be left relatively unhindered, free to use and hone those skills, subject to adequate controls to avoid any backsliding. The proposed rule singularly fails to do this. The rules are inflexible and inordinately detailed in setting forth required practices and procedures." RESPONSE TO COMMENTS, supra note 34, at 2 (emphasis added). Similarly, "[t]he Act clearly mandates that attempts be made to address deficiencies... If a company has used an RMP in the past and commits to use it as required in the future, this should be adequate." Id. at 73.
187. N.J. ADMIN. CODE tit. 7, § 31-2.9(k)(2). Industry had anticipated that any compe-
DEPE defended its choice on the need to assure equitable enforcement.\textsuperscript{188}

\textbf{FIGURE 1}

NARROW READING OF STATUTORY FRAMEWORK

\begin{figure}
\centering
\begin{tikzpicture}
\node (start) [diamond, text width=2cm, text centered] {Established RMP \hspace{1cm} No RMP};
\node [align=center, below of=start, text width=2cm] {\textbf{Yes} \hspace{1cm} \textbf{No}};
\node [align=center, below of=start, text width=2cm] {Facility Has an Established RMP \hspace{1cm} \textbf{}};
\node [align=center, below of=start, text width=2cm] {Department Reviews RMP and Identifies Deficiencies \hspace{1cm} EHS Workplan Scenario};
\node [align=center, below of=start, text width=2cm] {Agreement to Repair Deficiencies \hspace{1cm} \textbf{}};
\node [align=center, below of=start, text width=2cm] {Yes \hspace{1cm} \textbf{}};
\node [align=center, below of=start, text width=2cm] {Consent Agreement \hspace{1cm} Adjudication if Necessary};
\node [align=center, below of=start, text width=2cm] {Administrative Order \hspace{1cm} \textbf{}};
\node [align=center, below of=start, text width=2cm] {Compliance and Acceptance of Facility's RMP \hspace{1cm} Adjudication if Necessary};
\node [align=center, below of=start, text width=2cm] {Compliance and Elimination of Hazards \hspace{1cm} \textbf{}};
\end{tikzpicture}
\end{figure}

The statute's second tract addresses facilities without an existing safety program and prescribes a workplan process. (See Figure 2.) Arguably, the goal of that process is to identify and mitigate individual risks, not to develop a safety program. Indeed, one of the remarkable features of the TCPA is that it enables the Department to order facilities to implement those risk reduction measures the Department deems necessary.\textsuperscript{189} DEPE, however, determined that the goal of the workplan is to develop a risk management plan.\textsuperscript{190}

\textsuperscript{188.} RESPONSE TO COMMENTS, supra note 34, at 15. More generally, DEPE approached its job with conviction. Throughout its response to comments, DEPE vigorously responded to objections.

\textsuperscript{189.} N.J. STAT. ANN. § 13:1K-26(a).

\textsuperscript{190.} "Although the Act does not specifically state it, one of its main goals is clearly to ensure that all registrants have an effective RMP. The purpose of the EHS risk reduction work plan, the EHSARA and the EHS risk reduction plan is clearly the development of an effective RMP . . . ." RESPONSE TO COMMENTS, supra note 34, at 78.
DEPE's interpretations have strong statutory support. First, the statute includes provisions that allow DEPE to send facilities with existing, but inadequate, safety programs through the second tract. Thus, the Department was not obliged to grandfather in existing programs. Second, as the Department suggested, the workplan as described in the statute places safety program elements on a par with the identification of individual hazards. Accordingly, the Department chose to have both tracts culminate in an RMP satisfactory to it. (See Figure 3.)

Although no single provision of the statute directed the Department to promulgate detailed standards for the RMP, it nonetheless did so. According to the Department, specific minimum standards were the "means necessary" for it to identify material deficiencies in the RMP's to determine equitably which facilities are being operated prudently. DEPE's commitment to comprehensive risk management plans complemented its conclusion that its own role was to scrutinize each risk management program.

There is no doubt that New Jersey adopted a demanding program. But it is equally striking that at virtually every turn, New

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191. The statute authorizes the Department to order facilities with existing safety programs to participate in the workplan sequence. N.J. STAT. ANN. § 13:1K-24 ("[T]he department shall [develop an EHS workplan] for each registered facility without a risk management program agreed upon by the facility owner and the department or subject to a consent agreement or administrative order entered into pursuant to section 5 of this act.").

192. For example, the workplan must address training and management practices, preventative maintenance practices, and other internal mechanisms to safeguard against accidents. Id. § 13:1K-24.

193. DEPE has a knack for assigning itself broad authority. "These rules shall be liberally construed to permit the Department to discharge its statutory function." N.J. ADMIN. CODE tit. 7, § 31-1.2. No analogous provision appears in the statute.

194. Nine pages of statute gave rise to 80 pages of regulations. For example, the written training program must include individual job descriptions, testing procedures, and minimum durations for initial and annual refresher training. The actual training must include the following: general orientation to the site and its safety features; classroom training on standard operating procedures and on the hazards present; and on-the-job training concerning equipment, data collection, startup and shutdown, operating conditions, and standard operating procedures. Id. § 31-3.7. These details add up to one and a half pages.

195. RESPONSE TO COMMENTS, supra note 34, at 15, 103.

Jersey's public officials embraced responsibility for chemical plant safety. They understood safety as their public duty. DEPE avoided the most obvious peril of this path, the potential for chemical process safety to be beyond its competence, by taking the necessary steps to hire experienced personnel. Finally, the program appears successful on two levels. First, it appears that the TCPA has reduced the incidence of chemical accidents in New Jersey.\textsuperscript{197} Second, there are reasons to believe that the TCPA's regulators enhance, not diminish, industry's own commitment to safety.\textsuperscript{198}

\textsuperscript{197} See \textit{infra} text accompanying note 212.
\textsuperscript{198} See \textit{infra} part III.C.2.
4. Evolution of the Program

The entrée to regulation under the TCPA is the list of extremely hazardous substances (the EHS's) and the associated registration quantities. A facility that handles, uses, manufactures, stores, or "has the capability to generate, within one hour" the registration quantity of an EHS must register with DEPE and enter the regulatory process. The statute itself lists eleven chemicals and directs DEPE to amend the list within eighteen months. The Department added ninety-three compounds. Not surprisingly, some commentators complained about the expansion. Compared to analogous programs, however, the TCPA regulatory universe is strikingly small.

In 1986, 628 facilities registered under the TCPA: 214 chemical plants, 234 wastewater plants, and 180 water treatment plants. Those numbers have been steadily dropping. By 1991, only 202 facilities were registered: 125 chemical plants, 51 wastewater plants, and 26 water treatment plants. The common explanation is that many facilities find it cheaper to reduce their inventories, or move, than to comply with the TCPA’s onerous provisions. By mid-1993, the total number of registrants was 137. However, DEPE estimates that the new EPA rule will require 1500 sites to be regulated under the TCPA.

199. N.J. ADMIN. CODE tit. 7, § 31-2.3.
200. Id. § 31-2.5(a).
201. N.J. STAT. ANN. § 13:1K-22. The two lists reflect Baer’s deliberate balancing of political and technical considerations. The earliest version of the legislation did not list any chemicals, relying entirely on regulation. AB 3660 (May 6, 1985). Industry objected to the uncertainty and Baer recognized the danger that the whole program could be delayed by litigation over the listing process. At the same time, he was skeptical of the legislature’s ability to make wise decisions around the edges and recognized that a detailed list in the statute would have created difficulties in the legislature. The two-tier structure was his compromise. Telephone Interview with Assemblyman Byron Baer, supra note 137.
202. RESPONSE TO COMMENTS, supra note 34, at 48.
203. DEPE Chart, Composition of TCPA Registrants in 1986 & 1991 (Feb. 1992) (on file with author). Wastewater and water treatment plants have been an important feature of the TCPA from its inception. Such facilities store large amounts of highly toxic chlorine gas.
204. Id.
205. DIV. OF ENVTL. QUALITY, N.J. DEP’T OF ENVTL. PROTECTION AND ENERGY, TOXIC CATASTROPHE PREVENTION ACT READOPTION RESPONSE TO COMMENTS, at 10 (June 18, 1993) [hereinafter READOPTION COMMENTS]. DEPE reports that “total registered EHS inventories in New Jersey have decreased from 64,000 tons to about 39,000 tons . . . .” Id. Reduced inventories improve plant safety but sometimes increase transportation of hazardous chemicals.
206. Id.

The comparison with California is also striking. California’s law potentially covers almost 6000 facilities. Local regulators plan to regulate approximately 2700 of them. See infra note 255. The two states have comparably sized chemical industries. New Jersey, however, has a greater number of large plants, while California has a greater number of small plants. See BUREAU OF THE CENSUS, U.S. DEP’T OF COMMERCE, COUNTY BUSINESS PATTERNS,
The small size of New Jersey's regulated universe may be an essential feature of the program's design. New Jersey regulators give each facility a substantial amount of time and may spend weeks working on a single, large facility. Such investment would be impractical for a larger number of facilities. Moreover, even with a small number of facilities, industry objects to the regulatory costs. The Department is under significant pressure from industry to justify the eight chemical engineers and eight to ten other scientists the program employs. The detailed RMP requirements create significant expenses for industry. The political opposition to those requirements would have been greater if the regulated universe was larger.

Has the TCPA been successful? DEPE seems pleased with it. The mandatory five-year readoption regulations stayed the course and were perhaps even stronger than their predecessors. The most dramatic changes included adding a separate management of change section and strengthening the risk assessment protocols. As importantly, the U.S. EPA believes that the New Jersey program is effective. EPA reports that there has been a twenty-seven percent reduction in accidental releases in New Jersey compared to the rest of the nation.

Industry itself has given the TCPA mixed reviews. Industry representatives generally credit the skill of the TCPA staff. However, some industry representatives doubt whether the program helps prevent a "Bhopal-type" event and generally resent the imposition.

The apparent success of the TCPA can be traced to the program's genesis. There would not be a well designed program without the will to adapt the civil service system and hire skilled staff. And if the program had seemed politically vulnerable, industry more likely would have invested its energy in fighting the rules, rather than adapting to them.

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208. Interviews with Reginald Baldini, supra note 181. For one large facility, six inspectors spent six weeks auditing the risk management plan. Inspection of a wastewater treatment plant RMP generally takes two people one or two days. CHEMICAL EMERGENCY PREPAREDNESS & PREVENTION OFFICE, U.S. ENVTL. PROTECTION AGENCY, CHEMICAL ACCIDENTAL RELEASES PREVENTION PROVISIONS, REPORT ON FOCUS GROUPS AND ROUNDTABLE DISCUSSIONS 21-22 (1992) [hereinafter EPA ROUNDTABLE].

209. READOPTION COMMENTS, supra note 205, at 12-14. The program is fee funded, so industry must pay for the Department's staff. N.J. ADMIN. CODE tit. 7, § 31-2.16(c)(1)(i).


211. Id. § 31-3.9.

212. 58 Fed. Reg. at 54,211.

213. Telephone Interview with Carla Israel, supra note 181, at 7-8; see also EPA ROUNDTABLE, supra note 208, at 7-8 (New Jersey participants found "knowledgeable regulators and seasoned inspectors, who knew their business and were primarily interested in educating and improving a facility's approach to reducing risk rather than imposing unreasonable fines.").

214. READOPTION COMMENTS, supra note 205, at 10. Some resentment is evident throughout the comments.
B. California’s Approach

While New Jersey enacted the TCPA as a strong response to its sense of hazard, California seemingly enacted its program as an instinctive reaction to the possibility of doing so. With neither a popular mandate, nor any real governmental commitment to CAP regulation, California’s bill resulted in a regulatory structure unconducive to promoting systematic safety.

I. Political and Legislative Process

In 1986, California’s legislature began considering adopting a chemical process safety program. The principle proponent of CAP regulation was Paul Donaghue, a young aide to Republican Assemblymember Marian LaFollette. Donaghue heard about the TCPA, and with the news of Bhopal still fresh, sought to import the legislation. Early in 1986, Donaghue obtained a copy of the TCPA, made minor modifications, and persuaded his boss to introduce it as Assembly Bill (AB) 3777. At the same time, leading environmental legislator Democratic Assemblymember Lloyd Connelly introduced a toxic air pollution bill containing CAP provisions. Industry was firmly opposed to both bills. When Connelly’s bill was in the Assembly Committee, Connelly decided to emphasize its air toxic provisions and removed the CAP provisions. Donaghue, fresh from law school and new to politics, began the process of negotiating with industry on adopting AB 3777.

AB 3777 was amended seven times before, with industry’s support, it passed out of the legislature and went to the Governor’s desk. In the process, AB 3777 lost many of the strong features it inherited from the TCPA. The very first amendment took away agency authority to write a facility’s risk reduction plan. The amendment not only took away substantive authority but sent a signal of a political inclination to create a weak program.

215. Interview with Paul Donaghue, Consumer Affairs Agency, in Sacramento, Cal. (Mar. 13, 1992). In part the changes were a response to the concentration in California of smaller chemical plants. Id.; see supra note 207 and accompanying text for a discussion of the relative chemical industries of the two states. LaFollette introduced AB 3777 on February 21, 1986.
216. Interview with Paul Donaghue, supra note 215. Connelly’s bill was AB 4001 (1986).
217. Interview with Paul Donaghue, supra note 215. Connelly fought for his air toxics bill for several years. It was finally adopted as AB 2588. 1987 Cal. Stat. ch. 1252 (codified at CAL. HEALTH & SAFETY CODE § 44300 (West Supp. 1994)).
219. Compare AB 3777 (Feb. 21, 1986) with AB 3777 (Apr. 21, 1986). The amendment not only took away substantive authority but sent a signal of a political inclination to create a weak program.
220. AB 3777 (Apr. 21, 1986). The state now has no direct administrative or enforcement authority under the Act. The program is run by approximately 140 local agencies.
Later amendments removed the state’s obligation to write regulations and generally obscured the hazard assessment requirements.

AB 3777 lost many of its strong features for several reasons. In the mid-1980’s, California’s environmentalists were generally frustrated. The Republican Governor had a deep antipathy for environmental programs. The legislature had become ever more factionalized and gridlocked. Out of frustration, environmentalists learned to bypass the legislature and legislate by popular initiative. In this context, a strong CAP program, with its implicit intrusion into the facility, would have been an unlikely accomplishment.

Another obstacle to strong CAP regulation in California stemmed from the fact that California had no department of environmental protection and, consequently, no obvious home for the program. The first draft of AB 3777 gave regulatory authority to the Department of Health Services (the DHS), an Agency charged with regulating hazardous waste. The second draft gave regulatory authority to local agencies and moved state oversight to the Office of Emergency Services (OES). In the end, the DHS had no role in the program. The choice taken, granting authority to local agencies with OES oversight, was detrimental for two reasons. First, at the state and local level, the regulatory program was merged with, and competed with, the emergency response program. Second, OES was not primarily a regulatory agency.

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221. Id. It was clear to Donaghue that the bill would never pass if the RMPP’s were mandatory. Interview with Paul Donaghue, supra note 215.
225. The most notable initiatives were Proposition 65 (the Safe Drinking Water Act), several large bond acts, and eventually, the omnibus environmentalist proposition, Big Green. Id.
226. In 1986, at least five separate state agencies had primary responsibility for some major pollution program. In 1991, they were put under a single roof, the California Environmental Protection Agency. See Chief of EPA Enforcement Office Will Resign to Head New California Environmental Agency, 21 Env’t Rep. (BNA) 1735 (Feb. 1, 1991).
227. AB 3777 (Feb. 21, 1986). At the time the DHS was in substantial disrepute. James Sweeney, Rebirth of the State’s Toxic Clean-up Program?, 18 CAL. J. 588 (1987).
228. AB 3777 (Apr. 21, 1986). The DHS’s environmental mandate was restricted to hazardous waste; providing it any formal responsibility under AB 3777 would have been a major expansion of responsibility.
Moreover, in contrast to DEPE’s support for the TCPA, OES opposed AB 3777. Because of state constitutional limits on spending, new state programs directly competed with existing programs for funding.\textsuperscript{230} OES was already struggling with its substantial responsibilities under the state’s community right-to-know and emergency response program, to review area emergency response plans and write regulations.\textsuperscript{231} Seeing AB 3777 as more responsibility and burden without more resources, OES urged the Governor to veto the bill.\textsuperscript{232}

Local agencies faced the same problem of competing priorities. Responding to constitutional spending limits, California policymakers learned to delegate state programs to local agencies.\textsuperscript{233} Thus, the state hid fiscal needs rather than resolving them. At one point in the AB 3777 adoption process, even the Democratic Senate committee consultant expressed concern that the administrative agencies could not implement this program so quickly on the heels of the 1985 emergency response bill.\textsuperscript{234} It has taken many years for local agencies to begin implementing the program.

California’s failure to produce CAP regulation more like the TCPA is somewhat surprising. California is, after all, an environmental leader.\textsuperscript{235} Moreover, California experienced almost 1200 toxic chemical fires in 1984.\textsuperscript{236} Yet, perhaps because the state is so spread out, Californians did not see chemical accidents as the common threat New Jerseyites did. Thus, even with a less obdurate governor and a less gridlocked legislature, California might not have felt the same drive as New Jersey to adopt strong CAP regulation.

2. The Act and Its Implementation

On the surface, California’s current CAP program is similar to New Jersey’s.\textsuperscript{237} Companies handling a listed chemical in an amount greater than DEPE’s support for the TCPA, OES opposed AB 3777. Because of state constitutional limits on spending, new state programs directly competed with existing programs for funding.\textsuperscript{230} OES was already struggling with its substantial responsibilities under the state’s community right-to-know and emergency response program, to review area emergency response plans and write regulations.\textsuperscript{231} Seeing AB 3777 as more responsibility and burden without more resources, OES urged the Governor to veto the bill.\textsuperscript{232}

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than the threshold quantity are subject to regulation.\textsuperscript{238} The regulatory agency must then determine if specific risks rise to the threshold risk level.\textsuperscript{239} The three tiers of the RMP are discernable in the RMPP; they include an assessment requirement,\textsuperscript{240} a safety program requirement,\textsuperscript{241} and compliance verification protocols.\textsuperscript{242} In most respects, however, the structure of the two programs is strikingly different.

Companies handling threshold quantities of acutely hazardous materials (AHM's) must register with the local administering agency (the AA).\textsuperscript{243} The legislature, however, has sent the agencies mixed signals about the program's priorities. Almost every other year, the legislature changed the criteria by which the AA's determine if individual facilities are required to prepare an RMPP.\textsuperscript{244} Currently, the AA determines which facilities pose an AHM accident risk and requires those that do to prepare RMPP's.\textsuperscript{245} The AA must address the most hazardous facilities first.\textsuperscript{246} A facility must prepare an RMPP within twelve months after the AA requests one.\textsuperscript{247}

The statutory description of the RMPP is terse and fundamentally ambiguous.\textsuperscript{248} California, like New Jersey, defines the RMPP to be all of

\begin{itemize}
  \item The RMPP law regulates "acutely hazardous materials." The list and threshold quantities are taken from EPA's list of "extremely hazardous substances." \textsuperscript{238} CAL. HEALTH \& SAFETY CODE §§ 25532(a), 25536 (West 1992). California's definition of AHM accident risk, \textsuperscript{239} id. at 25532(b), is identical to New Jersey's definition of extraordinary hazardous accident risk. \textsuperscript{240} N.J. STAT. ANN. § 13:1K-21(a) (West 1991). \textsuperscript{241} Id. § 25534(a), (d). \textsuperscript{242} Id. § 25534(d). The hazard assessment must be a HAZOP. The statute also requires an off-site consequence analysis (OSCA) for identified hazards. The statute does not appear to require that the OSCA include a calculation of the likelihood of release. The HAZOP and OSCA are not formally part of the RMPP, but rather are background to it. \textsuperscript{244} Id. \textsuperscript{245} Id. § 25534(a)(1). The AA has the discretion to require RMPP's from other facilities. \textsuperscript{246} Id. § 25534(a)(2). \textsuperscript{247} Id. § 25534(b). \textsuperscript{248} Id. § 25534(c).
\end{itemize}

The brevity would not be so remarkable if there were accompanying regulations. The statute's entire substantive content follows:

The RMPP shall be prepared within 12 months following the request made by the administering agency pursuant to this section. The RMPP shall include all of the following elements:

1. A description of each accident involving acutely hazardous materials which has occurred at the business or facility within three years from the date of the request made pursuant to subdivision (a), together with a description of the underlying causes of the accident and the measures taken, if any, to avoid a recurrence of a similar accident.
2. A report specifying the nature, age, and condition of the equipment used to handle acutely hazardous materials at the business or facility and any schedules for testing and maintenance.
3. Design, operating, and maintenance controls which minimize the risk of an accident involving acutely hazardous materials.
a company’s programs contributing to chemical process safety.\textsuperscript{249} However, wording in AB 3777 suggests that the RMPP is a document rather than a safety program.\textsuperscript{250} Nothing in the statute or OES’s guidance document resolves the ambiguity or strongly suggests that local agencies are required to formulate a minimum safety program.\textsuperscript{251} The only clear obligation is that facilities must improve whatever safety program they already have in place. The absence of a legislative mandate for minimum safety levels is mirrored by the lack of agency authority to issue regulations clarifying the scope of a minimum safety program.\textsuperscript{252}

The ambiguity in the character of the RMPP is further compounded by an ambiguity in the AA’s authority to reject or modify an inadequate RMPP. While the statute allows the local agencies to review and reject an RMPP,\textsuperscript{253} it gives no indication of what standards the agency should use.\textsuperscript{254} The absence of both a clear delegation of authority and clear standards inevitably constrains agency action.

\begin{itemize}
\item (4) Detection, monitoring, or automatic control systems to minimize potential acutely hazardous materials accident risks.
\item (5) A schedule for implementing additional steps to be taken by the business, in response to the findings of the assessment performed pursuant to subdivision (d), to reduce the risk of an accident involving acutely hazardous materials. These actions may include any of the following:
\begin{itemize}
\item (A) Installation of alarm, detection, monitoring, or automatic control devices.
\item (B) Equipment modifications, repairs, or additions.
\item (C) Changes in the operations, procedures, maintenance schedules, or facility design.
\end{itemize}
\item (6) Auditing and inspection programs designed to allow the handler to confirm that the RMPP is effectively carried out.
\item (7) Recordkeeping procedures for the RMPP.
\end{itemize}

\textit{Id.} § 25534(c). The HAZOP and OSCA requirements are in § 25534(d).

\textsuperscript{249} Compare \textit{id.} § 25532(g) with N.J. \textsc{stat. ann.} § 13:1K-21(i). The statutory definitions are virtually identical.

\textsuperscript{250} \textsc{cal. health \\& safety code} § 25534(c). Paragraphs (1), (2), and (5) are primarily document like. In other words, whereas New Jersey’s RMP is a program that includes operating and reporting requirements, the California statute sometimes suggests that the RMPP is itself a report. See, e.g., \textit{id.} § 25535.2 (public review of the RMPP).

\textsuperscript{251} \textsc{hazardous material division, california office of emergency services, rmpp: guidance for the preparation of a risk management and prevention program} 2 (1989) (referring both to the RMPP document and the RMPP program and discussing how a facility “develops” an RMPP).

\textsuperscript{252} Under the statute, the OES has authority only to issue regulations regarding the registration form. \textsc{cal. health \\& safety code} § 25533(b).

\textsuperscript{253} “\textit{An owner or operator . . . shall submit the RMPP to the administering agency after the RMPP is certified as complete by a qualified person and the facility operator. . . . \textit{[If] the administering agency determines that the handler’s RMPP is deficient in any way, the administering agency shall notify the handler of these defects. The handler shall submit a corrected RMPP . . . .\textit{ Id.} § 25535(a).}

\textsuperscript{254} The exception is the HAZOP requirement that must be done pursuant to CCPS guidelines. Those guidelines, however, were also written in a general way. Even so, the administering agency has only indirect authority to review and reject the hazard assessment.
3. Evolution of the Program

In essence, California has 134 separately administered chemical process safety programs that encompass a large universe of regulated entities. These 134 administering agencies report that there are over 6600 facilities that use AHM’s. However, at the end of 1992, six years after the bill was enacted, only 291 RMPP’s were complete. Inevitably, in such a dispersed program, there is tremendous variation in implementation. Indeed it may be impossible to make an overall summary of the program’s effectiveness.

In one sense the variation in implementation is overstated. A significant portion of the chemical industry is located in the jurisdiction of three administering agencies: those of Contra Costa County, Los Angeles County, and Los Angeles City. Each of these agencies has developed a more demanding program than the state requires. Nonetheless, Contra Costa County’s program, perhaps the most progressive in the state, illustrates the limits of local programs. Contra Costa County, like New Jersey, has hired experienced chemical engineers, but these engineers are contract employees. The county has not made the investment of a new civil service category. Similarly, although the county has published its own RMPP guidelines, based on the petroleum industry’s RP-750, these nonbinding guidelines were not formally promulgated are not as demanding as the TCPA regulations. The net result is that although Contra Costa County has committed skilled regulators, the program does not convey the permanence and governmental commitment that a state-wide program could.

At the state level, the RMPP program seems unstable. Since adopting the RMPP Act in 1986, the California Legislature has amended it

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255. Hazardous Materials Division, California Office of Emergency Services, 1992 Program Implementation Survey of Administering Agencies, attachment 2 (1993). The agencies reported that they intended to require approximately 2700 facilities to complete RMPP’s. Id. The EPA rule takes the choice out of their hands.

256. Id. This number is close to the number of facilities regulated under the TCPA. See supra part II.A.4.

257. Risk Management Programs for Chemical Accident Release Prevention, 58 Fed. Reg. 54,190, 54,205 (1993) (to be codified at 40 C.F.R. pt. 68) (“Because the California rules are more general and because different administering agencies have interpreted the requirements differently, it is not possible to determine, except on a case-by-case basis, to what extent a California facility will be in compliance with EPA’s rule.”).

258. Of the 57,000 chemical industry employees in California, 24,000 are located in Los Angeles County and 3000 are located in Contra Costa County. Of the state’s 15,000 petroleum refining employees, 8000 are located in Los Angeles County and 4000 are located in Contra Costa County. Bureau of the Census, supra note 207, at Table 2.

259. Interview with Sandra Hollenbeck, RMPP Coordinator, in Contra Costa County (Apr. 2, 1992).

260. However, these engineers are broadly recognized as county employees.

261. Interview with Sandra Hollenbeck, supra note 259.
nine times.\textsuperscript{262} In 1991, Assemblyman Dave Elder, representing the Southern California refinery district, created a worker and chemical process safety program that significantly supplants the RMPP in chemical plants and refineries.\textsuperscript{263} Finally, the 1993 sulfuric acid release in Richmond caught the attention of the entire state.\textsuperscript{264} Among the results of this accident, the legislature and Governor granted some authority over the RMPP program to the California Environmental Protection Agency, close to where Paul Donaghue had initially lodged it.\textsuperscript{265}

\section*{C. Approaches to Process Safety Regulation}

New Jersey and California developed very different chemical accident prevention programs. Three differences stand out. First, New Jersey designed a centralized program, while California chose decentralization. Second, New Jersey enacted detailed requirements, while California decided to rest with general requirements. Finally, the New Jersey Legislature granted the implementing agency specific authority over the process, while the California legislature granted only vague authority. In short, New Jersey chose to invest in and take responsibility for chemical accident prevention, while California did not.

These choices were made deliberately. The differences are not merely the happenstance of last minute legislative decisionmaking. In New Jersey, there was a near consensus on the need for a strong program. The elected officials chose to endorse the aggressive approach already taken by the regulatory agency. In California, there was an apparently well-meaning decision to enact a program, but there was no consensus that chemical accident prevention was a priority for the state.

To the extent that the goal is solely to prevent accidents, it will be difficult to tell if New Jersey's aggressive approach is worth the costs. Preliminary indications suggest that the TCPA does reduce the frequency of accidents.\textsuperscript{266} But there is a tremendous variety of chemical plants and accidents; short-term statistics may prove unreliable.


\textsuperscript{264} One commentator linked this accident with other evidence of the "decline" of California, evidence that he rejected. Rob Morse, The Cloud Over California, S.F. Examiner, July 27, 1993, at A3.


\textsuperscript{266} See supra note 212 and accompanying text.
Fortunately, we can look at New Jersey's choices, and chemical process safety generally, from another point of view—the system's view. At the heart of every chemical plant, and of every chemical accident, are the organizations that run the plant: the corporation itself, the plant managers and designers, the teams of operators, and their supervisors. There are many groups of people involved. The road to chemical accident prevention is to ensure that those groups function well. The next section elaborates the systems view of chemical plants and argues that New Jersey's choices promise improved organization and greater safety.

III
GOALS OF REGULATION—WHAT MAKES CHEMICAL PLANTS SAFE

Part I of this comment introduced basic chemical engineering standards and suggested that the emerging approach to chemical process safety involves systems management. This part further describes the importance of systems and organizational factors in chemical process safety. These considerations, as well as chemical engineering practice, should inform the design and operation of regulatory programs. This part also revisits the features of California's and New Jersey's CAP programs in light of systems management.

Many elements of the CAP programs in both California and New Jersey promote a disaggregated view of a chemical plant. For example, consider the elements of the TCPA's RMP discussed above: The training programs are designed to train individual plant operators; the hazard assessments identify individual hazards; even the standard operating procedures can be seen as a collection of individual steps. Chemical plants are thus commonly approached as collections of discrete machines operated by individuals. Under this view, safety is a matter of carefully carrying out each individual step. A more complete view, however, sees the plant as a system with technological subsystems as well as human subsystems. Chemical plant behavior depends on the collective as well as the individual responses of operators. Accordingly, the systems view of chemical plant operation focuses both on causes of chemical accidents and on opportunities to enhance safety through improved organizational interaction.

267. Najmedin Meshkati, Human Factors in Large-Scale Technological Systems' Accidents: Three Mile Island, Bhopal, Chernobyl, 5 INDUS. CRISIS Q. 133, 138 (1991); see also Perrow, supra note 3, at 351 ("The main point... is to see these human constructions as systems, not as collections of individuals or representatives of ideology.").

Consider also the example of shipbuilders. No one is a shipbuilder. In a shipyard there are "welders, carpenters, foremen, engineers and many other specialists, but no shipbuilders." Only the system is the shipbuilder. Karl E. Weick, Organizational Culture as a Source of High Reliability, 29 CAL. MGMT. REV. 112, 120 (1987) (quoting John Gall).
A. Chemical Accidents as Normal Accidents

Chemical accidents are frequently understood to have specific initiating steps. Generally, however, each "initiating" step may be traced to the larger operation of the plant. For example, while operator error is a common explanation for accidents, some errors occur because the operators at steady state plants have few demands placed on them in normal operations and are lulled into a sense of complacency. Operator responses, while situation-specific, depend on larger operational considerations such as operator skills and training levels, plant design, and decisionmaking authority. Similarly, the failure of a particular valve or node in a plant, another possible initiating step, seems at first to be a discrete event unrelated to the larger system. However, failure rates of discrete nodes are strongly influenced by a plant's operational history, how aging has affected the plant, and whether the plant has been operated and maintained properly. Finally, even external initiating steps cannot be wholly isolated from the larger operation: terrorists, earthquakes, and floods should be expected and prepared for. In short, the cause of an accident is not some mythical first step, but the plant itself.

Chemical plants are complex systems. Each part of the system interacts with several other parts. These interactions may be a feature

268. Engineers often model possible accidents by forming event trees. An event tree begins with a particular mishap or first cause and examines possible consequences. See generally Karl E. Weick, Mental Models of High Reliability Systems, 3 INDUS. CRISIS Q. 127 (1989) (discussing the first cause model).

269. This explanation, however, is often unreasonably made. See Tombs, supra note 36 (arguing against the ideology that chemical plant accidents are usually caused by "accident-prone" workers).

270. Similarly, nuclear power plant operators complain of excruciating boredom, of having to concentrate for five hours "on nothing happening." Weick, supra note 267, at 118; see also Weick, supra note 268, at 128-29 (describing the special safety hazards of continuous systems).


272. "Pierce Nye, the man who crashed a car into the Three Mile Island nuclear power plant and hid inside for four hours Sunday, was mentally ill and should not have been allowed on the street, family members said yesterday." Andrew Smith, TMI Crasher Called Mentally Ill, NEWSDAY, Feb. 9, 1993, at 17. The incident led the nuclear plant's operators to create a public alert designed for events that "involve actual or likely major failures of plant functions." Andrew Smith, 'Emergency' Status Rare, NEWSDAY, Feb. 8, 1993, at 3. It is also noteworthy that soon after the Bhopal tragedy, Union Carbide found sabotage to be a more likely explanation than operator or equipment failure. It wasn't true, but the incident illustrates industry's tendency to deflect attention from systematic causes of accidents.

273. Some estimate that individual chemical plants can be even more complex than nuclear power plants. Linnerooth-Bayer & Wahlström, supra note 271, at 243; OECD, RISK ASSESSMENT, supra note 27, at 48-49.

274. Charles Perrow distinguishes complex interactions from linear interactions, where each item interacts with at most two other items. Perrow, supra note 3, at 72-89.
of deliberate and efficient design, or may result from the physical proximity of otherwise unrelated components. This complexity increases the likelihood of accidents. Even well-operated plants are subject to small missteps that may escalate into tragic releases. Errors made in maintenance procedures, for example, may lie dormant until other errors emerge during routine operation. Major accidents, thus, are not generally the result of a single error but of many coincidental faults and abnormal conditions.

Complexity, moreover, may prevent effective responses to deviations from normal. When things go wrong, operators must intervene without making the system worse. Under routine conditions, operators apply basic skills to operate the plant. In emergency situations, however, operators must anticipate emerging problems in the face of incomplete information. As the plant deviates from normal, operators must make sophisticated and informed inferences about the state of the facility. Ideally, the operators will be able to identify the state of the system and apply particular rules to return the system to normal. Training and simulations can prepare the operators to respond to such situations. But if the situation is truly unfamiliar, the operators must rely on knowledge of the system rather than particular skills to predict and respond to emerging plant conditions. Complexity both increases the number of possible deviations, thereby increasing the training burden even for small deviations, and makes predicting plant behavior more difficult.

275. For example, a single source of chemicals or energy in a plant may supply several subsystems. If an occurrence in one subsystem forces the supply to shut down, all connected sub-systems will be affected. Valves or other barriers to protect the supply from the first system are no guarantee, since those valves may fail to operate. See id. at 72-73 (describing "common mode" failures).

276. For example, a gas release from one pipe might change the temperature of a nearby pipeline. Alternatively, due to proximity, it may be impossible to repair one unit without impacting the second unit.

277. Jens Rasmussen, Human Factors in High Risk Technology, in HIGH RISK SAFETY TECHNOLOGY, supra note 74, at 143, 144-47.

278. Id. at 152. Charles Perrow began Normal Accidents with a personal account of this phenomenon. PERROW, supra note 3, at 1.

279. Rasmussen, supra note 277, at 146. Similarly, operators must be exceptionally well informed at startup and shutdown.

280. Id. at 158-59.

281. However, simulations present their own risks. If the simulation is not precise, operators may learn to expect the plant to respond in ways that it will not. See Weick, supra note 267, at 113-14.

282. Rasmussen, supra note 277, at 158-64.

The operator's passive role, however, changes to one of active involvement in cases of unexpected systems events, emergencies, alerts, and system failures. Moreover, operators of these systems, faced with the system's inherent opacity and decision uncertainty, are working in a centralized location (e.g., control room), sharing and exchanging data, collectively analyzing information and making decisions.

Meshkati, supra note 267, at 137.
Whether an individual misstep or a succession of missteps leads to an accidental release or other uncontrolled situation depends on another characteristic of a system—"tight coupling." Chemical plant systems are often tightly coupled in the sense that there is no slack or buffer between connected items: "What happens in one directly affects what happens in the other." Disturbances quickly propagate through tightly coupled systems. The system changes rapidly, response times are short, and make-shift substitutions are ineffective. Because disturbances propagate quickly and again because of complexity, operators are unlikely to recognize the total set of consequences and take appropriate action. Such accidents are expected and are, hence, "normal accidents." Such mistakes can happen in any complex system. If the system is also tightly coupled, there will be few opportunities for second thoughts. Chemical plants are both complex and often tightly coupled. These characteristics explain why chemical accidents are "normal" and why accidents like Bhopal, Institute, West Virginia, and Richmond, California, occur.

**B. The Challenge of Safety—Highly Reliable Organizations**

Accidents in any organization are undesirable, but because they are inevitable, organizations are advised that it is "folly" to try to prevent all accidents. Managers of large, complex organizations with many layers of delegation and reporting cannot control the organization in a deterministic fashion. Such control is an "achievement" arrived at only after much trial and error. But the cost of large chemical accidents is such that society cannot afford to operate by trial and error. Managers must strive for "trials without errors."

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283. **Perrow, supra** note 3, at 90. Perrow also observes that tightly coupled systems tend to be inflexible: there is commonly only one way for the system components to produce the output. **Id.** at 93-94.


285. **Perrow, supra** note 3, at 95-96.

286. One safety engineer has observed that in "complex situations, the operator's identification of the plant state and his decisions will typically be unreliable and unpredictable." Rasmussen, **supra** note 277, at 146.

287. See **Perrow, supra** note 3, at 120-22.

288. See, e.g., Perrow, **supra** note 36.


290. "Even if unlucky, experimental acts are necessary: without them, there can be no learning. . . . It bears much repetition, then, that solutions to problems cannot be commanded, they must be discovered: found on the basis of imagination, analysis, experiment and criticism." **Id.** at 152.

While accidents in complex systems are inevitable, there are examples of remarkable technological systems that present frequent opportunities for error and a substantial risk of catastrophic accident, yet operate with excellent track records. Consider, for example, a single fighter jet landing on an aircraft carrier; as the plane touches down, the pilot simultaneously accelerates the engines (to abort the landing if need be) and engages a steel cord that pulls the plane to a screeching halt. Even a single such landing challenges the imagination. The full picture is even more astounding: jets land in rapid sequence, sometimes in rough seas, with high reliability. Similarly, air traffic controllers at busy metropolitan airports bring in and let out hundreds of passenger jets with remarkable track records. Consider also nuclear power’s operational history. Despite their complexity and staggering catastrophic potential, nuclear power plants in this country have logged many hours of operation without a large-scale catastrophe. Even the Three Mile Island incident was minor compared to many plausible accident scenarios. Nuclear power plants, air traffic control operators, and aircraft carriers all include examples of high reliability organizations (HRO’s)—organizations for which the possibilities for and consequences of failure are large, but failure is uncommon.

These HRO’s are quite complex and would appear to be subject to normal accidents. High reliability organizations thus present something of a paradox. In theory they should not operate with such high reliability; in practice, they do. Even if such systems reached their current state through an evolutionary process involving errors when the stakes were not so high, we must still account for their ability to respond to new situations without disruption.

Two elements seem to be common to high reliability organizations. First, operators of complex HRO’s employ elaborate techniques to understand the system’s operation and to describe and characterize the

292. Id. at 38-39; John Pfeiffer, The Secret of Life at the Limits: Cogs Become Big Wheels, Smithsonian, July 1989, at 38, 39, 42-43.


294. See Perrow, supra note 3, at 50 (describing the potential for catastrophic nuclear accidents).

295. La Porte & Consolini, supra note 291, at 20. This is not to suggest that every nuclear power plant is well operated, let alone operated in a highly reliable manner, nor to suggest that young fighter pilots do not die in tragic crashes. Rather, the point is that the track record of some individual systems suggests the possibility of highly reliable operation.

296. Operators of HRO’s do engage in trial and error on small controlled areas, id. at 27, but these exercises are unlikely to train the operators for truly abnormal conditions.

297. See, e.g., Todd R. La Porte & Craig Thomas, Regulatory Compliance and the Ethos of Quality Enhancement: Surprises in Nuclear Power Plant Operations, IGS Working Paper 93-17 (Institute of Gov’t Studies, Univ. of Cal. at Berkeley), Sept. 1993, at 25-26 (“We were struck by the extraordinary effort devoted to processes of discovering ‘root causes’ of errors—the reasons why thing fail. It is an intense, multi-faceted process . . . .”).
system's state. Second, HRO's encompass sophisticated, and frequently redundant, communication patterns between various individuals, networks, and groups. These networks are maintained by a strong sense of a common mission and shared values.

Chemical plant operators until recently did not have strong incentives to develop highly reliable management. First, the need for chemical plants to be highly reliable systems became clear only after Bhopal. With Bhopal came the recognition that neither the chemical industry nor the rest of the world can afford the global consequences of such a major tragedy. Second, the growth of chemical plants, which created immense hazards, took place gradually over several decades. Accordingly, operators and management did not initially perceive the need for a new management style. Third, the chemical industry, unlike the HRO's discussed above, suffers a collective action problem that dilutes each company's incentive to guarantee reliability. The "companies" that

298. Consider two examples from aircraft carriers. First, immediately before a plane is to land, the pilot must inform the deck crew of the type of plane and the weight of the remaining fuel; the crew then sets the braking pressure of the arresting gear accordingly. After each landing, the crew inspects the arresting gear. La Porte & Consolini, supra note 291, at 38-39. Second, when they need to ensure that the deck is clear, crew and officers walk shoulder to shoulder to inspect for debris. Pfeiffer, supra note 292, at 43. In one nuclear power plant, operators constantly monitor and question the state of the system. See La Porte & Thomas, supra note 297, at 15, 25-26.

299. For example, air traffic controllers, their supervisors, and their coordinators shift roles as the pressure in the system increases. Supervisors and coordinators act as alternative eyes and ears. They also respond to the controller's condition, watching for stress and ready to replace the controller "in the seat." La Porte & Consolini, supra note 291, at 32-33. "Carrier duty means nonstop communication." Pfeiffer, supra note 292, at 44. Communication patterns include substantial redundancy. Id. The High Reliability Research project has also described the sophisticated overlap of internal regulators and quality enhancement personnel at a nuclear power plant. The various groups both support each other and are in gentle competition. La Porte & Thomas, supra note 297, at 19, 23.

300. "What [aircraft carrier personnel] work hard to maintain is a quality rarely encountered in the civilian world—completely unselfish devotion to the task at hand. A feeling for the team, the ship, the Navy, a feeling so intense that when someone else slips up, you feel as depressed as if it were your own failure." Pfeiffer, supra note 292, at.44. See also La Porte & Thomas, supra note 297, at 28-35 (describing the deep commitment to excellence and peak performance of nuclear power plant operators).

301. Some safety engineers recognized this new hazard earlier. "The traditional method of identifying hazards was to build the plant and see what happens—'every dog is allowed one bite'. . . . This method is no longer acceptable now that we have dogs as big as Flixborough." Kletz & Lawley, supra note 284, at 317-318.

302. See supra note 19 and accompanying text (describing the post-World War I advent of chemical accident risk).

303. This was graphically illustrated by the 1977 investigation report of a fatal accident prepared by the British Health and Safety Executive, which absolved a local Dow chemical plant of responsibility because the plant is part of a large, diverse chemical company. It opined that the plant's management could not be expected to understand the hazards of the chemical it handled because "Zoalene is only one of many thousands of reactive chemicals being handled by Dow internationally." Tombs, supra note 36, at 199-200; see also Slovic, supra note 60, at 283 ("In some cases, all companies in an industry are affected, regardless of which company was responsible for the mishap.").
operate HRO's tend to be monopolies: electric utilities, the U.S. Navy, and the air traffic control system. Following mistakes, public and political distrust focuses on the monopoly alone. In contrast, all chemical companies took the heat from Bhopal. In fact, it is unclear that Union Carbide's reputation suffered more than any other chemical company's. Since every chemical company suffers the consequences of every chemical accident, the incentive for individual action is reduced.

The question is if, and how, CAP regulatory programs can promote a systems management view and induce the characteristics of highly reliable operation in chemical plants. More specifically, do the extra efforts of the New Jersey program seem likely to produce the desirable behavior? The remainder of this section concludes that regulatory programs should be designed to achieve the characteristics of HRO's and that New Jersey's comprehensive program provides an appropriate model for CAP regulation.

C. Making Chemical Plants Safe—The Roles of Regulation and Regulators

Effective chemical process safety programs force companies to craft a model of plant operations that operators can rely on in normal and emergency situations. These programs help operators, company management, and regulators redefine their notions of safety and of the plant itself; they also promote appropriate management and operational styles. The new visions and patterns of interaction, in turn, help promote high reliability. The aggressive approach taken by New Jersey seems well-designed to have this effect.

This section discusses three specific areas where the components of CAP regulation, particularly those modeled after the TCPA, can promote safe chemical plant operation. First, hazard assessments promote a general understanding of the plant's operation. Second, improved organizational interactions within a chemical plant are essential to the plant's safe operation. Appropriately designed hazard assessments, training

304. La Porte & Consolini, supra note 291, at 21. Indeed they tend to be public or semi-public. Notably, societies tend to rely on government to assure high reliability. See id. This reliance seems at odds with the common belief that only private entities with financial liability can be relied upon for high quality. It may be, however, that—when the stakes are high enough—a personal sense of responsibility, the desire to protect turf, and the threat of congressional inquiry effectively motivate careful work.

305. Nuclear power plants are an exception. Plants all over the country are owned by different utilities. Recognizing their interdependence, the utilities formed a private regulatory agency for nuclear power plants: the Institute of Nuclear Power Operators (INPO). Whereas the CCPS is essentially a research institute, INPO acts like a regulatory agency.

306. Nor is it clear that after a few years, the Valdez oil spill weighs more heavily on Exxon than on other oil companies.

307. The distinction between promoting understanding and improving organizational interactions is somewhat misleading. It is the organization that must develop the understanding.
programs, and operational guidelines help improve organizational interaction. Third, the safety program helps promote corporate management’s awareness of risks in the plant and ensure that management participates in critical decisions.

1. Visualizing and Understanding—Hazard Assessments Revisited

Regulators can play an active role to ensure that hazard assessments promote systems management. Risk assessors, such as HAZOP teams, adjust their practice according to the purpose of the risk assessment.\(^{308}\) If the effective purpose of a hazard assessment technique degenerates into mere compliance, the assessment may become a routine, lightweight process.\(^{309}\) Regulators report that even large companies sometimes do a poor job preparing hazard assessments.\(^{310}\) To combat inattention, regulators need effective criteria for reviewing hazard assessments. For example, currently regulators typically check the thoroughness of a HAZOP by examining randomly selected nodes and ensuring no reasonable causes of deviations were overlooked.\(^{311}\) Such procedures may be insufficient to ensure high reliability. In addition to such examination, regulators should consider review criteria such as time spent on the hazard assessment and whether the process included significant interaction among plant operators and designers.\(^{312}\) Other opportunities to promote the hazard assessment as a learning tool should be further explored. HAZOP’s, which are both comprehensive and open ended, present a particularly appropriate opportunity to develop operator understanding of the interconnected aspects of the plant.

Although hazard assessments, such as HAZOP’s, are designed to identify potential hazards,\(^{313}\) the assessment process also helps the team

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\(^{308}\) Thus, a HAZOP done as part of quantitative risk assessment is conducted differently from one conducted for risk reduction purposes. OECD, RISK ASSESSMENT, supra note 27, at 58.

\(^{309}\) Id. at 65.

\(^{310}\) Interview with Mel Wagshul, Chemical Safety Engineer, Bureau of Release Prevention, Department of Environmental Protection and Energy, in Trenton, N.J. (July 30, 1992); Interview with Leon Nolting, Chemical Safety Engineer, Bureau of Release Prevention, Department of Environmental Protection and Energy, in Trenton, N.J. (July 30, 1992). The first RMPP for the Chevron refinery in Richmond, California, was stunningly brief.

\(^{311}\) Interview with Ken Axe, supra note 111.

\(^{312}\) The TCPA readoption included one such provision: “The team shall include a person assigned to lead the study and a person to record the results, both of whom are technically trained and will be available for the duration of the study.” N.J. ADMIN. CODE tit. 7, § 31-3.9(c)(2). DEPE defended the requirement, explaining that the leader needs to be free to think and speak, while the recorder needs to be accurate and comprehensive. READOPTION COMMENTS, supra note 205, at 49.

\(^{313}\) HAZOP’s were developed as a deliberate response to complexity, but the principle purpose was to “recognize and eliminate potential problems at the design stage.” Lawley, supra note 110, at 45. Indeed, guidance manuals for conducting HAZOP’s emphasize the need
create a comprehensive, complex mental image of the plant and its operation. The physical models of the facility that HAZOP teams employ—piping and instrumentation diagrams and other documentation of the plant—not only identify critical nodes, but also help the team create a mental image of the plant system. HAZOP’s conducted by teams, rather than by individuals, provide not only a richer selection of ideas, but also a larger cognitive capacity for understanding the system.

The plant operators’ mental image of the plant is most critical when the plant deviates from planned operation. If the deviation is minor and routine, the operators can return the plant to normal by applying their basic skills. Where the deviation is more extreme, the operators must rely on their understandings and images of the plant to respond properly. Effective CAP regulation, such as the TCPA, promotes safety in nonroutine situations by requiring that operators are trained to handle abnormal and emergency situations. The hazard assessment helps ensure that the training and operating procedures are complete. Moreover, operators who train by participating in the hazard assessment, as well as the other information-generating elements in the first tier, enhance their image of the plant.

Comprehensive hazard assessments are thus an appropriate regulatory feature not only because they help identify hazards, but also because they help operators create a mental image of the plant that is essential to safe operation. These qualities suggest that CAP regulations should require sophisticated hazard assessment techniques, especially for more complex plants. Less sophisticated hazard assessment techniques are unlikely to serve the generative function. In New Jersey, on at least one occasion, the operators of a large refinery inappropriately chose to fulfill

for comprehensiveness. Practitioners are to examine “each” node and to consider “every” deviation. See supra notes 109-12 and accompanying text; Kletz & Lawley, supra note 284, at 318, 320.

314. See generally Weick, supra note 268, at 133 (Complex technologies “involve the material technology of the largely invisible process that is actually unfolding, and the implicit technology of an imagined process that exists in the mind of an individual or team.”). The HAZOP is part of a story telling process, an enactment where each player knows their part. See Weick, supra note 267, at 120-23. Consistent with this view, HAZOP teams are advised not to get bogged down trying to refine the suggestion on a narrow issue. Kletz & Lawley, supra note 284, at 321. The goal is to keep the narrative moving.

315. Weick, supra note 267, at 115-16.

316. See supra notes 284-88 and accompanying text.

317. For example, the gauges and other indicators in the plant have a very different meaning depending on whether the plant is under normal or abnormal conditions. See supra note 282 and accompanying text.

their hazard assessment requirement with a simple checklist. In the early years of the program, New Jersey regulators sometimes used their authority to order a quantitative risk assessment (QRA), a technique that demands significant investigation and visualization. Regulators should also have clear authority to limit the use of consultants in mandatory hazard assessments.

2. Human and Organizational Factors—Beyond Hazard Assessments

Communication, like understanding, is essential to developing high reliability. Operators of dynamic high reliability systems talk incessantly. "The talking never stops. . . . They talk to reduce ambiguity of information, to correct misinformation, often without a hint of blame or accusation." This communication helps develop collective understandings. A group can have a higher cognitive capacity than an individual; conversation, even ordinary banter, helps improve that capacity. The HAZOP team discussions undoubtedly improve the cognitive capacity necessary for reliable operation and, thus, should be designed with this goal in mind.

Because operating a chemical plant is a collective activity, all members of the group must be involved in promoting chemical process safety. Examples abound of accidental releases that followed the action of a maintenance worker or a foreman, rather than that of a front-line operator. Collective activity itself is particularly important in times of stress when several operators must assess the situation and respond in tandem. A mismatch in the timing of responses can cause or exacerbate an acci-

319. Interview with Leon Nolting, supra note 310.
320. Interviews with Reginald Baldini, supra note 181. In readopting the TCPA regulations, the DEPE made a remarkable choice. They incorporated a mandatory risk management threshold into the regulations. Facilities that identify a potential leak with sufficiently adverse consequences must plan and implement mitigation measures. To determine what releases trigger the requirement, facilities must model a number of releases, most likely at great expense. See supra note 166 and accompanying text.
321. These provisions do not seem likely to promote organizational development. Facilities will be forced to invest effort in dispersion analyses and highly hypothetical release estimates. See D.A. Carter, Quantified Risk Assessment of Petrochemical Installations and Pipelines in the United Kingdom, 11 Risk Analysis 385, 386 (1991) (describing difficulties in estimating the size of a potential release). The release and dispersion modeling will not make a substantial contribution to the understanding of the plant operation and are even less likely to help build organization. This new requirement is a risk management standard. Complex organizations, however, blur the distinction between risk assessment and risk management. See Linnerooth-Bayer & Wahlström, supra note 271, at 239.
322. Pfeiffer, supra note 292, at 43.
323. Weick, supra note 267, at 115-16.
324. See generally Tombs, supra note 36 (describing the multiple sources of six chemical plant accidents).
Supervisors, also, must understand the situation and either support operators’ choices or provide guidance.  

The collective action of operating a chemical plant illustrates the need for communication in many directions. Management should inform all workers at a plant of operational hazards so that the workers avoid creating additional hazards. Similarly, designers should communicate design concepts to workers, and operators should communicate the hazards they recognize to management and to plant designers. It is particularly important that plant designers and operators communicate. Plant designers create “micro-ergonomic” conditions, such as the maneuverability of individual controls and the clarity of visual displays, affecting the operators’ behavior and control. Ergonomic considerations are important because of the subtle difference between operator and design errors. Many so-called “human errors” are, from the systems view, “design-induced errors.” While a hazard assessment may identify obstacles facing the operators, optimizing plant ergonomics requires further communication. Over the long term, safe operation requires that plant designers be aware of the particular abilities and limitations of a plant’s operators.

325. See Meshkati, supra note 267, at 143.
326. In the early stages of the Bhopal breakdown, the plant operator appropriately shut off the waterflow, but his supervisor ordered him to turn it back on. Shrivastava, supra note 49, at 50. The need for supervisors to understand the situation is most dramatic in dynamic, reliable systems. For example, in the air traffic control system, operators and supervisors respond to pressure and increased work load by shifting from a normal, bureaucratic control structure to a system of profound cooperation, where observations and interpretations are shared in a suggestive rather than a dictatorial manner. Even while one person remains at the controls and another maintains formal authority, decision-making, and perhaps understanding itself, is de-localized. La Porte & Consolini, supra note 291, at 32-33, 37.
327. Tombs describes several accidents that would have been avoided if workers had been informed of the hazards of the materials involved. Tombs, supra note 36, at 201-05; see also Reich, supra note 28, at 159-60 (describing information sharing as an occupational safety measure).
328. Complex systems inevitably suffer “non-design” emergencies (those not predicted by the system designers). In these situations “there is no clear-cut distinction between system design and operation.” The operator must therefore be aware of the design concept to be able to adapt to contingencies unforeseen by the system designers. Meshkati, supra note 267, at 137-38; see also supra notes 279-82 and accompanying text (describing the role of knowledge in responding to emergencies).
329. Equally important, management must respond to those hazards. Tombs, supra note 36, at 194-95.
330. Meshkati, supra note 267, at 138. The Bhopal plant, for example, presented operators with both complicated displays and an unnecessarily labor-intensive shutdown process. Union Carbide employed a more modern, less demanding design in other facilities. Najmedin Meshkati, An Etiological Investigation of Micro- and Macroergonomic Factors in the Bhopal Disaster: Lessons for Industries of Both Industrialized and Developing Countries, 4 INT’L J. INDUS. ERGONOMICS 161, 168 (1989).
workforce. Thus, one aspect of a safety program should be improved opportunities for communication between the operators and designers.

The role of communication, like the role of understanding, demonstrates the need for nontraditional regulatory standards. Simulations and other training exercises are one opportunity to foster communication. A New Jersey regulator spoke about the importance of training exercises and suggested that the biannual schedule followed by one company is not enough. Similarly, the manager of the Shell Oil Refinery in Pittsburgh, California, announced that one of the strongest lessons the facility had taken from their HAZOP's was the need to increase safety drills and simulated shutdowns. Regulators should develop techniques to ensure that training exercises promote sophisticated interactions among plant operators and supervisors. Developing avenues to communicate with designers and management about operational difficulties is particularly important.

Safety in a complex system also depends on corporate culture. A demoralized work force can contribute to accident scenarios as it did in Bhopal. In positive terms, a safety culture is recognized as an important aspect of HRO's. Chemical company management must identify opportunities to promote a corporate safety ethic. Regulators can reinforce this safety ethic. For example, New Jersey regulators suggest that their presence and determinations help empower the safety personnel within a plant. Where the regulated facility independently commits to the regulatory goal, and where the regulators assess the facility in a sophisticated way, the regulators can inspire the operators to act more safely. Preliminary indications in regulated chemical plants suggest such inspiration.

332. This is a particular issue for plants operated in developing countries where operators may have different body sizes and cognitive patterns. Meshkati, supra note 267, at 139-40.
333. Interview with Mel Wagshul, supra note 310.
334. John Fisher, Shell Oil Staff Engineer, Presentation at Shell Oil RMPP Community Meeting, Martinez, Cal., Oct. 27, 1992 (notes on file with author) [hereinafter Shell Presentation].
335. SHRIVASTAVA, supra note 49, at 49.
336. See id. at 126-28; Karlene H. Roberts, New Challenges in Organizational Research: High Reliability Organizations, 3 INDUS. CRISIS Q. 100, 104 (1989); Weick, supra note 267, at 123-26.
337. Interviews with Reginald Baldini, supra note 181; see also EPA ROUNDTABLE, supra note 208, at 10.
338. Observations at the Diablo Canyon Nuclear Power plant suggest that the resident NRC inspectors, when highly skilled, command respect from the operators. Skilled inspectors can inspire the slightly annoyed operators to stay one step ahead of the inspections. It should be noted both that the regulators have a substantial coercive power by virtue of the cost of a shutdown and that the power plant has a singularly extensive internal regulatory program. La Porte & Thomas, supra note 297, at 26-28.
339. Representatives of the Shell refinery in Martinez, California, spoke of safety innovations that they implemented as a result of the mandatory hazard assessments. Shell Presentation, supra note 334.
The opportunity to use regulation to promote a safety culture suggests several choices for the design of regulatory programs. First, agency management should strive, as did New Jersey's DEPE, to hire regulators with substantial industrial expertise who can command the respect of both safety and production personnel at the plants. The regulators must be capable of finding oversights and, thereby, challenging the facility to strive for greater safety. Second, the regulatory agency must foster its own safety and quality ethic. This suggests that agency management should centralize CAP regulatory programs, at least until a sufficient ethic has developed. The differences in quality between the New Jersey program, which is centralized, and the California program, which is decentralized, support this conclusion.

3. Management Roles

Another institutional feature impacting safety is the corporate form of chemical companies. Social and legal sanctions that normally promote safety efforts are often undercut in a corporation. For example, middle management works within an incentive structure that promotes safety violations in the interest of short-term profitability. Thus, "middle management faces a very different set of potential costs and benefits than the corporation." A middle manager may well choose to ignore a known hazard that, from a long-term perspective, should be abated.

A second set of perverse incentives affects upper management. Lower level employees often are encouraged to shield upper management from bad news. Where the feared bad news carries criminal liability, the corporation may even invent isolating devices such as a "vice-president responsible for going to jail." Even outside the criminal context, upper management and the corporation have an incentive to blame mistakes on lower-level employees. Executives do not welcome the conclusion that an error lay in their immediate control, such as in the design and management of the plant. Consequently, executives look for "deviants, not deviance." The alternative, "finding that management was re-

340. See supra notes 179-83 and accompanying text.
341. See Weick, supra note 267, at 124 (describing the role of centralization in forming an agency culture).
342. Christopher P. Stone, Controlling Corporate Misconduct, PUB. INTEREST, Summer 1977, at 55, 57-61 (describing attempts to apply sanctions to corporations).
343. See Tombs, supra note 36, at 196 (describing management desire to restart plants as soon as possible after a shutdown).
sponsible[,] would threaten those in charge." In other words, acknowledging that safety results from good organizational design and behavior deprives the organization and its management of the favored explanation for mishaps: operator error.

One common proposal to remove the barriers that isolate upper management from bad news is to require that certain information concerning public risk be given to upper management. In theory, this requirement helps to ensure that management has the information it needs to make decisions of significant social consequence, such as those concerning accident prevention. Current debates about environmental auditing and the expressed fears of attorneys and other corporate representatives that knowledge of environmental risks could create financial liability suggest that management habitually relies on ignorance of hazards.

Ensuring that upper management is notified of risks is especially challenging since hazard assessments tend to be generated by decentralized groups. The TCPA confronts this problem by requiring the company to designate a responsible manager:

"Responsible manager" means the member of the registrant's management who is responsible for the management of the registrant's risk management program at the site and who shall possess sufficient corporate authority and technical background to adjudicate issues relating to the execution of the risk management program based on information provided by manufacturing, engineering, maintenance, safety and environmental representatives.

The TCPA definition of "responsible manager" addresses the challenge of keeping upper management informed, but also poses an additional problem. The responsible manager is to review individual findings of possible chemical hazards. Yet, according to the definition, the individual must have authority for the entire site. A person with such broad

349. Coffee, supra note 344, at 450-52.
350. One example of this approach, in a very different area, was enacted by the Federal Communications Commission, which requires that at least one record company executive have read any questionable lyrics. Stone, supra note 342, at 63-64.
352. N.J. ADMIN. CODE tit. 7, § 31-1.5 (1993). EPA's analogous provision has raised industry eyebrows. Commentators contend that EPA has failed "to address and dispel industry's actual concerns, which include the potential liability of the identified individual and the possibility that the agency will single out a person with titular, but not actual, responsibility to simplify the post-accident investigation process." Thomas S. West et al., Accident Prevention and Emergency Response Planning under the Clean Air Act, 24 Env't Rep. (BNA) 1555 (Dec. 24, 1993).
responsibility will not be able to give attention to individual, complex possibilities. The admirable decision to require that the responsible manager be technically competent is meaningless without adequate review time. One possible alternative, suggested by a New Jersey regulator, is to allow the designation of individual responsible managers for individual processes.353 If this approach is taken, avenues for communication between the individual responsible managers must be developed to ensure effective systems management. In any case, finding a balance between authority and detailed knowledge for a responsible manager requires serious consideration. DEPE and similar agencies should look for opportunities to optimize this tradeoff. Similarly, agencies should develop clear standards that dictate when responsible managers must alert upper management of particular hazards.

CONCLUSION

Chemical accident prevention programs must be competent from two perspectives. First, of course, is the chemical engineering perspective. New Jersey, California, OSHA, and now EPA have been able to create comprehensive process safety regulatory programs because, in the wake of Bhopal, industry groups created a foundation for chemical process safety management. Agencies achieve engineering competence by hiring trained, experienced chemical engineers. This is no small accomplishment; even in much less demanding areas, regulatory competence is often questionable. The New Jersey experience suggests that when a state makes a commitment to safety regulation, regulators and plant operators can successfully collaborate to raise safety standards.

Chemical process safety programs must also be competent from the perspective of organizational development. Plant safety, like high reliability in general, depends on people working well together. Managers, operators, and designers must learn to interact fluidly. Accident prevention depends on collective responses to both familiar and unfamiliar situations. It is here that the intensity of the TCPA seems essential. The experience in New Jersey suggests that skilled regulators, who command respect and make substantial demands aimed at improving organizational competence, can improve plant safety.354 Reinforcing the vision of the chemical plant as a system requiring fluid organizational interactions

353. Interview with Mel Wagshul, supra note 310. Mr. Wagshul, however, did not think that there was anything to gain by requiring that upper management be notified of risk. Id.

354. The compactness of the TCPA universe facilitates the growth of the program. The changes in management of change provisions, hazard assessment requirements, and even the risk management provisions reflect DEPE’s conclusions about what worked and what didn’t. Even if not all of the changes are improvements, each change reflects the Agency’s attempt to improve its relationship to the regulated activity.
for reliable operation takes serious time and regulatory commitment, supported by strong CAP legislation.355

This comment has identified several steps that regulators and industry can take to improve competence in both respects. A few bear repeating. First, the hazard assessment requirement should be structured to promote interaction as well as to identify hazards. For example, elaborate modelling of individual release scenarios is probably less valuable than efforts to identify additional scenarios. Also, while there is a clear need to bring skilled hazard assessors into the process, there is an equally important need to have a spectrum of a plant’s permanent personnel on the assessment team. On the regulatory side, agencies should experiment with specific criteria for the communication and organizational aspects of hazard assessments.

Second, there must be a broad view of the goals of training. Operators should be trained to respond to the unexpected as well as the expected abnormalities. Training must be inventive. And the organization as well as the individual operators must be trainees. Groups of operators must learn to work together. Training programs should also be designed to bring together individuals with diverse roles in the plant. Operators need to understand design concepts as much as designers need to understand operational constraints. Here again, regulators must strive to identify meaningful criteria for these training goals.

Third, operators and management alike must understand the hazards and, indeed, the risks of their chemical plant’s operation. Operators who do not know the hazards that are present will not act with appropriate caution; neither will top decisionmakers. The training element of each process safety program can promote operators’ understanding. Management presents a more difficult problem. Regulatory programs must therefore develop standards for the upward transmission of information. Because the manager of a large plant cannot be expected to understand every element of her operations, characterizing the information appropriate to each level is a continuing challenge. Finally, highly skilled regulators are essential to CAP regulation. Only experienced chemical engineers can meaningfully engage chemical plant personnel in a consideration of the plant’s operations.

This list is by no means comprehensive and there is much work to be done. Fortunately, there are promising efforts to develop tools to include management and communication factors in regulatory assess-

355. Regulators have the opportunity to define the type of expertise that is brought to bear on chemical plants. Experts in systems behavior should be involved both in regulatory design and as consultants. The absence of such experts may adversely affect safety. Tombs, supra note 348, at 64 (describing how the paradigm of accident-proneness attracted the wrong experts to chemical safety work).
ments. But the most important lessons will come from practical experience. Here the Federal Government seems to be missing an exceptional opportunity. EPA recognizes the role of organizational competence. "EPA's proposed rule, particularly the prevention program, emphasizes the importance of management and management commitment . . . ." However, EPA's proposed program, with 140,000 regulated entities, is unlikely to generate many opportunities for learning about the organizational aspects of process safety. Inevitably, with so many facilities, regulatory oversight and the safety programs themselves will be cursory. OSHA has already mandated chemical process safety for much of America's chemical industry. EPA should not merely reiterate OSHA's requirements, but should strive to extend the state of the art.

This comment began with the observation that chemical accidents are an inevitable consequence of the chemical industry. Process safety programs can go a long way to improving safety, but there will always be another accident. The reason, Perrow tells us, is straightforward: "[o]ur ability to organize does not match the inherent hazards of some of our organized activities." The next accident, like the last one, will produce myriad harms. The direct victims suffer first, but many others develop a deep discomfort with the chemical industry and technology generally. Reducing accidents is essential to maintaining the public trust on which industry and government depend.

I end on a hopeful note. The benefits of accident prevention may be as widespread as the costs of accidents. Chemical accidents are just one example of the need to strive to improve the organizational competence of high hazard activities. Regulating to reduce chemical accident risk is an opportunity to develop further the public capacity to manage complex organizations. That capacity is essential to the safety of current and future technologies.


358. Perrow, supra note 3, at 10.