

ENERGY RISK REGULATION IN FRANCE

Marc Poumadère¹ and Claire Mays²

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¹Ecole Normale Supérieure de Cachan

(Groupe de recherche sur le risque, l'information et la décision- GRID)

²Institut SYMLOG, Cachan

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When once you have taken the Impossible into your calculations its possibilities become practically limitless.

Saki, about 1911

I. INTRODUCTION

I.1 FRANCE'S ENERGY CONTEXT

France today has a special energy situation in comparison to the countries represented in this book: the dominant source of electricity for private and industrial use is nuclear. While French nuclear power production capabilities had been under development from the 1940's, the 1973-74 worldwide oil crisis was a springboard for massive expansion of this energy option. Today over 75% of the nation's electricity production is nuclear generated.

Jasper (1990) contrasts this outcome with the current situation in the United States and in Sweden, two countries which had comparable technological resources and policy plans for the development of nuclear energy at the time of the energy crisis. In the States, reactors under construction in 1973 have not been completed; existing orders were cancelled and prospects for further development today appear extremely limited, especially in light of the ongoing conflicts over management of the fuel cycle back end (Slovic et al., 1991). In 1993, nuclear generation produced only 20% of electricity consumed in the States. A little under half of Sweden's electricity today is nuclear, and some ten reactors were added to those in existence in 1973, but a post-Chernobyl referendum decided a complete phase-out of nuclear power by 2010 (a date untenable according to national energy decision makers). In this context of high public scrutiny

and low public acceptance of the nuclear option, Sweden has been successful in constructing a low and intermediate level waste repository by "overdesigning" safety features¹.

Meanwhile, France's national utility, Electricité de France, sometimes called "a State within the State", has grown and prospered; its nuclear production capacity is generally over demand levels, even with export schemes. Jasper (1990) provides an historical and sociological analysis of the French "technocracy" that developed and is exemplified in the nuclear power system. He describes the worldview common to the upper echelons of France's administrative and energy decisionmaking structures as "technological enthusiasm", putting progress above cost/benefit analysis.

The nuclear power establishment may rightly be taken as an outstanding model of energy risk control in France. A single national utility (the biggest in the world), a homogeneous set of reactors built by a single constructor, a strongly centralized regulatory authority, have combined (and evolved in response to public pressures) to form a tightknit system. Its advantages may be measured in one example: in case of operating incident, plant managers throughout the territory are immediately informed, such that they may make verifications within their own unit and take any control measures which may be found appropriate. Significant budgetary resources and expertise are devoted to research, training, and the building of a safety culture.

The Electricity of France (EdF) organization may also be considered to be the source of strong technological, methodological, and organizational advances in risk analysis, safety, quality, and industry coexistence with the public, advances which in many cases have been transferred to other industries and domains of activity.

¹ According to comments made by attendees at the Safewaste '93 international conference.

The exemplary nuclear establishment certainly reflects the French national, scientific, and political culture in which it developed. It is often taken by outside observers (see e.g. O'Riordan and Wynne, 1987) to be the single example that best describes the French style of risk regulation, a style highly distinct from that found in other contexts. One major outcome of the present study may be to report an alternative view: insiders maintain that the nuclear power system is a "special case", and has been shaped by factors which are far from being operant in other domains. Those factors are principally public risk perceptions and demand for strong, visible risk regulation. The distinct environment and character of regulatory approaches in the nuclear field, as opposed to those in other energy (or hazardous risk) sectors, will be soon apparent to readers of the case studies presented here.

This said, it is clear that national energy planning, consumption, and probably risk distributions, have been shaped by what the director of the new ministerial Agence de l'Environnement et de la Maîtrise de l'Energie (ADEME) called "the nuclear monoculture" in which France has bathed for so long (Enerpresse, 1991). Today, the supremacy of nuclear electricity (producing effects such as unparalleled consumer use of electric heating), if unlikely to be radically reversed, is being challenged, for example by a 1994 "National Debate on Energy and the Environment" sponsored by the Industry and Environment Ministries. The development of alternative concepts of energy source, supply and organization, and decision accountability, may have been handicapped by a situation in which EdF has been "both the operator and the regulator" according to the Debate rapporteur (Débat, 1994).

The complex calculation of energy price index has been criticized by the same Debate Report as underrepresenting the full range of costs implied in the nuclear cycle; the nuclear kilowatt hour comes out as one of the world's cheapest, on a par with Canada's, and significantly cheaper in France than coal or gas (EdF figures). (Favorable evaluations of the indexing process point to the use of multiple criteria, input by various institutions, and accountability; the index is fully published by the Industry Ministry

(DIGEC, 1993).) Research and development have been concentrated in the nuclear and, to a lesser extent, oil sectors. France is first in Europe in renewable energy production: about one fourth of her primary energy comes from (predominantly) microhydroelectricity, wood, and (far behind) waste transformation, geothermia, biocombustibles, solar and wind power, etc. In contrast, France's research and development in these sectors are Europe's most modest.

The National Debate involved participants from regulatory, governmental, scientific, industrial, and consumer or citizen organizations, on the national and local scales. The Report shows that all of these participants have clearly undertaken critical thinking about the economics and ecology of France's energy systems. The topic most notably absent from the Debate as reported, though, is that of risk.

As social scientists, active in risk research for over ten years, we have come to consider risk discourse in society as a means of representing decision choices in areas as diverse as technology, health, safety and quality of life, physical life settings, distribution of power, and economics. Although all these elements are considered in the Debate, they are not "sewn together" by the notion of risk. "Risk", to persons or to the habitat, is not invoked to clarify debate over issues such as territorial distribution of energy production, balance in the choice of energy sources, acceptability of technological choices, financial compensation, democratic process, or others.

The primary mention of risk we found in the Report places it, still, in the appropriate context of decisionmaking and uncertainty. A few short paragraphs state that quantified knowledge is lacking on the impact of pollutions on e.g. health and quality of life, or climate or landscape. "...Some, and not the least important, energy and environment decisions are taken on the basis of imperfect knowledge and ill-specified judgement criteria. Decision processes under uncertainty, attempts to take into account the remote future, acceptability of accident risks should be based on better knowledge of today's reality and on choices evaluated with clarity" (p. 13).

The research reported in this chapter may bring some answers to the question of why "risk" is not utilized and treated by French energy regulators in the same way as may be the case in other countries. "Risk" as a quantifiable concept is not absent; it is fully present in decision processes in the nuclear establishment, and in the petroleum industry, for instance. But there seem to be conscious reasons to do without the quantitative risk concept, or more specifically a quantified "tolerable risk limit", in other parts of the regulatory system. This gap is in part the reflection of public "unpreparedness" to participate in a risk debate, and, we hypothesize, the same gap may perpetuate such conceptual unreadiness in the public.

The major source of information for this chapter was provided by interviews performed in February 1995 with participants in the energy risk regulatory process. In the first phase of identifying principal actors, we used the direct method of examining ministerial organigrammes in the departments of clear interest, such as the Industry Ministry's General Directorate for Energy and Primary Materials. We contacted bureau chiefs whose title indicated proximity to risk regulation. We also contacted industry chiefs in the petroleum sector. (Specific titles are found in the opening of chapter sections reporting each interview.) In every case, our interview request was cordially granted and recommendations were made as to further contacts. Perhaps the first noteworthy finding of this study is that the French administrative technocracy is far from impenetrable, but that its members are willing and able to share its objectives and working methods.

Many of our interviewees stated that they were satisfied to participate in view of gaining access to the other country studies that make up this book. Thanks are due to all our correspondants for their very willing consideration of our questions and for their frank replies. We came away impressed with the caliber of thought, and the clear dedication to public service in our interviewees.

We did not approach industry representatives in electrical power production or distribution, nor in the natural gas sector (although both EdF and Gaz de France are considered to be frontrunners in applied risk research). The study project focused specifically on regulatory frameworks, rather than on their day-to-day application, or on the risk control systems which appear to be highly developed within these industries. These applications and developments merit attention; a complete overview and manual of quantitative systems analysis, for instance, is to be found in Villemeur (1992).

Nor did we investigate the special domain of radioprotection, an area in which ALARA management is highly developed on both the international and French national planes. Regulatory rationales, methodological strengths and shortcomings, accomplishments and challenges for the future are well analyzed in Hubert (1990; 1994). These references, as well as Brenot et al. (1994a, b), were particularly useful background material in planning this country study.

I.2 RISKS IN FRANCE TODAY

What are the principal industrial risks observed in France today? An accident inventory (BARPI, 1994) shows that more than half of the 731 events recorded in 1993 involve accidental pollutions, usually of water bodies, by chemical substances or hydrocarbons. Transport is on average the riskiest sector for all types of recorded events and consequences.

Energy production industries (mining, refining, nuclear) are among the safest of this inventory, together responsible for under 7% of recorded events (generally in the category of accidental pollution). Electricity and gas distribution account for under 5% of events. (An exhaustive international study of the entire range of health risks inherent to different energy sources may be found in Fritzsche, 1989).

What are the principal industrial risks in the view of the French public? A major study of perceptions (performed simultaneously with national samples in the US and in France; Slovic, 1993; Poumadère et al., 1995) asked 1500 French residents to rank 25 hazards in terms of their health risk to the public. The list included industrial, lifestyle, and environmental hazards. Results are shown in Figure 1 (along with US results). Hazards are shown ranked from most to least risky. The five highest perceived risks to the French public include two industrial topics: radioactive waste, and chemical pollution; AIDS, street drugs, and tobacco, however, share the stage in terms of perceived risks.

Figure 1: Perceived health risks to the public, France and USA. From Poumadère et al. (1995).

Radioactive waste management is one of the most interesting recent cases of regulatory evolution in France (see Section II.5, and Mays, 1995). As in other countries, however, energy may not be the primary domain in which public debates on risk issues are taking place in France. The 1995 presidential campaign did include references to reducing greenhouse gas emissions²². However, basic social inequities (health care, shelter, employment), AIDS (and institutional management of blood supplies), and winter flooding appear to be major concerns of the French public as measured, or amplified, by media attention (cf. Poumadère & Mays, 1994).

I.3 WHAT IS ENERGY RISK REGULATION?

The Center for Technology Assessment (Stuttgart, Germany) states in the description of the Project of which this book forms a part, that "one of the central issues in the controversial debate on energy systems is the evaluation of risks related to the different options for energy supply and demand. Models of risk evaluation are meant to promote a rational discussion about evaluating advantages and disadvantages of energy options using intersubjectively valid criteria. The results of such a discussion are normative statements about the acceptability of risks.

"(...) It is possible to distinguish between two methods of risk evaluation and risk allocation for collective decision making. The first set of models refer to government regulation [their description and analysis is the objective of the present book]. A governmental agency can use specific models to determine an acceptable risk level.

²² Various candidates made traffic pollution reform part of their platform. The outgoing government created a sizeable rebate on electric cars, which in France are partly an EdF venture. However, a campaign rumor of uncertain origin seems to reveal a negative grassroots attitude to individual change in behavior needed to reduce the greenhouse risk. The rumor claimed that one candidate planned to reverse the tax structure, which currently is favorable to diesel-fueled transport, and further even planned to finance deficits and France's contribution to the European budget by a heavy new tax on individual diesel

This level is binding for risk producers and risk bearers. (...Included are) risk comparison models, quantitative or qualitative standards (BACT, ALARA) and economic models (cost-effectiveness, cost-benefit models, decision analysis)."

With this statement as a guide, we set about to characterize the models of energy sector risk evaluation in use in France, their underlying rationales, their aims, and the data they propose to draw upon. The foregoing statement describes a straightforward and rational process. We have not met with such a clearly delineated situation in France, based upon the interviews kindly granted to us by institutional participants in the regulatory process.

Does the situation in any country in the world conform to the theoretical statement above? That question may be partially answered by this book. The outcome of our country research, in any case, shows that particular questions subsist in France on the formal status of models, on the types and sources of data that may enter into energy risk analysis and management, and on the meanings, forms and judgments of "acceptability".

Our interviews allowed us to identify overlapping and renewable phases in the history and process of energy risk regulation in France. What follows is an overview; the laws, their philosophy and their application will be examined later in the chapter. It should be noted that the statement often heard in France that "nuclear power is a case apart" can be corroborated; risk models and management, and the "acceptability" context are observed indeed to have a unique profile in the nuclear production sector. The following phase descriptions are meant to characterize processes observed mainly in the petroleum products sector, on which many of our interviews concentrated.

vehicles! Journalists reported that the rumor spread quickly, causing outrage and a temporary dip in voting intentions.

I.4 DESCRIPTIVE PHASES OF THE RISK REGULATORY PROCESS

France has suffered no major accidents, but has formulated her risk regulation in response to societal concerns over the years, as well as to specific major events outside her borders.

Phase of identifying interests to be protected

The elaboration of views as to what should be protected by the governing body, through laws, rules, and instructions, dates certainly to the creation of the French Republic and its founding Declaration of Human Rights. Precursors of the modern institutions can be traced to the creation in 1822 of oversight and control bodies concerned with sanitary population conditions. France's modern Seveso nomenclature is traced to an 1810 imperial decree.

France's philosophical orientations to regulatory protection, and the development of her institutions, have shown continuity over this long period. Until the 1970's, the primary risk regulation law, protecting health in the presence of "dangerous, unsanitary or inconvenient establishments", dated from 1917 (with modifications throughout the interim).

However, it should be noted that democratic organization is a much more recent development in France than her administrative model, which remains napoleonic in great part. This contrasts with for instance the United States, where federal regulation developed in parallel, or in counterpoint to, democratic exercise.

There has been particular activity in organizing risk views and institutions in France since the early 1970's. This period saw Western societal consensus on the natural environment as a cherished entity and political focus. In the early 1970's the environment was perceived by the French governments as a coherent ensemble requiring its own Ministry and a fundamental law for its protection from industrial impacts. The major environmental protection law of France was authored in 1976, and has since been modified to further reflect the 1982 Seveso Directive of the European Community.

In Section I.5 we will describe the various interests protected by governmental regulation of risk, and the major laws and regulatory texts.

Phase of developing rules for operators

The French Seveso law (Law of 19 July 1976, modified, and its companion documents) regulates industrial activities through a nomenclature (reference awaited) identifying dangerous substances or technological components across sectors. This classification scheme serves land use planning and defines risk management responsibilities and controls on classified installations. The thresholds designating different control classes are based on observation of operating experience, and on individual health threshold values as defined by the international scientific community. However, these justifications, although available for scrutiny, are not put forward as part of the regulatory demand. They form an invisible framework behind the nomenclature, which focuses on the risky activity.

Authorization to plan, build and operate industrial installations presenting major risks is granted on evaluation of a danger study and environmental impact report, provided by

the operator under his express responsibility. Thus we observe a demand on operators to provide data and perform analysis.

The demands on operators in terms of hazard assessment are firmly couched in a deterministic philosophy, imposing analysis of prescribed "worst case" scenarios for a given activity, no matter how infrequent the event. There is at present little methodological support offered for performing danger studies.

However, we observe a movement toward developing centralized and decentralized support, including the creation or certification of expert service bodies. The Law is complex and authorizations depend to some degree on the exercise of official judgement. Numerous authorizations have been attacked by environmentalist groups and overturned by the courts on purely formal grounds. This is one reason why guides have recently been developed by the Environment Ministry.

This is the top-down component of the regulatory framework, highly apparent in procedures dictated by the 1976 Law. These procedures, typical of European Seveso legislation, will be detailed further in Section II.1.

In other regulatory domains, elements of a bottom-up approach to rules definition may be observed. This is the case in the elaboration of safety goals for pipeline petroleum transport, for instance. Here, rules are the outcome of negotiations with industrial participants, and represent the Industry Ministry's "best guess" as to the acceptable tradeoff between risk and societal advantages of energy supply. The annual safety statistics furnished by industry as part of their control requirement, serve too as a data base from which to formulate "reasonable objectives". Rulemaking bodies are highly dependent on industrial input to judge what is "reasonable" in technical terms. Final rules are thought to guarantee, if respected, the Ministry's strong requirements for safety without imposing excessively costly risk reductions.

Keeping pipeline economically attractive is a way for the Ministry to favor this objectively safest crude oil transport option, and thus prevent transport from "escaping" to less highly regulated, and more dangerous, options.

Rules are thus part of an integrative optimization effort. The French administration is a strong defender of the integrative approach in the European forum. Still, industry criticizes a perceived gap with their own economically tighter optimization practices.

Public acceptability considerations

Acceptability of risk is assessed and stated differently in different regulatory fields. The public demand to demonstrate strict risk reduction appears to be concentrated overall on the nuclear field. In other sectors, regulatory actors speak of little manifest public demand. One objective of rulemaking is to create operating conditions that will allow the industrial activity to keep a low profile, that is to avoid a traumatic accident whose effect would be to focus public outcry. Indeed the public is perceived as apt to make demands for residual risk reductions in any field where risk is called to their attention. One regulator spoke of the danger that the "medecine then might kill the patient". Such demands, if they entailed excessively costly measures, might have the perverse effect of giving economic encouragement to riskier options, at least until an accident occurred there. Given that there is little tradition of negotiating acceptable risk levels and tradeoffs with the public, today's tacit regulatory definition of acceptable risk (in objectively low-risk sectors) includes the notion of danger remaining below the public perceptual threshold.

At the same time, France's Seveso regulators state their intention to make the public aware of the major risks associated with certain industrial activities. Installations are "classified for the protection of the environment" in the explicit goal of raising risk

perceptions and encouraging prudent local urban development decisions. Here the de facto acceptability of technological risks would appear to be greater in the public than in the Environment Ministry.

In any case, France has not selected quantitative values for negligible, tolerable or intolerable risk, as have other European countries. The reasons for this choice, and some of its impacts, will be explored throughout the chapter.

I.5 INTERESTS TO BE PROTECTED THROUGH RISK REGULATION

The opening sentences of the several regulatory texts of law identify the "interests targeted" for protection. Such introductory paragraphs also define the sources and media of risk subject to regulation.

The Law of 19 July 1976, relating to installations classified for environmental protection (modified to become France's Seveso law), opens with these words:

"Under the present law come all factories, workshops, depots, worksites and in general all installations [including certain mining operations], operated or held by any person or group, which may present dangers or inconveniences be it for the comfort of proximity³, or for public health, safety, or sanitation, or for agriculture, or for the protection of nature and of the environment, or for the conservation of sites and monuments [Tit. 1, Art. 1; 1993 wording]."

³ What comfort of which neighbors is not specifically stated, but it may be understood that ongoing human activities in the vicinity of the installation are to be protected.

The structure of this law, and its application, lay emphasis on informing land use decisionmakers about the risks inherent to certain classes of activities.

The Law of 22 July 1987, relating to the national Civil Defense organization, as well as to the prevention of forest fire and of major risks, states that:

"Civil Defense (la Sécurité civile) has as its object the prevention of risks of all natures as well as the protection of persons, property and the environment from accidents, disaster and catastrophes".

The Law of 2 February 1995 (Loi Barnier), one of many to update and modify the Law of 19 July 1976 and related codes, appears to specify areas of major concern as targeted by legislative provisions:

"...Protection of nature and the environment, improvement of life settings, protection of water, air, and soil, of sites and landscapes(;) urbanization, or (...) the fight against pollutions and harmful nuisances⁴ [Tit. 1, Ch. II, Art. 6]."

This law provides for reinforced information measures, and for early input by environmental defense or other citizen groups that in the past have tended to manifest their opposition to already formulated and authorized land use plans (train or highway routes were the examples given by the Minister in his presentation of the law to the Assembly). Such groups are also granted the power to bring third party suits.

These laws are drafted by the Ministry of Environment and signed by all the Ministers whose sphere of intervention is involved. Representing other bodies of law, the Code of

Work and the Code of Public Health each open on a statement of intent revealing the philosophical and practical framework of risk identification and prevention. The Code of Work (latest wording 1991) is remarkable in that it is specifically structured around the notion of risk. It dictates that:

"The head of an establishment (will take) the measures necessary to ensure the safety and protect the health of workers in the establishment (...) including actions to prevent occupational risks, information and training, and appropriate work structure and means. He oversees the adaptation of these measures to take into account changes in circumstance and to tend toward the improvement of existing situations. (...These measures are based on) the following general principles of prevention:

- a) Avoid risks;
- b) Evaluate the risks which cannot be avoided;
- c) Combat risks at their source;
- d) Adapt the work to (the worker...) [ergonomics of workstations, equipment, and organization];
- e) Take into account the state of technical evolution;
- f) Replace that which is dangerous by that which is not dangerous or that which is less dangerous;
- g) Plan prevention, integrating into a coherent whole techniques, work structure, working conditions, social relations and the influence of ambient factors;
- h) Take collective protection measures in priority over individual protection measures;
- i) Give appropriate instructions to the workers [Art. L230.1]."

The Code of Public Health (latest wording 1986) regulates for our interest:

⁴ Noise, odors and other nuisances harmful to healthy and peaceful living conditions.

"...the sanitation of (...) all human life environments;

(...) the exercise of activities not coming under the legislation of installations classified for environmental protection [Art. L.1]", and other industrial processes that come under the rubric of energy systems.

We could cite other Laws and Codes; the examples above were chosen for their value in setting out particularly the realms targeted by risk analysis and management.

II. INTERVIEW REPORTS

II.1 SEVESO LEGISLATION: THE ENVIRONMENT MINISTRY'S BUREAU FOR TECHNOLOGICAL RISKS AND CHEMICAL AND PETROLEUM INDUSTRIES

The Environment Ministry's Directorate for the Prevention of Pollutions and Risks (DPPR) includes an Industrial Environment Service (SEI), charged with developing national legislation, as well as representing the French point of view in European work to update Directives related to major risks, pollutions, etc. We met with an interim chief in the Bureau des Risques Technologiques et des Industries Chimiques et Pétrolières, who explained the spirit and the letter of French Seveso legislation.

The Law of 19 July 1976 (modified), relating to installations classified for environmental protection (ICPE), sets out the mechanisms for risk identification and control of dangerous or polluting installations, as well as for public information. When planning an installation, the industrial operator must consult an extensive nomenclature organized in terms not of installation, but of activity. Some four hundred activities, mechanical systems or chemical substances are identified and coded according to the classification they confer to the installation.

Certain activities or reduced tonnages of chemicals require only that a declaration be made to the prefect when operating or applying for building or other permits. Other classes of activity or manipulation of greater levels of dangerous substances require an authorization (conferring ICPE status). The nomenclature also states, for each activity requiring authorization, the radius within which information must be posted in defined public locations (town halls, etc.).

A third, most restrictive category is that of authorization and servitude, that is, the ICPE is placed inside a protection zone which must be incorporated into the local land use planning documents. Restrictions are placed inside this zone on residential or industrial building, and transport. This mechanism, legislated in 1987, isolates sites representing major risks as per the European Seveso Directive. It also permits neighbours of installations created (or extended) after that date to receive compensation for expropriations. (Installations predating 1987 cannot give rise to compensation. This avoids legal arguments among neighbours over "who was there first". Town mayors criticize this aspect of the law but there has not yet been sufficient demand to bring it to consideration by Parliament.)

Technically, standard exclusion or protection zones could be stated in the nomenclature. The choice was made, however, to determine zones on a case by case basis, taking into consideration danger and impact studies performed by the installation; this choice also reflects France's more recent tendency toward decentralization, giving local political actors more scope in defining their land use planning commitments.

The nomenclature has its roots in an Imperial Decree of 1810 identifying the most dangerous activities of the napoleonic era. There is a clear sense of continuity; the nomenclature and the basic approach, sorting installations into categories requiring different levels of formal control, have been developed and refined over the intervening 185 years. Thresholds are set according to the "sense" officials have at a given time as to the dangerousness of activities or substances; they are then revised based on analysis of operating experience, including accidents. No large-scale industrial accidents stand out in the history of France, as having, in the manner of Seveso, given birth to the regulatory system.

Today the system permits control of each type of danger or inconvenience (explosion, fire, toxic effluents, air, water or noise pollutions, wastes) connected to an installation, which may be subjected to declaration or authorization procedures on numerous

components. An oil refinery, for example, is subjected to authorization for some 15 activities or substances and to simple declaration of another dozen. The nomenclature is currently being revised to collapse similar rubrics (cutting the 400 entries in half) and to harmonize thresholds with European legislation. (Many French limits are stricter than European thresholds; these will not be relaxed.)

Authorization procedures

Installations whose activities are below nomenclature threshold have no formalities to fulfill. The base category of declaration requires submission of a document describing the activity, the substances present, plans for pollution control and waste treatment, and site maps to facilitate access should intervention be necessary. The authorization category places a requirement on the operator to perform much more extensive description and analysis. The authorization request must include an environmental impact study, a danger study, a worker health and safety report, and a nontechnical resumé of the impact study made available to the public.

This set of documents is submitted to the prefect who opens a public enquiry lasting one month in the defined information radius. (Written input by citizens, conclusions by the commissioner who reviews this input and makes his own observations, and the position held by town mayors are handed up.) The technical studies are evaluated by the DRIRE (Directions régionales de l'Industrie, de la Recherche et de l'Environnement), decentralized inspectorates serving the Industry and Environment Ministries. Other regional offices concerned by safety, health, architecture, etc. also perform review. The Inspector makes a report setting out the conditions under which the installation will be authorized to operate (e.g. discharge levels). This report and the nontechnical impact resumé report receive the opinion of the Conseil Départemental d'Hygiène, a regional council in which state administrations, industry, commerce, environmental defense committees and consumers are all represented. Based on these opinions the prefect then

announces the authorization decision and operating restrictions (including periodic updates of the danger study). The prefecture also makes an emergency plan (public and private emergency response resources may be requisitioned). In case of conflict, the operator, or members of the public, may bring the prefect's authorization decision before administrative court (Guérin, 1994).

There are some 600,000 installations subject to declaration in France; 60,000 are subject to authorization, and of those, 6000 are classed by the DRIRE as priority inspection sites (of which 357 are Seveso sites and certain to receive regular inspection). Against these numbers there are 600 DRIRE inspectors (or Veterinary inspectors for agricultural concerns). Each DRIRE sets its own priorities, which it notifies to the prefect. This situation has been criticized as the sign of incoherence in the overall system: the extensive regulatory scheme should be accompanied by the resources necessary to ensure systematic control. The Law of 2 February 1995 thus creates the possibility for certified private engineering consultancies to offer inspection services to lower priority installations; they in turn report results to the DRIRE, who perform secondary controls and sanction infractions.

The various elements of the authorization request are presented under the express responsibility of the industrial operator. The environmental impact report is meant to describe impacts under normal operating conditions. The danger report studies accident conditions. Instituted in France by the Law of 19 July 1976, the danger report was given greater emphasis by the European Directive of 24 June 1982, which laid down fuller requirements for description and justification of chosen risk reduction measures. An even more exhaustive safety study, reviewed by a certified expert, is required for installations representing major risks. The importance given to this risk ("anticipatory") outlook is, according to the SEI, one of the most significant contributions of the Seveso Directive to French (and other national) law. French legislation then goes farther, in making public the contents of the danger study for consideration during the enquiry (SEI, 1990).

A standard format for danger reports is not laid down in the modified Law of 19 July 1976. Until 1990, the various DRIRE had their own requirements, developed through operating experience and jurisprudence. In that year the Environment Ministry specified six accident scenarios whose analysis is now uniformly required. These include a boiling liquid and expanding vapor explosion (BLEVE, concerning liquified inflammable gas stored under pressure) and unconfined vapor cloud explosion (UVCE).

The French Environment Ministry does not hide its resolutely determinist approach. The scenarios which must be analyzed in danger studies are worst case scenarios: full guillotine rupture of a main pipe, for instance, whereas in UK requirements, industrialists object, only the case of partial rupture is set forth for analysis. There is no rule against introducing probabilistic analysis into a study, but in no case may such an approach be substituted for the deterministic outlook. The rareness of an event, states the SEI, cannot justify leaving it aside in a danger study and operating provisions, including the internal emergency plan. The Ministry's reticence toward probabilistic approaches is one of its most strongly affirmed characteristics.

"On a technical level, probabilities are very uncertain and hardly reliable. There is no data bank providing malfunction frequencies for the entire set of materials used in industry, and, moreover, the human factor is very difficult to evaluate and quantify. Probabilities are thus, for the moment at least, too insufficient and gap-ridden to provide the base for such an important subject (as major risk control). French industrialists have in fact used probabilistic risk assessment little or not at all in their danger studies. History confirms, finally, that probabilistic calculations have often proved wrong; the American space shuttle Challenger exploded although the probability of this accident was too small to be taken into account; the same is true for nuclear accidents, particularly that at Three Mile Island. Another example: the BLEVE, a phenomenon described as very unlikely by some operators, has already come to pass 135 times in 30 years!

"The only approach both politically acceptable and technically founded is to consider major accidents, to determine their effects and to present them to the public and their elected officials without a priori censure. Every person must be conscious of the range of consequences of different possible accidents before taking any decision as to land use planning" (SEI, 1990, p. 73).

The most recent Annual Report of the Union of French Petroleum Industries (UFIP, 1994) states one type of criticism this ministerial position has received. UFIP, in agreement with a National Grouping of Townships for the Control of Major Technological Risks, accept the notion that the civil protection zone defined around a hazardous installation should be extended as far as implied by the maximalist scenarios considered. They plead, however, that the exclusion zones, within which building and activity are restricted, should on the contrary take into account the risk reduction and mitigation measures applied by the operator. This would be in keeping with the position adopted by other European countries; the two groups wish to see that position generalized by the Seveso Directive update on the boards in Brussels in 1995.

France presides the European Union in 1995 and intends indeed to push its positions in the revision of Seveso and pollution control directives. France considers herself to be the country whose legislation and practice are most in conformity with the standing Seveso Directive, and would like other countries to make the same efforts. Ministerial priorities for revision will be the simplification and rationalization of the nomenclatures annexed to the Directive, and the reinforcement indeed of land use control, especially in better public information to guide local decisionmaking.

II.2 HYDROCARBONS DIRECTORATE, INDUSTRY MINISTRY: PIPELINE SAFETY

The French Industry Ministry contains a large Directorate General of Energy and Primary Materials, including a Hydrocarbons Directorate. We spoke with two members of the Refining and Environment Bureau about the rationale underlying safety regulation for crude oil pipeline transport. This mode of transport is evaluated by the Directorate to be by and large the safest. Our contacts consider their work to be the development of rules that will maintain this safety level, enabling them to represent France's oil interests (as distinct from oil industry interests) in energy and risk negotiations with other ministries.

"We have some housekeeping to do", in the multitude of overlapping texts of law regulating the pipeline transport of hazardous materials. France has some 8000 km of oil pipeline (in sections of 600-2000 km), and 27000 km of liquified natural gas transport pipeline (as well as another 140000 km of distribution network). Chemical transport by pipeline represents another 4000 km, over short distances (80 km maximum), usually between factory sites. The distinctions drawn among (and within) these categories are seen to be fundamentally administrative, rather than functional. In the same way, based on historic divisions, the regulatory management of related energy technologies is spread physically across Paris in various Bureaux (perhaps the greatest dispersion to be found in French administration). In contrast, a single system of law governs oil products pipeline transport safety, and today's project is to develop unified safety regulation for all manner of pipelines.

The French state created a monopoly on oil imports in 1928, delegating refining and distribution to national industries. The first pipelines were installed in 1949; in 1959, they extended far enough that the need was felt to establish national safety regulation. During the intervening ten years, the design, maintenance and operation of pipelines had been governed solely by American "rules of the art"... in an industry "respectful of the American oil experience". Today American Petroleum Institute (API) and American

Society of Mechanical Engineers (ASME) standards are still relied upon, along with French and European standards.

The Law of 22 July 1987 concerning major risks became, retroactively, the major governing text in the pipeline sector. We learned that there is no European technical safety legislation (the last attempt, in 1974, was dropped) and indeed no administrative legislation on transnational pipelines (French and German national administration and safety guidelines, for instance, are seen to be sufficiently harmonized).

Liquid hydrocarbons pipeline transport has had a very good safety record in France (a single lethal accident in thirty years). This record makes it highly preferable in safety terms to road transport. Safety rules take on a special function in this context. They must protect what is seen to be the optimum balance among transport options. A dramatic incident, it is felt, would produce public outcry for overexpensive risk reduction technologies, with the result that objectively more dangerous road transport would be economically favored.

Thus the Bureau is engaged in making rules that must "translate our safety concerns without handicapping the economic competitiveness of pipelines". The outcomes are seen to be gains in both safety and in the wider economic context affected by energy pricing. All risk regulators in France do this sort of cost/benefit analysis, we were told; simply, not everyone admits to it.

How does the Bureau assess this balance between "the benefits of the industrial activity" and residual risks borne by society? In the manner of a "French lover"... it takes feeling! The Bureau's approach is readily described as common sensical, pragmatic as opposed to "niggling", empirical, and lacking in formal evaluation. France is seen to have a long way to go before building a computerized data base on pipeline performances that may compare to those of other European administrations. Annual

safety statistics provided by industry demonstrate that the rules are functioning as expected; no mechanism exists, however, to make close evaluation of the impact of a rule change. Two broad criteria are held in view: that the technical state of the art is satisfied, and the public as well.

The actual formulation of pipeline safety rules suffers from no imprecision. Three types of input are used: evolutions in available technology, observations by the DRIRE from their periodic pipeline inspections, and information provided by operators. Professional organizations, but also and especially single refiners are solicited for the degree of detail they can bring to dialogue. Although "we don't wait for operators to propose their own rules", "we can do nothing without them"; the Bureau relies on field statistics and the pragmatic view of experienced operators "who've gone farthest on a given problem" to determine what safety level is reasonably achievable. Such a collegial approach is also the only means to ensure good acceptance of the rules that, after discussion, are set out in ministerial instructions. Consensus is sometimes "induced" by the Bureau which is firm in requiring that safety levels be maintained.

The resulting body of rules is felt to be rational and fitting; if they are properly followed, they provide "reasonable assurance that safety goals will be met". The guiding spirit of pipeline safety regulation is, like ICPE regulation, determinist. Three fundamental principles are observed: identification of hazards, their technological separation or limitation, and defense in depth.

Evidence that the rules are working is provided by the excellent safety record, by the fact that oil pipelines are seen in France to be an "objectively low risk sector", and, indirectly, by the worse safety records in other nations whose regulation or practice does not provide for comparable risk control and maintenance. An indirect example was provided in a telling comment on the rupture of a natural gas pipeline in Oukhta in the Russian Federation (flames attracted the attention of an overflying Japanese plane). An Emergency Situations Ministry spokesman said at that time that such accidents "are

experienced on Russian oil and gas pipelines every week" (Le Monde, 29 April 1995). (A French Civil Defense official, interviewed on national radio, found the accident regrettable, but nonetheless expressed satisfaction that the theoretical accident scenarios required for ICPE danger studies had received confirmation: "We have the right flame height".)

Pipelines are relatively simple systems, with a single potential fault: a hole in the line. A fault on the pipeline is generally detected after the fact and the search for causes is different from that in a geographically concentrated ICPE, where "you know everything that goes on". The major cause of polluting pipeline failure is external (and unintentional) "agression", often by agricultural, building or road works.

The Bureau sees both material and immaterial prevention measures which may reduce this risk of aggression. Foremost may be information. Efforts are underway to "publicize" the existence of pipelines and to sensitize builders and agricultural workers to their presence. A recent proud achievement is the issuing of a joint order signed by ten ministers. Under development for eight years, the Arrêté of 16 November 1994 harmonizes information requirements for all manner of transport or distribution lines whose failure would have wide impact: electricity, gas, sewage, water, and telephone lines as well as hazardous materials transport. The order requires operators to provide maps to the town hall, identifying the presence of lines in the zone governed. Moreover, it requires persons or organizations planning works to consult these maps, and to contact operators whose lines are present.

Relationship with the public

The French public today appears on the whole to be "indifferent" to the risks that may be posed by the transport of hazardous materials, by pipeline or by road. The Bureau has formulated this perception in interactions with industrialists and with local officials

(rather than through survey, for instance). Objections raised to the building of pipelines are more likely to be based on quality of life considerations (protecting "three trees in a field") than on other dimensions of risk. Indeed the public would seem to lack practice in reasoning about risk tradeoffs (ignoring the fact that the "highway ten kilometers away is more dangerous" for trees and for people than the pipeline). "Nothing is neutral in environmental protection", decisions about what to preserve are never easy; but "some solutions are better than others in terms of safety and shouldn't be economically handicapped". For the moment the discussion of cost efficiency and residual risk has not been opened with the public.

The question of public acceptability of risks stands out most in the nuclear realm in France; regulators in other energy sectors have relative liberty then to follow their pragmatic, empirical approach. "We are less theoretical about risk" than the Dutch, for instance; French legislation puts requirements on means, rather than ends (in the form of quantitative risk limits). The French public, in the judgment of the Bureau, would not be favorable to probabilistic risk arguments from their decisionmakers; if they were to hear quoted the empirically acceptable individual lethal risk level of 10^{-6} /year they "would be apt to respond 'it's not low enough!'".

The public "may not necessarily have a demand for zero risk, and nothing says that they would not accept quantitative risk thresholds if educated" to that sort of reasoning, but as of today the nation has neither quantitative safety goals nor a project to educate the public to the question. Nevertheless some thought has been given by the Bureau to the gap between regulators and the public in terms of risk perceptions and priorities, and to the sort of risk comparisons that might be made to defend regulatory views should they be questioned. ("We'd first have to explain the risks attached to crossing the street to buy a baguette.")

Is it true that in France acceptance for probabilistic risk assessment could be found among "prepared" members of the public? Probabilistic and determinist approaches are

used in combination in the nuclear field and by industry and local planners (as in e.g. truck routing; see Brenot et al., 1994a). In the non-nuclear regulatory sector, however, the Industry Ministry generally shares Environment's reticence toward the probabilistic model. Probabilistic methods are seen to be "debatable", even in the hands of the best experts. "Basic assumptions must be subjectively chosen at the outset; the very culture of the expert is involved". The Bureau alludes to international debates over pipeline safety: "The English and Germans start with the assumption that one tube has such a big diameter that a whole class of accidents can't take place; they demonstrate that there is zero risk."

The determinist philosophy, placing emphasis on risk identification and mitigation, may be most appropriate today to French society. Brenot et al. (1994b) report that a large majority of French residents feel that even rare catastrophic accidents (probability 10^{-6} /year) should be "managed". Almost 90% of safety specialists and experts are shown to agree.

II.3 THE INDUSTRY MINISTRY'S INDUSTRIAL SAFETY SUBDIRECTORATE

France is said to count three major institutions for energy risk regulation. These include the SEI (Section II.1) and the Nuclear Safety Authority (Section II.5), and finally the Industrial Safety Subdirectorate (SDSI), part of the Industry Ministry's Direction de l'Action Régionale et de la Petite et Moyenne Industrie. This Subdirectorate is concerned with the control and oversight of human and environmental safety features and operates through the DRIRE, or regional inspectorates.

We were channeled by a number of interviewees to the "Underground Techniques" Department of the Industrial Safety Subdirectorate. This Department is concerned with the risks of fire or explosion in underground fuel storage systems. The Department head

described authorization requirements for his domain, but also industrial health and safety inspection in general.

We reproduce the inspection table he drew for us, for it illustrates once again the multiplicity of French state instruments for risk control, rooted both in historic divisions and in modern evolutions.

Health and Safety Inspections: Three Ministries

The DRIRE are the Regional Directorates of Industry, Research and Environment; regional antennae of both the Industry and Environment Ministries, they carry out various types of inspection and evaluation and are the state's direct technical interlocutors for industry. The DRIRE, overseen by the SDSI, perform traditional worker health and safety inspections in the energy domain. The DRIRE also carry out the external safety inspections legislated for classified installations, under the supervision of the Environment Ministry. (Each year, as risk knowledge extends, new types of industrial activities are added to the ICPE nomenclature and pass thus into the Seveso realm. In this way the Industry Ministry is steadily dispossessed of former control and oversight responsibilities which are transferred to Environment.)

Table I also highlights the different, overlapping regulatory frameworks governing the various types of industrial installation. The Mining Code originated in the Napoleonic era, when coal was a major energy source and mining the center of industrialization, and when Mining Engineers came to represent a scientific and power elite. Revised and completed over the decades, the Code regulates mines (with which oil wells are grouped in a legal sense) and quarries. Quarries have recently been incorporated as well under the ICPE legislation, implying a new range of inspection requirements. Gas and electricity installations, too, may be partially regulated by the Seveso framework (a gas compressor is an ICPE, but a pipeline delivering gas to Paris from the Mediterranean

region is not). In other aspects, they are regulated by the Work Code and Employment Ministry. However the highly technical DRIRE "cross over" to perform the worker safety inspections.

In non-energy sector Seveso installations, as well as other, nonclassified, industries, worker health and safety inspections are carried out by the regional corps of the Employment Ministry (Inspection du Travail). This inspection activity is interesting for our research in that it provides an example of how economic incentives and sanctions may be handled in direct correlation with risk levels. National health insurance employer contributions are directly indexed on sector risks but also on site safety performance. The state Regional Funds for Health Insurance (CRAM) become in this connection an important intellectual and practical resource for industry, providing a forum for exchange of research and training in risk reduction for workers. Acceptable risk levels in a given context are negotiated by multipartite Health and Safety Commissions (required in companies of over ten employees); these CHSCT have decision power to study working conditions and implement prevention.

Safety Studies in the Non-Seveso Domain: the Safety and Health Document

Similar to the danger study in the ICPE domain, a Safety and Health Document must be submitted to the Industrial Safety Subdirectorate for authorization of new non-ICPE energy operations. (Such a document is also called for in recent European Union Directives 92-91 and 92-104 concerning drilling and mining activities, directives expected to be fully translated into French law in 1995.) The Safety and Health Document is composed of two sections. The first identifies characteristic hazards of the proposed installation, generally on the basis of cause or consequence trees. Then, in a determinist framework, the Document reports measures chosen to reduce the expected frequency of each identified risk, or to mitigate anticipated consequences. The SDSI appears to be less reserved concerning the value of probabilistic risk assessments; this is said to be a "bone of contention" with Environment. Operators routinely present probabilistic statements as part of their Document.

The Industrial Safety Subdirectorate plans to elaborate a guide to aid operators fulfill the Document requirement. Today, guidance exists in the form of reference values for the principal dangers (e.g. heat radiation limits). Such state of the art values are published by the Environment Ministry and are in force for all industrial domains.

II.4 THE FRENCH UNION OF PETROLEUM INDUSTRIES (UFIP)

We sought an industry point of view from the Union Française des Industries Pétrolières, a professional lobby grouping French national, international and small petroleum industries. Our interview with the president of UFIP's Environment Commission, and later input from the technical director in charge of Health and Safety, gave insight into cooperation and tension between authorities and industry in attempting to define workable regulations. Cogent criticism was offered concerning gaps in

optimisation models. Finally, we obtained information on the probabilistic model for risk assessment disseminated by UFIP to aid its members in site risk control and in responding to authorization requirements.

Dialog and Pressure: Defending ALARA from Candide and BACT

Oil refineries are classified installations, subject to the Laws of 1976 and 1987 on environmental protection and on major risks. The third guiding piece of legislation cited, the Ministerial Order of 1 March 1993, sets petroleum and chemical sector emission limits through the year 2000, in keeping with the Geneva protocol and engagements taken at the Rio Environment Summit. This order represents integrated pollution control for air, water and soil; authorizations, safety plans and population protection concerning these three elements are overseen by one authority.

"In France there is a long tradition of centralized regulation, control and intervention by the public authorities. The negative aspect is bureaucracy; the positive aspect is that ministries and industries long ago got into the habit of dialoguing." The development of the integrated pollution control order provides an example of long and fruitful dialogue. The Environment Ministry put forward its requirements, but took into account UFIP positions... most importantly, the "bubble concept", in which the focus of measure is not each chimney emitting SO_2 or NO_x , but the whole of a designated industrial installation. This concept permits the industrial operator to take responsibility for internal optimisation measures to meet an overall maximum emission allowance. For instance, concentrated SO_2 emissions may be more efficiently and widely dispersed at a higher air level by tall chimneys. This design feature would have been underexploited had a cap been put on single chimney emissions. Such a cap would require that more chimneys be constructed to handle a same volume, and actually provide economic incentive to spread environmentally more harmful low dispersions over a set of shorter chimneys.

In the past five years, the petroleum industry has observed a net increase in national and international environmental protection requirements, in concert with heightened public sensitivity to technological risks and ecological value choices. Accepted in principle by the industry, which rejects "working methods" such as those whose pollution legacy is now revealed in the ex-Eastern bloc, this net increase is "worrisome" in that optimisation concepts seem far from regulators' concerns. Indeed, it is feared that an ALARA approach of selecting environmental quality indicators and reasonably achievable protection goals may be overlooked.

Such a tendency is observed specifically on a European level, in the preparation today for instance of the future Integrated Pollution Prevention and Control (IPPC) Directive. The German European Union Member philosophy is perceived as tending to require homogenization along an ever-upward progression of best available control technologies. In contrast, and more positively, the French European presidency is seen as oriented toward introducing controls of another order. Thus, the French advocate a truly integrated and homogeneous set of regulations, standards, and frameworks for land use planning, authorization, control, and enforcement, based on its own Seveso and pollution control experience. ("Best available technology" was the term used by the French Environment Ministry in the early eighties, but the SEI now calls "... not entailing excessive cost" the "magic words" for ensuring industrial economic health.)

UFIP warns too against the tightening of authorization timeframes. The refining industry makes investments on a ten year cycle; if three year authorizations are settled upon in Europe, in combination with the pure BACT approach, operators could face licensing renewal refusals if they fail to refit with the latest available technologies, regardless of their environmental or economic justification. This is perceived as an unnecessary increment in the environment of "uncertainty" already surrounding longterm economic decisions.

The French administration is currently developing depollution incentive taxes on industry, managed by the Agence de l'Environnement et de la Maîtrise de l'Energie (ADEME); as factory emissions are reduced and fuel products introduced that will make transport less polluting, industry will bear a lighter parafiscal tax load. In the interim, tax revenues are invested in air, water and soil depollution technologies. The philosophy is accepted by the industry, which however is lobbying for a more active role in the management of the framework. This management participation "should be commensurate" with the considerable sums now collected, and might lead to "more reasonable" emission limits, seen today to outpace depollution as they become more restrictive (and more revenue-productive).

These and other examples demonstrate concern in the face of gaps observed between industry optimisation analyses and practices, and national or international regulatory approaches. The petroleum industry criticizes shortsighted risk goal setting and control policies that fail, it is felt, to take into account the finite economic environment -- and the social environment. The bubble concept, it is argued, should be applied over the whole range of environmental risks, and... risk producers.

" 'The polluter pays' is a good principle-- except that no one wants to see himself as the polluter." Rational pollution reduction measures, according to UFIP, should be realistically paced, and integrate not only industry limits and sanctions, but revised traffic and transport laws, and economic or other incentives to private citizens to modify their driving behavior (including greater use of public transport) and to acquire new, cleaner cars. Better measurement and feedback of regulatory effectiveness and efficiency are also pointed to as necessary goals.

UFIP of course is not the sole source of such integrative thinking; the National Debate on Energy and Environment (Souviron, 1994) reported such criticism. It should be noted that elements of the recommended approach to pollution reduction are found today in France on a regional level, with the help of the state, as in the recent

reintroduction of electric tramways to several major cities. UFIP also points to cooperative research initiatives with the European Union, such as that to monitor city air quality over a significant time period and make comparisons with World Health Organization tolerability limits. Another European collaborative program models pollution optimisation schemes, varying a range of parameters including engine and fuel design, and industrial and transport trends.

A final example of concrete cooperation, and necessary communication, is given in reference to France's Special Protection Zones first defined by a 1974 decree. These are urban areas identified as particularly vulnerable to pollutions. In each, an Air Quality Monitoring Network is funded and managed jointly by local and state administrations and industry. Captors monitor airborne pollutant levels as defined by European directives; various thresholds when crossed trigger public information, alert or intervention mechanisms. The same type of networks exist for water quality monitoring although there is no public alert provision.

This example underlines for us the fact that data gathering and risk reduction effectiveness monitoring, as well as public protection, in France are investments shared by industry and public authorities. It is likely that such data, and many brands of intervention, would be financially and structurally inaccessible to the state alone.

A Uniform Method of Risk Assessment

In the first part of the 1980's the French petroleum industry developed a uniform method for risk assessment in any refinery subsystem; it was presented to the Environment Ministry in 1985. A British consultancy refined the method in 1987 and further critical evaluation was performed in 1989 by the national agency CERCHAR (now INERIS, Institut National de l'Environnement Industriel et des Risques) at the request of the Ministry. The method has been used in its present form since that time,

and may be revised, we were told, subject to new advances in knowledge or in regulatory orientations.

This probabilistic assessment method is commonly used by the the members of the French oil industry in preparing danger studies called for under the legislation (see Sections II.1 and II.3). The method is presented in the industry Danger Study Sample Outline document (UCSIP, 1988) as allowing the user to determine whether the system studied may demand further safety analysis, or require modification in order to bring its risk to an acceptable level. The classic concept of risk as damage x probability is used, with provision of a scale of severity and a semi-quantitative probability of occurrence scale. When these two values have been assigned to a system event according to fault tree analysis facilitated by the document, the user may check a matrix to judge the acceptability of the risk level found, or the priority assigned to reducing unacceptable risk levels.

This Uniform Method thus provides a semi-quantitative statement of acceptable risk, a type of model consciously avoided by French regulators outside the nuclear sector, and just as consciously adopted by the Dutch Parliament or the British Health and Safety Executive to guide national risk decisions. Evaluations of system safety along this model are used within the refinery as part of ALARA management, and make up part of the danger study presented in view of licensing. They are accepted by the regulators under the "express responsibility" of the industrial operator. They cannot replace in such a study the consideration given to accident scenarios dictated by the Environment Ministry in a determinist outlook.

The Uniform Method notion of accident severity combines statements of consequences to both persons and materials, and the spread of these consequences. A six-level scale provides definitions more detailed than we may reproduce here. Level 0 through Level 2 designate events ranging from "zero consequences" to "significant consequences", limited to damage to system performance and availability, and without damage to

persons or equipment. Level 3, "critical consequences", may include personal injury and/or system or equipment damage, within site confines. Level 4 designates "catastrophic consequences" within confines, including system destruction and/or injuries and/or death. Level 5, finally, designates "critical" or "catastrophic" events whose effects spread to outside the refinery site.

The second risk dimension gauged by the method is that of probability. Again six detailed and semi-quantitative levels are provided. Level 1 (very improbable occurrence, frequency of under 10^{-10} per hour) to Level 4 (possible but infrequent event, probability of between 10^{-6} and 10^{-4} per hour) are considered under the Method to represent acceptable probabilities. Level 5 (frequent event, with a likelihood of occurrence of over 10^{-4} per hour) lies above the "safety cutoff". A final Level X designates the frequency of events to which probabilities may not be attributed (e.g. terrorist attack).

The risk level of the system considered then is designated by the severity level followed by the probability level. A decision criterion is then given: Only those systems characterized by a (severity x probability) risk level of 5X, 55, 54, 53, 45 or 44 are candidates for a more thorough safety study or for system modifications to bring probabilities or consequences to an acceptable level. Although the model is expressed differently, the values are comparable to those retained by the current Dutch legislation.

"People seem to forget that the industrial operator is the first one to want to protect and maintain system safety: it's our livelihood". At present petroleum industry survey data, and ministerial gut feeling, indicate that the public if asked does not enjoy a serene feeling of confidence that oil sector risks are sufficiently controlled. The Environment Ministry puts land use at the center of its regulatory approach, insisting that local planners and risk bearers should be aware of the maximal accident risks conceivable in an installation. This determinist model shared by regulators is meant not only to force

consideration of risks, but to demonstrate ministerial toughness. The Ministries thus leave the semi-quantitative probabilistic model to "the sole responsibility" of the industry. Yet this industry model is comparable to the strictest, quantified national legislation in existence, another national mechanism that forces industry and the public to "face the risks".

Examples provided throughout this Chapter show that gaps among models held by risk regulators, creators and bearers create gaps in optimization decisions. Today the public, the third and often phantom partner, is only a potential arbiter of such gaps. Would it be inappropriate to open discussions of these gaps among regulators and regulated, such that the public may become better prepared to arbitrate? Such a move would not be inconsistent with the Environment Ministry's choice to stress public information and the transfer of risk management decisions to local actors.

II.5 THE NUCLEAR SAFETY AUTHORITY :

NUCLEAR INSTALLATIONS SAFETY DIRECTORATE

We met with the Deputy Director of the DSIN (Direction de la Sûreté des Installations Nucléaires) The DSIN, in tandem with the DRIRE field inspectorates, make up the Nuclear Safety Authority under the Ministries of Industry and Environment. In keeping with the strong emphasis on internal clarity and public information that are increasingly a part of the DSIN's identity, a thoroughly documented presentation was made.

The Reference to Authority

The image of the broader French nuclear establishment has typically been one of a technocracy well apart from public view and control (see Section III). Criticisms have long been addressed to the Commissariat d'Énergie Atomique, for example, for the degree of secrecy surrounding its decisions and operations. The CEA has high confidence in the quality of its operations, based on a long record of technical achievement and protection of a nation's interests. This confidence however may also be at the source of small fiascos, like the unrecorded disposal of slightly radioactive materials in the countryside around CEA installations, followed by bad handling of public demands for accounts (Lallement, 1993). The National Debate on Energy and Environment updated critiques of the nuclear monopoly on France's energy scene.

The entire nuclear industry and regulatory establishment in the past fifteen years, however, has been making a steady move toward accountability on all levels, with attendant effects on safety culture (see e.g. Mays and Poumadère, 1989). Increasingly the strategy may be observed of couching nuclear management in the national legislative framework; decrees in the nuclear field have long existed, but now stress is laid on direct oversight by democratic representation. Conflict and crisis in the management of radioactive waste, for example, was sought to be resolved by Parliamentary intervention (hearings and the Law of 30 December 1991, fitting waste management to the principal dimensions of public concern). ANDRA, the French waste management agency, became independent from the CEA with that law. It has since taken pains to reinforce both an inner and visible organizational identity of subordination to the law as well as to principles of total quality assurance (Mays, 1995).

The DSIN appears to adhere to a similar strategy of reference to authority. The DSIN presents itself as one of a web of independent, accountable organizations under the French Prime Minister all concerned with general nuclear safety. The DSIN highlights its role of "enforcer" of ministerial orders and inspector of field practices to verify their conformity to DSIN-approved safety codes and standards. One of the DSIN priorities

for the coming months is the structuring of a law specific to nuclear safety, to which it may refer directly.

Such strategic choices (certainly appropriate) are part of the response to public pressure which, if stereotypically less turbulent in France than in other countries, concentrates itself on the nuclear establishment to express the fundamental demand for technological safety. Indeed this apparent special focus by the French public on nuclear safety, commented upon by every regulator, has produced a highly developed, visible and accessible safety authority... while other industrial and energy branches have remained outside the limelight. These are the "special conditions" which are seen to have forced development of a safety authority up to the measure of France's nuclear energy dependence. The same conditions of public demand (or perception by public actors of public demand), by diverting focus, may have handicapped development of regulation and especially monitoring systems in other sectors.

The DSIN slide presentation, through which we were led, thus puts forward the conditions under which the public safety demand may be met. "For the Safety Authority to be independent, competent and credible, it must have: a good charter" (the double oversight by Industry and Environment ministries is felt to be an advantage); "sufficient resources" (human resources amount to 200 persons in Paris and in DRIRE field inspectorates; some 350 other persons work in the research branch, part of the Institute for Nuclear Safety and Protection, IPSN). "The working method must be rigorous, we must have awareness of what the 'others' are doing" (in other industrial sectors, and internationally-- constant contact is maintained with fifteen national authorities), and "perform proper monitoring and reporting. Finally, a democratic system is needed." This last translates into permanent accessibility to the public, whose questions and challenges keep the Authority on its toes.

General Nuclear Safety: Government and Technical Spheres

Nuclear safety is overseen by a combined system of government and technical support bodies. Parliamentary control is exercised through the Parliamentary Office for the Assessment of Scientific and Technological Choices. This Office carries out hearings and formulates recommendations, often taken up in law, upon the demand of the Senate or Assembly. (Recent cases have concerned waste management as mentioned above.) An Interministerial Commission for Basic Nuclear Installations examines and validates legal dispositions.

Figure 2: The French Severity Scale. Source: DSIN.

A High Council for Nuclear Safety and Information meets every two or three months, and gives general orientations and specific opinions to the overseeing Ministers who have in charge the broad policy decisions. This High Council, composed of 20-30 persons representing industry, regulators, and also other scientific, professional, media, ecology, or consumer defense groups, in 1987-88 developed the French Severity Scale classifying incidents or accidents on six levels. The International Nuclear Event Scale is based on this work, with the addition of a zero level for incidents with no safety impact and an added highest level (7) to refine distinctions among major accidents with off-site consequences.

The Nuclear Safety Authority, composed of DSIN and the DRIRE, are also part of the governmental sphere. The technical support bodies are composed of the IPSN, three Standing Groups (on nuclear reactors, other nuclear installations, and longterm waste disposal), a Standing Nuclear Section of the Central Commission for pressure vessels, and ad hoc Expert Groups.

"Nuclear technical safety", states the DSIN slide presentation package, "means the prevention of accidents and the mitigation of their consequences. The nuclear operator has prime responsibility for operating safety; the French nuclear regulator, DSIN, makes safety inspections". DSIN's role in fact is much broader: it draws up regulations and monitors their application; carries out the licensing procedures for Basic Nuclear Installations defined under the Decree of 11 Dec. 1963 (excluding military installations, "small scale" industry, and transport); monitors installations and penalizes infractions; activates the emergency response plan in the event of accident and gives technical assistance to the prefect, the regional representative of the state; organizes public information on nuclear safety.

In contrast with practice in other countries, the Safety Authority does not handle every aspect of the nuclear domain. Radioprotection is covered by the Health Ministry's Office de Protection contre les radiations ionisantes (OPRI) with technical assistance

from distinct departments of the IPSN. The Interior Ministry covers crisis planning and management, the Transport Ministry controls transport of radioactive materials. As in other sectors seen in the course of this study, responsibilities are thus spread across various Ministries and organisms.

Rulemaking

The hammering out of rules is described as a back-and-forth process between the risk creator and regulator. The DSIN, as Safety Authority, issues Basic Safety Rules (BSR) on various technical subjects. These BSR are recommendations, defining technical safety goals and accepted practice at a given time. They may take the form of a probabilistic limit set on the risk of an accident at each level of seriousness.

The BSR do not constitute a regulatory document in a strict sense. The DSIN presents them to operators, saying, in essence, "make us an offer". If operators (Electricity of France, CEA, COGEMA fuel (re)processors, Framatome reactor constructors) can demonstrate that the technical safety aims underlying a BSR can be achieved by alternative means, they are free to refuse the detailed provisions of the rule.

It is thus the operator who carries out the primary safety analyses, and, indeed, "makes an offer " of terms and conditions thought to guarantee the BSR objectives. This is pointed to as a French particularity, uncommon on the international nuclear regulatory scene. The fact that France's fifty four operating pressurized water reactors are so highly standardized makes centralized analysis by operators and then relatively compact regulation possible. In contrast, other safety authorities (and especially the US Nuclear Regulatory Commission) are confronted with a highly varied population of operators and technologies.

For each installation, the operator must develop and submit documents detailing rules, codes and standards for design, construction and operations. These are reviewed by the DSIN and once approved, have binding force. Their respect is verified by the Safety Authority field inspectors. Six hundred inspections were carried out in 1993 (a figure on the rise, not because infractions are frequent, but because the Safety Authority has enlarged its DRIRE inspection corps).

This rulemaking process is thus characterized by a moving exchange of expertise and counterexpertise between the regulator and the operator. Conflict may enter this process, if the operator refuses to withdraw proposals which the DSIN rejects on the basis of commissioned study by the IPSN. At that time the Standing Expert groups are called upon. International data bases are accessed to defend the DSIN position and specific advice may be requested from other national authorities with experience in the technical area under dispute. Throughout this time the installation is frozen (conflict has lasted for over a year in some cases). The conflict may go to the ministerial level when an exceptionally large number of conditions are under dispute.

Such conflict may bear, for example, upon retrofitting. When new BSR are published for late generation technology, the DSIN asks operators to identify the gaps between standards observed on ageing equipment and new standards, and to propose solutions. The operator defends the acceptability of any remaining gap, and the DSIN, after consultation, accepts or rejects the proposal. Here cost optimisation may enter into the operator's reasoning (e.g. how much intervention is merited given that the equipment may have only ten more years of service), but this is not a Safety Authority criterion. There has not been much conflict on such points to date, but more is anticipated as a larger set of France's reactors come into their final service period.

"Cost is easy to estimate; efficiency more difficult, especially for equipment installed to prevent accidents of greatly reduced probability. In theory cost efficiency analysis is fine. In practice, regulators in France apply a determinist approach." Even when

probabilistic safety goals are set, as by the BSR, there is no numerical evaluation of unacceptable consequences in terms of human death (in contrast with UK or Dutch practice). Probabilistic risk analysis is generally limited to verifying risk reduction priorities in defined technical systems. The judged rarity of a supercombined accident does not eliminate planning for emergency response, another of the Safety Authority's major social roles. Determinist scenarios are developed and assessed each time offsite conditions change, as when for example new construction may be planned within the 10 km safety radius of a nuclear installation. Recent cases include planned enlargement of a shopping center and extension of a bullet train line. The local reactor safety studies and emergency plans were revised in response to these modifications.

Serious or minimal, any subject of conflict between regulator and risk creator, like any operating event (in 1993, 327 below scale, 148 operating anomalies, two Level 2 incidents), is reported to the public via the "Nuclear Magazine": MAGNUC, a videotext server. Public information was a statutory part of DSIN's mission from its creation in 1973. In early 1978 a bimonthly print magazine, now called Contrôle, began publishing dossiers in which the DSIN point of view is balanced by replies from operators, ecologists or other sources. The Chernobyl accident in 1986 called forth a huge surge in requests for information from the public. Within one week, the DSIN found an innovative solution based on the videotext technology that had recently been made available to French households by the telephone company. Since that time, MAGNUC⁵ presents safety, radioprotection and measurement bulletins updated weekly or immediately upon report.

Responsiveness to public concern is shown in the Safety Authority's current project to develop well-identified provisions for every species of nuclear waste to be found in France. To date, low, medium and highly radioactive waste have each been assigned a specific management framework (see Table II). In keeping with the international consensus that there is no absolute human health safety threshold in terms of

radioactivity, even very low level waste should now receive its own regulatory status and defined management measures.

Table II: Operational classification of radioactive waste. Source: DSIN.

⁵ The French Safety Authority's "nuclear magazine" may be accessed by videotext in France by dialing 3614, and from abroad by +33-3643-1414, and entering the code "MAGNUC".

II.6 THE PUBLIC HEALTH ASPECT

Throughout our research, we sought to evaluate what appears to be at stake in France's energy risk control systems. It is in this spirit that we have described, in Section I.4, the interests designated for protection in the various laws and codes. The ICPE law (19 July 1976), for instance, refers to "public health, safety and sanitation", but we observe that the health rationale seems absent in general from further regulatory or practical discourse. The objective of protecting citizens' life, health, and wellbeing may be fundamental, but it is seldom referred to overtly as a guiding principle.

Seeking to make the link between risk control and public health, we contacted the Ministry of Social Affairs, Health and Cities, and were directed to the General Directorate for Health. The Health Watch Subdirectorate contains five Bureaux; we met with the head of the Bureau des Risques des Milieux, or habitat risks. We were able to learn of various public health priorities and how they come to the fore, but also heard a political interpretation of why France does not yet have a fully developed regulatory notion of "environmental health".

Structure and Priorities

The Health Watch Subdirectorate is concerned with observation, analysis (epidemiological and toxicological) and alert in the public health area. Action domains include environmental risks, radioprotection, infectious disease, water and foodstuffs. The Bureau des Risques des Milieux covers the domains of chemical risks, soil or atmospheric pollution, habitation risks including indoor air quality and domestic accidents, other environmental nuisances like noise, and some aspects of radioprotection.

Attached to the Health Watch Subdirectorate are a number of permanent consultative committees, among which the High Council of Public Health (CSHPF, first created in 1822) and the Office for Ionizing Radiation Protection (OPRI). These scientific committees are frequently solicited for expert evaluations, be it for inspection in a given situation or to set future research and prevention priorities.

The Subdirectorate's major mission lies in prevention, education, and anticipation of major public health issues. Prefects may also solicit the Subdirectorate for advice in case of public health emergency (e.g. an overturned chemical tank truck). Here too the Subdirectorate wants to promote primary prevention, and modify the "information culture" seen to reduce risk communication in the Health Ministry today to "media management" in times of crisis.

One of the Bureau action priorities for the coming year, particularly interesting for this research, concerns the health effects linked to growing traffic, and especially the pollution contribution of those 40% of France's vehicles which run on diesel fuel. In the face of public and media concern, the Bureau perceives a need for advanced study in this area, identifying what is known or needs to be known about health effects and future transport trends. Critical analysis too is needed of the social and economic environment (for instance, current tax structures provide incentives to maximize diesel fueled highway truck transport).

Territorial Conflicts

The Health Ministry must be very active in putting forward the public health point of view and priorities, especially in today's particular political context of "institutional instability". Recent budgets allocations show the importance successive governments have attached to environmental issues, but the organizational structures for handling them are still in an evolutionary phase. Broad responsibilities now are assigned

essentially by the Prime Minister's cabinet, and the Health Watch Subdirectorate regrets that the Health Ministry was entirely overlooked in the 1993 creation of an interministerial committee on the environment. The Environment Ministry is becoming increasingly the major actor, if not an outright competitor, in legislative areas touching on health such as air or noise pollution or ozone protection.

Our observer sees openly shared priorities today between the Health and Industry Ministries, but sees "immaturity" in the Health-Environment ministerial relationship. The Health Directorate finds itself in the role of badgering the Environment Ministry to keep in view the objectives of protecting human health and of building coherent public health policy. There is common ground in a determinist risk control outlook: both Ministries feel that the lessons learned from the Seveso, Chernobyl, or Bhopal catastrophes must be guiding forces, even if such tragedies are of minimal frequency.

Perhaps in the same way as other interviewees regret vestigial separations among bodies concerned with energy risk control, the Bureau notes and regrets the difficulty of formulating a "synthetic" view in today's organizational context; "environmental health has not arrived here as it has in other countries". One further obstacle to forming such a concept may be the relative poverty of observation and evaluation mechanisms, which might measure for instance the impact of environmental regulations on public health. As in all the (non-nuclear) public sectors encountered in the course of this research, the evaluative phase of the risk regulatory process is the least developed. The Health Ministry has responded to this weakness with the 1993 creation of twenty six Regional Health Observatories, which should develop standardized criteria to make nationwide comparisons of health data, including environmental health data. These Observatories should come into high gear with the traffic pollution study project.

Our interviewee sees the French preoccupation with environmental issues as a relatively late development in comparison with Anglosaxon or German history. He pinpoints its start with the 1973 oil crisis, at which time the nuclear electric option was pushed

forward by the Government; nascent public interest in ecology channeled itself precisely onto that issue (and the Environment Ministry itself was born in about the same period). "It's a paradox; the French have the most rigorous, logical, accountable, advanced nuclear safety structure in the world, yet nuclear power is what worries them most⁶. There are areas in which policy is much more obscure, but which worry them not at all". Chemical pollution strikes him as an area which might merit public concerns about health, but in which for the moment the worry remains below threshold. Public demand does determine administrative priorities to some extent. Thus "we were doing classical, traditional public health for years, concentrating on vaccinations, and recently on AIDS issues; it's just recently that the links between environment and health are coming to the fore".

⁶ This perception of public concerns appears to be shared by most of our interviewees. Data from our comparative risk perception study (Figure 1, Section I.2), however, moderate this intuitive evaluation.

III. DESCRIBING REGULATORY STYLES: A PRELIMINARY SURVEY

Throughout the foregoing, we have attempted to describe the letter but especially the spirit of France's energy risk regulation, as transmitted by regulatory and other actors in interviews. From these interviews emerge some of the beliefs and guiding principles behind regulatory activity. Is it possible to characterize the determinants of the French approach? Can we define a French "style" of regulation? Answering the first question would require extensive historical and sociological review. Some tools exist to make a rapid evaluation, on the other hand, of style.

In the past fifteen years, various researchers have attempted to apply and refine a typology of regulatory approaches classified as adversarial, consensual, authoritative or corporatist (cf. e.g. Brickman et al., 1982; the Italian study in this volume also refers to the model).

O'Riordan and Wynne (1987) compare various countries' environmental regulation through the filter of this model; France is used to illustrate the "authoritative" approach. We quote at length from their article, for in the eight years since its publication much has changed but, as the famous French saying has it, much too may have remained the same:

"This (authoritative) approach is most likely to be found in countries with strong central government but weak legislatures, where local or regional government is constitutionally limited to executing commands from the center, and where the public have little tradition of militancy or distrust. The closest example to this approach is to be found in France, where the regulatory official is granted considerable freedom to act, where rights of appeal are restricted, and where public consultation is formal,

preemptory, and one-sided (...). The most elaborate aspect of this style is usually negotiation in private between government agencies, and with industry, though even the latter is performed in a climate of strong governmental elitism and paternalism.

"The authoritative style is regarded as efficient and cost-effective by its supporters, but unjust and inequitable by its critics. It is not an approach which commands intrinsic public confidence, except by default of issues being brought to public attention. Hitherto, it is this ability to keep issues from the public agenda which has been its strength, but in the area of environmental risk regulation this is already becoming eroded. Its mode of operation is so at odds with the public requirements increasingly demanded of risk regulation (...) that it is likely to undergo further change. Nevertheless, (...) interconnectedness of style, and approach and structure must not be forgotten. In France, for example, regulatory officials in the nuclear industry believe very much in their exclusive powers and competence: they will not give way easily to any attempts to open up their standard setting or licensing procedures (pp. 402-403)".

Some significant changes have come about since that text was written. France under socialist government decided upon and has been steadily developing constitutional decentralization since 1982. The effects and extent of this ongoing decentralization process remain to be fully assessed. A general tendency toward accountability, transparency, and democratic process may be observed in environmental laws under various governments (e.g. especially the Loi Barnier of 1995, and in a related area, the Loi Bataille of 30 Dec. 1991 for the management of long-lived highly radioactive waste). Section II.5 on the Nuclear Safety Authority shows how this part of the "authoritative" establishment has evolved in response to events and to public pressure.

Such changes appear to contradict aspects of the above characterization of the authoritative style. Despite this, the description well anticipated some of our interview findings, for instance that delicate situation in which some risk management may be

considered viable partly insofar as it succeeds in maintaining risk just under the public perceptual threshold (see the pipeline case study, Section II.2).

Although O'Riordan and Wynne (1987) refer to certain countries as exemplifying the various approaches, they caution that no regulatory system corresponds to a unitary type. They state that there is no evidence of strongly distinct regulations or levels of efficiency flowing from emphasis on one or another approach. The model is meant rather to provoke thought about the political and cultural context in which regulatory styles are embedded or develop. In that perspective we felt it might be illuminating to learn how our interviewees would describe the regulatory system in which they are actors.

We wrote an informal questionnaire condensing central descriptive phrases translated from O'Riordan and Wynne (1987). The authors stress that there is overlap in the approaches; indeed the fourth, "corporatist" style appears to be a composite to the extent that we were unable to make of it a sufficiently distinct category in the brief format chosen. We thus presented the following written definitions at the end of each interview, under the question "In your opinion, to what extent does the regulatory framework in your sector correspond to the approach described as:

"ADVERSARIAL: Regulations are extremely precise and detailed, openly documented and accessible to public view. Regulatory requirements for licensing are very formal and elaborate. The industrial operator is expected to meet the regulatory authority's standard in design and project management. However, authority is frequently challenged. Regulations are modified often in a judicial setting, in bargaining through scientific claim and counterclaim.

"CONSENSUAL: Relationships between the authorities and industrial operators are characterized by trust and cooperation. Rules are formulated in such a way that a

considerable margin exists to exercise judgment of whether they have been respected. Technical norms are often advisory and not obligatory standards. The ultimate responsibility for safety rests with the industrial operator.

"AUTHORITATIVE: There is minimal consultation between the authority and the operator (and even little public oversight of the regulator). The regulatory authority reserves the role of setting standards and enforcing their compliance. The formal scope for legal redress is limited, except where regulators can be shown to have acted arbitrarily or contrary to statutory procedures".

Each of the three categories was followed by a five-point scale on which the reader estimated the degree to which the regulatory framework in his sector corresponds to the category described ("not at all, hardly, somewhat, well, entirely").

This questionnaire was read and filled out by our interviewees with interest. It sponsored further discussion of the regulatory approach developed, defended or criticized by the interviewee. It was used playfully to evaluate the style of other partners in the regulatory process. And although obviously limited in scope, this preliminary survey suggests that the "authoritative" category may no longer be the most suited to describing the French regulatory process, or at any rate the self-assessed perception of the process by those at its center.

Indeed the "authoritative" category was the only one of the three presented to garner "not at all" ratings, and this from four out of eight respondents. The "corresponds somewhat" or "well" ratings were given by persons who crossed out parts of the text to indicate that they were considering only the final sentence concerning legal redress. Our interviewee in the Nuclear Safety authority stressed that although in the past the nuclear institution may have occupied a position beyond public view, new legislation and organizational identity now give top priority to transparency and accountability.

Judgments, comments and rectifications on the "adversarial" descriptor indicate that our respondents see in France a highly elaborate, publicly accessible regulatory corpus, periodically updated and revised through legislation. Most stressed though that these revisions are not the product of legal challenges (although as the oil industry representative stated, member companies often appeal sanctions through administrative court). The game of pitting expert against expert, on the other hand, is much a part of forming views of risk in France. The Nuclear Safety Authority specifically calls upon this process to refine in-house conceptions of risk and possible control measures. And in recent years, "counterexpertise" by "independent laboratories" has become a market service to local authorities distrustful of central administrative readings of various pollution levels.

The "consensual" style garnered five "corresponds well" ratings... once most respondents had eliminated the sentence describing rules as purposefully vague and subject to interpretation. Their comments and the content of the interviews in general put the accent on "relationships of trust and cooperation" needed among the partners in the negotiation of regulations (we would add particularly in the present situation in which the regulator relies on the operator for performance data). The degree of mutual trust and cooperativeness thus may have been the real object rated; our industry representative made the most pessimistic rating on this point.

All agreed that France places the ultimate responsibility for safety on the operator.

In discussion, non-nuclear regulators specified that of the three, the consensual approach seemed closest to their experience. This was stressed by the Environment Ministry representative... surprisingly, at first glance, in light of the highly codified Seveso nomenclature and the requirement on operators to perform danger studies based on deterministic worst case scenarios. Remember though that the safety study format remains relatively open, and that field inspectors have a certain discretionary power to

request further analyses or urge operators of classified installations to revise plans or practices. It may be that despite the elaboration and apparent rigidity of France's major risk regulatory framework, those active in developing, refining and enforcing it are greatly aware of the measure of diplomacy needed to make the system work. This too is far from the classic image of French bureaucratic regulation.

Such an inside view may explain the surprise expressed more than once when we revealed, after the questionnaire had been completed and discussed, that the authoritative style was thought to be exemplified by France (and adversity by the USA, consensus by the UK). It was agreed that an adversarial style might be expected in a context like that of the nuclear industry in the USA, where the central authority must deal with a multitude of operators. But our interviewees saw fit to lay emphasis on the cooperative aspects of regulatory development in France today, and the demand for transparency, accountability, and public participation, embryonic or full blown according to sector.

In sum, although a discussion-oriented questionnaire administered to a limited sample, this preliminary survey is source of four conclusions relative to the regulatory approaches model. First, results called into question the continued reference to France as exemplifying the authoritative approach. This past reference may have relied too heavily on the sole case of nuclear power regulation; profound changes have come about in this, and perhaps all hazardous risk sectors, since the late 1980's.

Second, the absence of "black and white" response confirms O'Riordan and Wynne's caveat that regulatory styles overlap in reality. Third, a more useful questionnaire would certainly have listed a large number of short descriptive items drawn from the original article, permitting respondents to make up their own composite regulatory portrait... and with French raters choosing so many different, partial elements of all three styles as presented, it may be anticipated that analysis of such a checklist questionnaire would yield entirely new categories. Fourth, such field research may be worth doing, and

certainly feasible, in light of the fact that our informal survey was so very well accepted by our subjects.

IV. DISCUSSION AND RECOMMENDATIONS

Regulatory fragmentation

One observer, from the Service des Energies Renouvelables et de l'Utilisation Rationnelle de l'Energie (SERURE, part of the Industry Ministry) pointed out France's strong points in terms of (major) risk regulation. France's technical operators are at the technological forefront. Uniform direction is given by national law; its application in the field is handled by three well-identified institutional actors (SEI, SDSI, DSIN; see respectively Sections II.1, 3 and 5), and the solid inspection framework of the DRIRE. (Indeed, France may be contrasted with the United States, with its maze of federal and State risk control requirements and court rulings following adversarial challenges.) Awareness of and adaptation to today's constraints on risk decisions are shown in France's environmental Law of 2 February 1995, with its provisions for transparency, decentralization, preventive information, public participation, and uptake of ideas that may be suggested by such traditional opponents as environmental protection lobbies. A first gauge of the adequacy of this Law is the fact that it was voted by the two national chambers with little opposition.

Despite this apparently high degree of coherence and cohesion, our research shows that France's energy risk regulation, and perhaps risk regulation in general, is fragmented. Agencies and departments are physically and institutionally dispersed. "Housekeeping" is needed among redundant decrees and rules. Certain actors complain of policy incoherence, producing paradoxical effects (e.g. tax structures encourage the use of private and commercial diesel vehicles despite the affirmed public will to reduce urban air pollution).

Efforts are being made toward integrative regulation, on both a national and European level. France's Seveso regulation is presented as Europe's strongest, for its systematic

and integrative qualities. However, an impression was gained in this research of bounded action views of risk and similarly bounded risk regulations, perhaps due to the institutional dispersion and resulting isolation of regulatory actors. Among our interviewees, calls for broader integration of regulation across the spectrum of risk creators and bearers, are heard primarily from actors working under different structural constraints. The oil industry representative is subject to more direct economic pressure to find cost effective measures than are regulators. The public health actor works within a model placing emphasis on the wide range of predisposing, triggering and maintenance factors in environmental health ailments.

The gaps in risk models among risk creators and regulators today appear to create gaps in optimization decisions. Although it must not be considered that the various parties are pursuing fundamentally opposed goals, gaps are seen too in objectives and in the primary objects targeted for protection (national, or industrial, economic health; human life, health or property).

Examining models and objectives may indeed be the key to combating the isolation of regulators and the fragmentation of risk control mechanisms. Here environmental health may provide an example. It is clearly multifactorial; the paradigm recognizes the contributions of different risks to overall health impact, and thus renders appropriate, indeed necessary, a widely integrative approach. The protection of public health is also a relatively unambiguous goal which may facilitate decision making and priority setting (even if their outcomes may be challenged).

Organized pluridisciplinary exchange, among regulators of different risks seems to be lacking as a way toward less fragmented regulation. Discussion among actors concerned with different pieces of the risk puzzle might shed light on interactive risk factors which exist on different levels. Part of this organized exchange might usefully center on the goals and objectives pursued. All public servants cite their mission to protect life and property. Perhaps the intermediary goals they set in pursuing this mission might be

further elaborated, clearly stated, and presented to partners in the exchange. In this way the different problem visions, ways and means proper to each risk regulator could be evaluated; discussion partners could benefit from acquaintance with alternative views. Such organized interregulatory exchange could well be enlarged to input from other actors (risk creators, bearers, social and physical scientists).

Quantitative approaches

National quantitative limits, such as those adopted by the Dutch or the British to identify negligible, tolerable, and intolerable risks, are a "satisficing" decision rule; the risk of any activity may be quantified and compared to the standard yardstick to learn whether it satisfies the requirement. These national goals are an integrative instrument in that they permit risks stemming from widely divergent activities to be given standardized treatment. France has not developed such a yardstick, and quantification of risks, or furthermore valuation of costs attached to activities, is not systematic. This reserved attitude toward a quantified satisficing tool is criticized by one observer. B. Ledoux (1995), describing the management of natural catastrophes in France, traces its beginnings to the Napoleonic restoration of mountain terrains through forest plantation. "Since that time, our country has not yet made the choice of a desired level of protection nor, in consequence, of an adequate prevention policy that will impose limits upon (land) owners and local government." He claims this absence of choice is manifest in what he considers to be inadequate land use schemes and zoning.

We learned that if the quantified satisficing approach described is rejected on the whole as a management device by our interviewees, that rejection is based on widely varying positions. Certain actors, in advisory rather than direct regulatory roles, had apparently never even encountered such a thing as a Farmer curve (number of deaths x event frequency). Some regulators acquainted with the concept said "We're less theoretical"; they perceive the quantification of risks, costs and benefits to be beyond their remit.

Another pointed out that "We can expect a firedamp (natural methane) explosion every thirty years in mining" (a lethal risk corresponding to 3×10^{-2} /year); "still, we don't stop mining activities". These examples appear to suggest the need in France to subject (semi-)quantitative risk goals to scrutiny, in order to strengthen arguments for or against, make more explicit the management tools in use, and find a more comfortable alignment between "theoretical" standards and operating imperatives.

The Environment Ministry, most affirmed in its rejection of probabilistic approaches, stresses that even "impossible" accidents must be envisioned by planners. A study commissioned by this Ministry reportedly showed that experts provided with identical base figures rendered highly divergent risk estimates according to their data bases or even cultural origins.

Further cultural arguments are invoked against the quantitative, probabilistic approach: It is highly Anglo-Saxon, goes against French or latin empiricism and intuition; the public is unprepared to consider quantitative safety levels. These objections may be subjected to criticism on the same grounds, of course, as the judgments found by the Environment Ministry study to reflect experts' own cultural biases.

O'Riordan and Wynne (1987) point out that national regulatory styles dependent upon diplomatic relations among risk regulators and creators (as our interviewees described their own practice) are at odds with the increasing use of formal models in neighboring nations. The development of the European Union, with its emphasis upon shared risk regulation, may have the effect of relativizing the approach chosen in any one country (e.g. France) in any area (e.g. energy risk regulation). Indeed the Union juxtaposes industrial, administrative and political traditions each carrying the unspoken conviction that the current approach is the best and corresponds to an objective rationale, is value-neutral and exempt from cultural influences. France has resolved, like other European countries with a high standard of living, to sacrifice no achieved level of protection to

come down to any less strict European requirement. In terms of regulatory approach, however, the future may show adjustments and inclusion of "foreign" rationales.

Monitoring and data bases

Today's regulatory reliance in France upon "intuitive" risk evaluations is in part due to, and perpetuated by, the relative absence of data bases. Each regulatory interviewee pointed to the lack of systematic data that might allow evaluation and adjustment of regulation. The lack of performance and accident data is also given as an argument against the adoption of probabilistic risk assessment.

This situation is probably not unique to France. An International Atomic Energy Agency study (Haddad & Dones, 1991) pointed out that it is "difficult to evaluate and to compare the frequency and gravity for health and the environment of serious accidents, for there is insufficient systematic, centralized collection of such data nationally or internationally. (...) This is particularly true of nonnuclear energy systems". In France, we learned of a number of data bases, or moves toward monitoring and systematization, that may bear fruit. Industry groups like the Institut Français du Pétrole maintain accident data bases. Worker safety reports required by work legislation could be better exploited, said interviewees. Regional air or water quality observatories are scheduled to monitor impacts of pollution reduction and furnish epidemiological data.

Assessment and expertise

At the same time as regulators regret the underavailability of data, the empirical success of risk regulation currently in place may tend to diminish perceptions of such data bases and evaluation as necessary. Hubert (1994), writing of radioprotection, describes three means of reinforcing risk control. Modifying technical systems can provide better protection. Behavior too can be modified, through educational action; the

interministerial order requiring publication and active consultation of information concerning the presence of transport and distribution lines (Section II.2) is a move in this direction, as is the ICPE philosophy of informing local planners of major risks (Section II.1). The third means pointed to by Hubert is the development of assessment tools and expertise. He cites the need to move from descriptive to decision oriented tools and models.

This third stream is clearly the weak point in today's energy risk regulation as described by this research. The technical and human resources probably exist today in France to perform state of the art assessments in almost every area. We learned, however, that evaluation has not been made a primary goal for regulators, and that the means by which performance assessment may influence legislation is not conceptualized. Regulations are not stated in a form identifying expected outcomes which might then be tested. Developing assessment and expertise will likely require a firm directive by ministers. But again, the empirically satisfactory level of performance in France may diminish any felt need for assessment. It may be recommended that regulators study the utility of evaluation in contexts where it has been applied.

Explicitation and operator guidance

France's risk regulation is national, avoiding thus the pitfalls that may be found when superimposed levels of authority each give requirements. Nonetheless, risk regulation is highly complicated, in light of several factors. Various degrees of regulation exist, from the general orientation given by national law, with sometimes highly detailed paragraphs, to decrees of application, to codes and attendant documents, to ministerial orders, instructions and rules sector by sector. Regulations are constructed in an iterative manner with multiple modifications and cross references. A single activity may be subject to numerous classes of regulation, and some rules may be defined sector by

sector where a single regulation would suffice, all due to the institutional dispersion analyzed above.

This complication fosters divergent interpretations by inspectorates and by jurists, and is recognized by interviewees to leave operators in a difficult position, all the more so that operators bear ultimate responsibility, in a legal as well as moral sense, for safety. Guidance is needed to make requirements clear and point to methods for meeting them, while respecting the fundamental notion of methodological liberty underlying much regulatory discourse. France is clearly in a developmental phase in this respect. It is somewhat paradoxical that France has produced Europe's most systematic Seveso regulation, but has published only this year a first step-by-step guide to completing its requirements. The various regulators share the objective to produce manuals aiding operators to perform danger studies or meet other documentary requirements. As part of the move to provide explicitation and guidance, paper studies may be commissioned to compare requirements and physical methods in use in other countries (e.g. Volcot, 1993). Such efforts might usefully be recognized and reinforced by ministers.

Developing incentives

France's energy regulation at present appears to carry few incentive mechanisms. Current incentives, as in the depollution tax, are seen by industry to be unfairly structured. Tax rates are felt to rise faster than promised research and clean up expenditures. Industry calls for a management role in proportion to the sums contributed.

A perverse effect may be anticipated in early stages of such taxation, in which managers in search of cost efficiency may prefer to be taxed rather than refit installations. Still, it would seem appropriate that incentive mechanisms, placing an accent on gains rather than on sanctions, be conceptualized in France. Constructing more positive incentive

mechanisms may require creative concertation, drawing on experience in operator/regulator exchange, but also on innovative points of view as might be found for instance in green political quarters.

Public involvement

Major risk creators and regulators have indeed developed experience in exchange and negotiation of risk models and safety goals. This exchange and negotiation however has not been extended, in most cases, to other groups in the public. Various comments were heard giving an image of the public as unprepared to enter the risk debate, holding a partial view of issues at stake, defending hedonistic values, poised to shift to "irrational" argument, or apt to express a "zero risk" demand whose result would be economic paralysis. Such representations appear to found the tendency to "do without" the notion of risk, as discussed in the Introduction, or to avoiding quantified evaluation as means of exploring the notion of acceptable risk in accordance with the public.

These assessments of public attitudes may be correct. However, they appear seldom to be made on the basis of focused study. To the degree to which such assessments are not validated, it appears inappropriate that they be invoked as regulatory decision rationales. Voicing these representations may be a first step toward testing them. Measures should be taken to prevent them from becoming self-fulfilling prophecies.

The public may not be fully prepared to take part in risk regulation decision making, but this is no more a reason to perpetuate their being held at a distance. Convergent factors appear to be operating now that may produce a future generation of risk initiates. More political demand, informal or organized, is heard in France from groups traditionally alienated from risk analysis and decision. Recent legislation recognizes this demand and provides mechanisms to channel it in a utilitarian manner.

This is indeed a special mark of the French approach. Argument becomes instituted dialog with the creation of such structures as "local information commissions" in the nuclear sector. Opinion and analysis which before was branded as opposition can gain in influence; a tribute is paid nonetheless to the dominant establishment which retains the prerogative to define acceptable forms of exchange.

Despite this observed tendency to standardize exchange, France deserves recognition for measures and practices that tend to emphasize public information, inquiry, and participation. Examples of this tendency have been given throughout this report. On the initiative of the Ministry of the Environment, prefectures now are developing "preventive information", mapping risks present in France's départements and discussing rationales behind safety instructions given to citizens at risk from natural or technological sources. This is a domain in which the "risk" concept is used without anticipation of outcry.

Public information measures in France have often been responses to crisis, when citizens opposed in late stages those public projects which had not benefited from sufficient consultation. Given this history, it might be recommended that France's risk regulators try to anticipate areas in which future confrontation may take place.

In line with our recommendations above concerning assessment and expertise, regulators might well explore formal means of fostering communication with affected publics. Today, regulatory impact upon the public is often measured in a purely intuitive manner, or through occasional complaint by mayoral or other associations. Organizing evaluative feedback will mean "putting one's head up", in sectors which up to now have designed regulation in the express goal of minimizing public attention. This strategy of discretion is rationalized as maintaining consumer energy supply at its current level without introducing undue economic constraints that would, it is anticipated, be the outcome of public demands for further risk reduction. Fostering communication and

debate, however, might contribute to better public accord on the trade offs implied by national energy benefits.

Equity debates

One area in which we may anticipate future conflict is that of equity in risk distribution. Today's risk control systems may be efficient, but in many cases they are not based on any explicit reference to equity considerations. Should a social demand emerge for equity as a primary guiding principle, as it clearly has in North America, many French regulators will be hard put to defend the "empirical" philosophy underlying decisions, or to demonstrate equity in a satisfactory manner. We would recommend quantitative and qualitative study of equity in risk distributions in the energy or other fields, in anticipation of what may become a principal criterion.

Preparation may be made as well for eventual demands for redress when groups may demonstrate that they have been placed at inequitable risk. Such preparation might include exploration, by representatives of various social groups, of precisely what damage is done when equity is not respected.

Working to a shared definition of acceptability

Presently, energy risk regulation in France does not benefit from formalized optimization analysis. This is in part a reflection of a certain vision of State, in which the quantification of trade offs appears to sit uneasily with the mission to protect life and property. Other reasons or rationalizations of the absence of an integrative ALARA

approach lie in the institutional dispersion discussed above, and the arguments concerning public unpreparedness to consider trade offs.

There are many reasons to consider that it is indeed not the State's business to seek optimization in the same way as an industrial system. However, the intellectual effort to define some optimization criteria might contribute to reducing the gaps seen today among regulators, risk creators and risk bearers. Defining criteria could involve these questions among others:

What are tolerable risk levels? For whom?

What kind of monitoring is needed to assess safety and environmental performances?

What economic factors should be brought into a regulatory equation?

How far should the "bubble" extend? What efforts should be asked of different classes of risk creators? To what extent should every citizen examine his own role in contributing to collective risks (e.g. pollutions)?

Today's energy risk regulation, while empirically successful in providing protection to the population, appears to relegate the acceptability question to late in the risk assessment process. A caricaturist might see the question reduced to binary form: "Acceptable? Take it or leave it". Research and experience in evaluating and managing collective risks today show that acceptability is an issue that focuses a broad range of questions and decisions. France has come far in creating innovative decision structures when centralized structures proved inadequate, and has proved her willingness to consider inputs that just a few years ago would have been branded as contestation. Developing methods to work toward a new, broadly shared definition of acceptable risk might be the next worthy challenge.

V. CONCLUSIONS

France's energy scene today includes traditional combustibles, some renewable energy source use, and the strong presence of nuclear electricity generation. Nationalized and private producers and transporters work together for generally harmonious delivery of a high consumer standard. There have been no catastrophic accidents or pollutions. Energy risk regulation is designed to maintain those good performances without imposing undue economic constraints upon industry, seeking an "empirical" balance between quality of life and national or industrial economic wellbeing.

The proportion of nuclear energy, high in both national and international terms, has produced some singular effects, including outstanding reliance on electric home heating. The nuclear establishment's high degree of internal homogeneity (a single constructor, a single national utility, a highly centralized regulatory authority) have allowed it to make significant technological, methodological and organizational advances in risk analysis, safety, quality assurance, and social integration, advances which are often transferred to other industrial sectors. At the same time, public perceptions of technological risks are seen to be focused on the nuclear domaine, to the exclusion of other energies, and public demand for risk control "chases" the nuclear establishment further ahead.

In contrast, our research found energy risk regulation outside the nuclear domaine to be fragmented. Regulations are defined sector by sector, where common regulation would suffice, and a single activity may come under several regulatory regimes. This fragmentation appears to be in part the product of traditional institutional separations, often dating from napoleonic times, and leaves regulators in unwanted isolation.

Although France's national legislation in the area of major risk control and environmental protection puts a strong and welcome accent on public information and participation, regulators outside the nuclear field have also been kept in relative isolation from the perceptions and demands of the public. In particular, the question of tolerable or acceptable risk has not been fully examined in the public forum.

Regulators, particularly in the Environment ministry, have generally adopted a strong position in favor of a determinist philosophy in risk assessment and control. France has chosen no quantitative national risk goals. Varying arguments are given in favor of the determinist orientation over a probabilistic approach, including the relative lack of systematic performance data, the need to consider operating imperatives over "theoretical" standards, and the supposed public unpreparedness to consider tradeoffs. This affirmed position, given the empirical success of risk regulation to date, may however perpetuate its own conditions, discouraging the development of regulatory assessment which would require strengthening data bases, and holding the public at a distance from risk evaluation and decision making.

The institutional dispersion observed is thought by public health actors to stifle the development of a transversal field of environmental health. Industrialists criticize what they call incoherence across different regulatory sectors, and gaps in optimization models. They call for a more integrative approach in which sanctions and incentives would all drive toward agreed pollution reduction, for example, and stimulate perceptions of even transport consumers as risk creators, rather than put all the onus on industry for behavioral change.

Despite these criticisms, we found a population of regulators deeply committed to their work, skilled in negotiating with operators, involved in the search for ways to improve their action, determined to bring France's degree of protection to European directives, open minded and eager to confront their experience with that of their colleagues in other countries. Recent legislation shows that regulators and politicians are committed to the

continuing improvement of France's risk control in ways that reflect her dedication to "democracy, transparency and responsibility". It is our hope that the observations and recommendations contained in this chapter may contribute to that movement.

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