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PUBLIC OPINION FACTORS

REGARDING NUCLEAR POWER

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"An Examination of the Factors

Defining the Regulatory Process for

Advanced Nuclear Reactors"

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INTRODUCTION

This paper is an effort to identify, as comprehensively as possible, public concerns about nuclear power, and to assess, where possible, the relative importance of these concerns as they relate to government regulation of and policy towards nuclear power. It is based on some two dozen in-depth interviews with key communicators representing the nuclear power industry, the environmental community, and government, as well as on the parallel efforts in our research project: 1) review of federal court case law, 2) a selective examination of the Nuclear Regulatory Commission (NRC) administrative process, and 3) the preceding George Mason University research project in this series.

The paper synthesizes our findings about public attitudes towards nuclear power as expressed through federal court case law, NRC administrative law, public opinion surveys, and direct personal interviews. In so doing, we describe the public opinion environment in which the nuclear regulatory process must operate. Our premise is that public opinion ultimately underlies the approaches government agencies take towards regulating nuclear power, and that, to the degree that the nuclear power industry's practices are aligned with public opinion, a more favorable regulatory climate is possible.

More specifically, we hope that our findings about public opinion can help government and industry craft policies, regarding, for example, research priorities, prototype development, and management practices, that make nuclear power more acceptable to the public. Another possible result of our research is that programs to inform the public about nuclear power can be prepared with greater appreciation of the public's true concerns.

We fully recognize that serious difficulties arise in any effort to translate public opinion into public policy, and note below four of the most important of these. At the same time, we remain convinced that, in a democracy like ours, public opinion is the ultimate arbiter of public policy, and it is in this spirit that we have carried out our study.

The first caveat about public opinion analysis we wish to make is that survey results are heavily influenced by the precise wording of the survey's questions, a point made by several of our interviewees. To insure the credibility of our survey, then, will require careful attention to objective phrasing of questions.

Second, one must be wary of statistical averages emerging from survey results. Everyone has his own variation on the quip about the family of five with an average age of 25: a 50-year old father, 38-year old mother, 18-year old daughter, 16-year old son, and 1-year old baby. The point, of course, is that averages can easily obscure the reality of a situation.

Similarly, statistics that a certain percentage of Americans favor nuclear power, or that another percentage of Americans don't think their community needs a new power plant, need to be broken out in significant detail to be of much use to anyone making policy or developing an educational program. There are simply too many unanswered questions about the demographics and psychographics of the respondents for the general numbers to do much good. We intend to recommend a sufficient sample size in our opinion survey to provide needed detail. Also, we will recommend the use of in-depth focus group interviews, which will offer greater depth of understanding about attitudes than a survey can provide.

Our third caveat is that public opinion is an extremely blunt instrument, and should be used with great care when being applied to complicated policy issues involving difficult trade-off questions. Public opinion is almost never the product of reasoned analysis, but rather is a melange of images, impressions, fragmentary thoughts, and even physical sensations, often the products of advertising or other advocacy messages; of opinions or gossip passed on by friends or acquaintances; of stereotypes or prejudices held over many years; or of emotional reactions to personal experiences, often reaching back years or even decades. Frequently public opinion reflects little more than trendy thinking or a reaction to recent current events, and may change substantially with shifts in intellectual fashion or the latest news developments.

A policy-maker, then, must be extraordinarily careful in using public opinion as a guide to complex, multi-faceted issues involving difficult technical, financial, and policy trade-offs. Examples of such issues trade-offs include government R&D on internal combustion engines vs. battery-powered cars; investment in high tech medical equipment vs. preventive medicine programs; or, closer to our concerns, promoting one or another nuclear power technology. In each of these examples, public opinion should certainly be taken into account as an important factor, but it must also be born in mind that the general public has very little understanding of the technical or financial details of any of these issues.

This point is one of the key conclusions of the 1987 George Mason University Law School study for DOE, which attempted to correlate the results of federal court litigation with the technical or regulatory issues of concern to the litigants. Professed technical concerns or alleged shortfalls in power plant performance capabilities were seen to be merely the articulation of other more basic social concerns identified in the study.

Our fourth caveat about public opinion is something every reader learned in a high school civics class -- this nation is not a direct democracy, but a representative government, secured against a "tyranny of the majority" by separation of powers within the federal government, and by division of powers among the federal, state, and local governments. The Founding Fathers did not intend, nor have subsequent generations of law-makers intended, that government should be by plebiscite, or what may be the current Information Age's equivalent, the public opinion poll.

Translated to the issue at hand, this means that neither is there, nor should there necessarily be, a direct relation between what people think about nuclear power, and what is done about nuclear power. On occasion, this fact may benefit opponents of nuclear power; on occasion, it may benefit proponents. But whoever may benefit, the fact is that identification of a public concern does not necessarily lead to measures addressing that concern. Even when it does, there may be numerous steps in between. The reader must bear in mind, therefore, that even if our study might identify one or another technology, policy change, or regulatory reform that would both benefit nuclear power, and be aligned with public opinion, ultimate enactment of such a proposal is in no way guaranteed.

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Our paper is organized into eight discreet chapters, each of which is fairly self-contained. A single, integrated executive summary of this paper, therefore, seems less useful than a compendium of the summaries that appear at the end of each chapter. Such a compendium follows.

CHAPTER SUMMARIES

I. DEMAND FOR ELECTRIC POWER. Sharply differing visions of America's economic future imply sharply differing perceptions of future need for electric power. In one of these visions, reflecting society's new conservation ethos and changing patterns of consumption, the historic link between economic growth and electricity consumption is significantly attenuated. Anti-nuclear advocates are promoting this vision, with the corresponding conclusion that our nation does not need substantial new electric power generating capacity. In a very different vision, an industrial renaissance in America would create a major increase in demand for electric power. Numerous others, including the U.S. Department of Energy, hold an intermediate position.

The public seems generally ignorant of the role nuclear power plays in supplying our nation with electricity, and of the need to replace aging power plants.

II. THE FEAR FACTOR: RADIATION. Public apprehension about radiation is very strong, and often characterized by considerable ignorance, extending to the notion that nuclear power-generated radiation is somehow worse than other types.

III. THE FEAR FACTOR: THE CATASTROPHIC ACCIDENT. Nuclear catastrophes are seen as falling into one of three types: an atomic bomb-like explosion of a reactor, a reactor meltdown, and world-wide radioactive envelopment. Each is associated with profoundly deep human fears.

IV. THE FEAR FACTOR: PERCEPTIONS OF RISK. Perceptions of risk of a nuclear accident fall into three categories: the probabilistic view of managers, regulators and other professionals involved in the day-to-day operations of nuclear power; the absolutist, held by nuclear critics who, in effect, argue that any level of risk is unacceptable; and the common sense, held by the general public. The common sense view can be quite subjective, and makes sharp distinctions among I'm-in-charge, you're-in-charge, and nature's-in-charge situations.

V. THE NUCLEAR POWER LIFECYCLE: SITING, DESIGN, AND CONSTRUCTION. The public is highly concerned with siting of nuclear plants, taking a generally NIMBY position. It is not concerned with design and construction issues, with the exception that it seems to want containment vessels surrounding reactors.

VI. THE NUCLEAR POWER LIFECYCLE: OPERATIONS, MAINTENANCE, AND DECOMMISSIONING. Nuclear plant operations do not currently raise serious concerns among most Americans, who, nonetheless, are not prepared to accept the notion that such operations can be fail-safe. A single major accident would have an enormous impact on public opinion, and, in all likelihood, prevent for the foreseeable future any revival of nuclear power in this country.

Plant maintenance is an increasingly important issue, as the first generation of reactors reach the end of their licensed lives. Plant decommissioning, while not yet an emotional issue, could become one soon.

VII. THE NUCLEAR POWER LIFECYCLE: WASTE DISPOSAL. The three basic categories of waste disposal -- high level commercial, low level commercial and weapons production -- are quite distinct in the public mind. High level commercial is clearly the most emotional issue. The public may see low level commercials nuclear waste as somewhat akin to toxic chemicals. And bomb waste disposal, while controversial around the WIPP site, has been relatively non-controversial nationwide.

VIII. FINANCES. Nuclear power's image as financially viable suffers from state utility commission retrospective prudency hearings; from the charge of excessive dependency on federal subsidies and Price-Anderson Act liability protection; and from Wall Street concerns about high up-front capital costs, regulatory delays, and waste disposal and decommissioning costs. Set against these negatives are the electric power industry's relative freedom from business cycles and the new product "S-curve" syndrome, and major new costs for coal plants mandated by recent clean air legislation. Recent polls show that three-quarters of Americans support nuclear power -- up from two-thirds in 1990. Some 70% of Americans who call themselves environmentalists support nuclear power.

The next generation of advanced reactors under development by the DOE offer possibilities for major breakthroughs in nuclear power economics, through smaller, modularly-built plants permitting greater financial flexibility and speedier regulatory approval, although they would face heavy start-up costs, and have other technical problems. Advanced reactor safety features, most notably a meltdown-free technology, could dramatically improve public acceptance of nuclear power, through addressing some of the most critical "Fear Factors" and "Life Cycle/Financial" factors identified in this paper.

I

DEMAND FOR ELECTRIC POWER

Demand for electric power, of course, provides the ultimate rationale for all types of power generating facilities, including nuclear plants. To the degree that the public perceives an ever-increasing need for electric power, there will be an underlying support attitude for new power plants, whatever their particular technology.

It is a commonplace observation that during this century increases in electricity consumption have generally tracked overall national economic growth. Whether energy consumption has been cause or effect of economic growth has not always been clear, but the correlation is indisputable. It is likely that the public is generally aware of this correlation, and that this awareness has contributed in a major way to support for continued power plant construction.

How public perceptions of electric power demand will evolve in coming years is very problematic, reflecting both uncertainty about the economy in general, and, more particularly, about the relation between economic growth and electric power consumption. Scenarios about economic growth range all the way from quite optimistic projections of an "industrial renaissance" in American with growth rates comparable to those in the early post-World War II period, through the U.S. Department of Energy's more modest forecast of growth rates in the 1.7% - 2.7% range during the next generation, to quite flat projections by pessimists and anti-growth advocates.

Opinions about the future relation between economic growth and electricity consumption vary nearly as widely. On the one hand, those who see an industrial renaissance envision a major increase in industrial demand for electric power. Even in the absent of such a renaissance, there is considerable evidence that electrification of fossil-fuel based industrial, commercial, and residential processes will continue. As detailed in

"Ecowatts: The Clean Switch -- Using Electricity to Save Energy and Cut Greenhouse Gasses" [Chevy Chase, MD: Science Concepts, Inc. 1991], these conversions are occurring in processes as diverse as steel- and copper-making, paint-drying, printing, cooking, freezing concentrate milk, and lawn-mowing.

The U.S. DOE sees a fairly close relation between electricity consumption and overall economic growth. As stated in its January, 1991, study, "Nuclear Power's Role in the National Energy Strategy":

"GNP is expected to growth through 2010 at a rate between 2.6 and 2.9 percent annually. After 2010, economic growth will slow to a rate of 1.8 percent annually through 2030. Even after including the effects of consumer investment in conservation measures and implementation of demand-side management programs by electric utilities, the demand for electricity is expected to grow at a rate relatively close to GNP projections. Based on the NES projections, electricity demand is expected to grow at a rate between 2.4 and 2.7 percent annually through 2010, and then slow somewhat to 1.7 percent annually in the 2010 to 2030 period."

On the other hand, a considerable body of opinion sees the need for electric power -- particularly from traditional sources -- as levelling off. This viewpoint reflects increasing attention paid to conservation of energy resources through either demand management or switching from traditional to renewable electric power sources (solar cells, wind farms, hydro-power), "alternative" sources (geothermal, garbage combustion), and co-generation of electric power from industrial heating processes. The electric utilities themselves, as they promote residential and commercial energy conservation through a wide variety of programs, contribute to the public perception that traditional means of producing electric power are less essential than was once the case.

This perception may be reinforced by changing consumption patterns in our country -- a sharp increase in low-wattage "Information Age" products like stereo, video and computer products, and a levelling off of demand for high-wattage "Edison Age" products like kitchen and bathroom electric appliances. Skepticism about the need for new electric power capacity may be further fed by society's more general conservation ethos, evidenced by widespread support for recycling of materials, increasing restrictions on oil drilling and mining, and greater use of renewable resources, such as paper versus plastic grocery bags.

Naturally, the opponents of continued economic development, and of nuclear power in particular, have seized on the issue of conservation to argue against new electric power generating capacity. Amory Lovins, for example, an ardent environmentalist recently featured on the cover of Business Week magazine, argues that electric power consumption in the U.S. could be cut 75% over the next decade with minimal disruption to the economy. And in our interviews with anti-nuclear critics, we frequently heard the argument that electric power consumption could be cut considerably without great cost to the economy, and the need for new nuclear power plants thereby obviated.

To a certain extent, this argument is reflected in public opinion polls showing that a sizeable proportion of people, while supporting nuclear power in general, feel that their immediate region does not need a new power plant at this time. Of course this is an essentially NIMBY ("Not in my backyard") argument, but it also reflects the notion that growth in electricity demand is not inexorable.

It is worth noting -- and a point made by more than one of our industry-oriented interviewees -- that people have no awareness of the proportion of their home or office electric power emanating from nuclear plants. Like any other commodity, electricity carries no brand name, so the fact that nuclear power is already delivering satisfactorily, and safely, one-fifth of the nation's electricity needs is lost on virtually all Americans.

It is also interesting to note that very few people seem to consider that electric power plants eventually wear out and must be replaced, so that simply sustaining current levels of electricity will require new plant construction.

To summarize, sharply differing visions of America's economic future imply sharply differing perceptions of future need for electric power. In one of these visions, reflecting society's new conservation ethos and changing patterns of consumption, the historic link between economic growth and electricity consumption is significantly attenuated. Anti-nuclear advocates are promoting this vision, with the corresponding conclusion that our nation does not need substantial new electric power generating capacity. In a very different vision, an industrial renaissance in America would create a major increase in demand for electric power. Numerous others, including the U.S. DOE, hold an intermediate position.

The public seems generally ignorant of the role nuclear power plays in supplying our nation with electricity, and of the need to replace aging power plants.

II

THE FEAR FACTOR: RADIATION

Exposure to excessive radiation, and the resulting ill-effects, are, of course, the principal danger posed by the nuclear power cycle, whether it be through leaks in an operating power plant, irradiated waste that is not properly disposed of, or some kind of major reactor accident.

The Chernobyl accident has claimed at least hundreds of radiation victims, and, depending on estimating techniques, perhaps many multiples of this figure. Nuclear power plant workers in this country have suffered ill-effects from occasional accidents in the course of power plant accidents. And the outcry in the 1950s and 1960s about atmospheric testing of nuclear weapons, the current concern shown over deterioration of ozone layer protection against solar radiation, and the lead shields we all wear when undergoing medical X-rays are all reminders of the real danger of excessive radiation.

That said, it is fairly clear that public fear of radiation, and, in particular, the ill-effects of radiation stemming from nuclear reactor operations, is far more intense than what is justified by the facts. Our interviews, public opinion surveys, and everyday conversations on the topic all point to intense public apprehension about radiation associated with nuclear power.

Perhaps the most succinct overview of radiation fear was provided by an interviewee who manages public relations for a nuclear power facility and has extensive experience with public attitudes in this area. He observes that radiation is associated with two of the greatest fears people have -- cancer, and nuclear war. Furthermore, he points out, radiation can be directly detected by none of the human senses -- sight, hearing, smell, taste, or touch -- and therefore has a secretive, hidden quality that is particularly fearsome.

Finally, he observes, radiation has an eerie "glows-in-the-dark" science fiction quality that leaves people feeling generally disquieted. By contrast, he argues, nuclear power's principal competition, coal, is seen by most people as a familiar commodity with an "old shoe" quality that is non-threatening and seems quite incapable of producing any catastrophic effects.

To this extensive listing of nuclear power's image problems with radiation could added yet another: The half-life of plutonium, running to tens of thousands of years, seems to the normal human to be almost infinite. It is as if the dangers posed by reactor operations reach to eternity.

Our interviews also brought out the fact that many people conceive of radiation as being either "good" or "bad". "Good" radiation is "natural" -- that is, it may come from the sun, outer space, or other natural sources -- whereas "bad" radiation comes from nuclear power plants.

As a variation on this good radiation-bad radiation concept, we were told of an incident in an Atlanta business park in the mid-1980's. Several drums of radioactive water -- waste from a medical X-ray processing firm in the park -- leaked, and the poisoned water spread throughout the complex, affecting several other businesses. A major clean-up effort was required, and, in the aftermath, state authorities held a public hearing on the mishap.

Of course, had this leakage occurred at a nuclear power plant, the hearing would have been overrun by hundreds of outraged local citizens and scores of anti-nuclear activists from around the country wishing to testify, speak to the press, berate industry officials, and otherwise make their case. Instead, only a handful of the public showed up to testify, and these were mostly out-of-staters from Florida who were activists on the food irradiation issue.

One may speculate as to why the turn-out was so low, and why the anti-nuclear community chose not to make an issue of this incident. Maybe the activists did not want to publicize the association of radiation waste with health care. Maybe they thought that a nuclear power plant, with its ominous-looking dome and cooling towers, was a necessary back-drop to achieving the emotional "critical mass" needed for a successful demonstration. But whatever the explanation, it seems that the radiation leaks appeared much less menacing when the source was not a nuclear power plant.

In none of our interviews, it should be noted, was there mentioned a specific example of radiation's ill-effects, such as leukemia, birth defects, or premature aging. Presumably this reflects the fact that, in real life, very few Americans have had any personal knowledge of people suffering from radiation illness. Yet this very lack of experience may cause the imagination to run wild with fears about "the horrible effects of radiation". The irrationality that can surround such fears is illustrated by a case told us of a high school science teacher who asked, in all seriousness, if radiation from a nuclear plant could enter her home through the electrical appliances to which it was supplying power.

To summarize, public apprehension about radiation is very strong, and often characterized by considerable ignorance, extending to the notion that nuclear power-generated radiation is somehow worse than other types.

III

THE FEAR FACTOR: THE CATASTROPHIC ACCIDENT

Much of the negative mythology surrounding nuclear power involves the so-called "cataclysmic accident". The movie "The China Syndrome" depicts a meltdown that continued through the whole core of the earth to the other side of the globe. An astonishing 84% of all American think it is at least "somewhat possible" that a nuclear plant could explode like an atomic bomb. And images of radioactive clouds circumnavigating the earth while dumping their deadly cargo are common fare at anti-nuclear rallies.

Each of these images has started with a germ of a fact, and grown into a nightmarish fantasy. It is just this kind of overwrought imagining that turned TMI and Chernobyl into "catastrophes", despite the fact that no-one died at TMI and that Chernobyl, while clearly a devastating accident, was hardly a global catastrophe. The public was prepared to see a nuclear catastrophe, so it chose to interpret these events as catastrophes. We explore in the following paragraphs why these images of catastrophe have gained such a hold on the public mind.

<u>The nuclear reactor as a bomb</u>. Perhaps the most insidious fear associated with nuclear power is the notion that a reactor is something like a nuclear weapon, and capable of an atomic explosion. According to one poll, 52% of Americans believe a reactor can "explode and cause a mushroom-shaped cloud like the one at Hiroshima", while only 31% called such an event impossible. And another poll found that 66% of Americans think a "massive nuclear explosion" can occur at a nuclear power plant, while only 20% said this could not occur [first poll: Resources for the Future, January, 1980; second poll: Harris, April, 1979]. We are not aware of survey research regarding the perceived likelihood of such an explosion, the perceived circumstances that might lead to such an explosion (for example, do people think a meltdown is precursor to an atomic explosion?), or other aspects

of this crucial dimension of public fear about nuclear power.

We offer the following thoughts on why the public holds this erroneous opinion about the explosive potential of a reactor. First, the fission process by which the atomic nucleus splits and releases energy is essentially the same in commercial reactors and atomic bombs. It is likely that the public is at least dimly aware of this similarity, and also likely that the public perceives the process as a quite violent kind of chain reaction, akin, perhaps, to the series of self-perpetuating explosions in an ammunition dump under attack. By contrast, the essential difference between reactors and bombs -- the density of fissile material -- is a far less vivid or arresting concept.

Add to this the popular image of the atom as some kind of nearly limitless source of energy -- a notion vaguely related to the concepts behind the famous formula E=mc (2), and promoted by the nuclear power industry in its early days -- and it is not hard to see why much of the public thinks of a nuclear reactor as having vast explosive potential.

Additionally, a link between reactors and bombs can be found in the fact that reprocessed commercial fuel can be used in both, an issue discussed more fully in the chapter on high-level waste disposal.

Finally, links between commercial nuclear power and nuclear weapons can be seen in various activities of the U.S. Department of Energy. DOE conducts R&D for nuclear plants and for nuclear weapons, refines uranium ore for both, manages waste disposal for both, and actually builds both prototype weapons and prototype reactors. Of course, there are very important differences in DOE's commercial nuclear and defense weapons programs, but these are less evident to the public eye than the similarities.

The meltdown. The 2,000 degree Centigrade heats generated in a typical nuclear reactor are really no greater than those in a steel mill or aluminum smelter. But the image of a run-away reactor, growing hotter and hotter through violent nuclear chain-reactions until its own uranium core begins to melt, evokes images in the public mind of an almost supernatural occurrence, unleashing volcanic nether-world forces that no mere mortal can control.

In the face of such primordial fears, it is almost useless to attempt to reassure the public with talk of controlling "LOCAs", "venting" gasses and the like. What is needed is a simple, credible assurance that a meltdown is absolutely impossible. Short of this, measures to control overheating may decrease the chance of meltdown, but are unlikely to have substantial impact on public attitudes.

Global effects of a nuclear accident. The fears of meltdowns and reactor "explosions" are given added horror by the image of global devastation they might wreak, through radioactive clouds enveloping the earth and dumping their deadly content on continent after continent. The spread of such clouds across Europe after Chernobyl gives some substance to this fear, although, of course, Europe comprises only a small portion of the earth's surface.

The notion of global catastrophe seems to hold a peculiar fascination for some people. Indeed, the "nuclear winter" scenario depicted by anti-war activists plays to this apocalyptic fantasy. Beyond this, the growing consciousness of the earth as a "fragile ecosphere", given such impetus by the famous Apollo moonshot photographs of a stunningly beautiful earth floating in a vast void, adds poignancy to fears of a nuclear power-caused global catastrophe.

To summarize, nuclear catastrophes are seen as falling into one of three types: an atomic bomb-like explosion of a reactor, a reactor meltdown, and world-wide radioactive envelopment. Each is associated with profoundly deep human fears.

IV

THE FEAR FACTOR: PERCEPTIONS OF RISK

It is obvious that perceptions of risk profoundly influence public fears about nuclear power. The greater the perceived risk, the greater the fear.

What is not at all obvious, however, is how these perceptions are arrived at. Perception of risk regarding nuclear power accidents is much harder to pin down than that regarding other major types of accidents, such as airplane crashes, bridge collapses, or mine cave-ins. In these latter cases, there is enough experience ("actuarial data") that rough estimates of probability, and of potential cost in lives and dollars, can be made.

In the case of a major nuclear plant accident there is virtually no experience on which to base estimates of likelihood, or of cost. Indeed, one of our pro-industry interviewees quipped that nuclear power has not suffered enough accidents. His point is that the public has not come to accept nuclear power plant accidents as a fact of life, regrettable, but nevertheless acceptable.

In the absence of actuarial data on nuclear accidents, perceptions of risk have taken quite divergent directions. We were able to discern three basic approaches to risk in our research: the "probabilistic", the "absolutist", and the "common sense".

The probabilistic approach attempts to quantify the risk of nuclear accidents, and is generally adopted by engineers, managers, and regulators, all of whom need to make day-to-day decisions affecting nuclear power operations. This might also be called the "professional" approach.

An excellent example of this approach is the 1960s Rasmussen Report, an exhaustive effort to quantify the risks of nuclear power. While the Rasmussen Report has been criticized on various scores, it remains a landmark effort at risk analysis. More recently, industry and regulatory analysis of the risk of a fracture of the Massachusetts plant Yankee

Rowe's embrittled steel containment vessel reflected the probabilistic approach.

While obviously useful to professionals, this approach has demonstrated two very serious short-comings from the standpoint of public perception. First, in the early years of nuclear power, its practitioners tended to produce extremely optimistic estimates about the risk of a nuclear accident -- often claiming that an accident could not happen in a thousand, or even ten thousand, years. TMI, Chernobyl, and assorted near accidents have made a mockery of these forecasts.

A second, and more current, shortcoming of the probabilistic approach is the all too frequent appearance of revision of risk estimates in response to political pressure. Thus, in the Yankee Rowe case, the Nuclear Regulatory Commission (NRC) revised its initial calculation that continued operation posed low risk, apparently as a result of strong environmentalist criticism. And, also in a recent instance, Virginia Power revised its estimate of the risk associated with its troubled Surry nuclear plant after a strong public outcry. (This case is discussed late in this chapter.) Such "flip-flopping" of course undermines the credibility of the probabilistic approach.

A second approach to risk is that taken by nuclear critics, and may be called "absolutist". It seeks to secure absolute assurance that a particular event, or accident, cannot occur, and tends to ask "What if ...?" questions, such as "What if a terrorist sneaked into this nuclear plant?"; "What if a nuclear-weapons carrying military aircraft crashed into this reactor?"; or "What if an earthquake measuring 8 on the Richter scale were centered under this reactor?" Such "What if ...?" questions are almost never ask for an estimate of the probability of the event occurring.

This absolutist approach to risk flies in the face of the way we live our everyday lives, which of course involves some degree of risk-taking all the time. But it nevertheless compels attention, for three reasons. First, there is a certain plausibility to the events suggested, however unlikely it is that they might actually occur.

Second, the tendency of nuclear proponents to present nuclear power as risk-free makes the industry vulnerable to such scenarios. As long as the public can conceive even a remote prospect of a certain unfortunate scenario, the nuclear critic has managed to smear this "risk-free" image. And third, simply asking these "What if...?" questions serves to re-awaken in people whatever nightmarish fears they might have regarding nuclear accidents.

There is a third general approach to the risk of nuclear accidents -- that taken by the general public. This is the common sense approach, "Is this activity safe?". This question is asked in the same way one might ask the question, Is it safe to cross the street now? or Is it safe to take this airplane trip? The public, we were told by interviewees expert in public opinion, does not think in terms of "probability" or "risk", which it sees as abstract concepts.

The common sense approach reflects the personal perspective of the individual involved, and therefore can be highly subjective. Just as one person is petrified of air travel while another is not bothered at all by it -- and the opinion of neither is affected much by airplane safety records -- so some people will live in continuing fear of nuclear reactor operations, while others will never give a thought to the problem. Numerous factors enter into these differing perspectives, including the person's psychological profile, interest in and knowledge about nuclear power, and more general political and social attitudes.

An important dimension of this subjective attitude is that people make a sharp distinction among risks depending on "who is in charge" of the situation. Generally, I-am-in-charge situations are seen as comparatively low in risk, you-are-in-charge situations are seen as holding far higher risks, and nature-is-in charge situations lie somewhere in between.

To take an example, if I jay-walk across a busy highway because I am in a hurry, the choice is mine. Under these circumstances, I tend to take a rather sanguine view of the risk. If, on the other hand, a chemical company builds a toxic waste dump just across my property line -- over my strong opposition -- I am likely to see enormous risk in the presence of the dump, probably a far greater risk than there actually is. One scholar estimates that perception of risk can increase by a factor of ten thousand when the circumstance move from I-am-in-charge to you-are-in-charge.

Yet a third category is nature-is-in-charge, exemplified by earthquakes, typhoons, lightning, and the like. We tend to look at these risks as lying somewhere between the first two categories.

There are serious implications of these different categories for anyone wishing to address public concerns about nuclear power. It is not meaningful, for example, to compare the risk of a nuclear power plant accident, which is a you-are-in-charge situation, to that of crossing the street, taking an automobile trip, or various other everyday activities, which the normal person sees as I-am-in-charge situations. Nor is it meaningful to compare, as did the Rasmussen report, the risk of a power plant accident with that of a meteor strike or similar nature-is-in-control phenomenon.

This is not to say that useful comparisons of risk cannot be made. For example, as suggested by one of our interviewees, it might be helpful to publicize the fact that a single airplane trip across the country involves exposure to more radiation than living beside a nuclear power plant for a whole year. Such a comparison might help people better understand the nature of radiation. It should be pointed out, however, that this comparison might not diminish perceptions of risk about living next to the plant, since the airplane trip is an I-am-in-charge situation, and living by the plant may be seen as you-are-in-charge.

The subjective nature of risk perception also affects comparisons between coal-fired and nuclear power. Objectively speaking, coal is the cause of far more injuries and deaths, through black lung disease, mine cave-ins, and the like, than is nuclear power. But the average citizen does not confront the dangers of a miner's life, so most likely finds this comparison meaningless. Coal's greenhouse and acid rain effects might seem more directly comparable to concerns about nuclear power, but, again, neither future ill-effects of global warming nor destruction of fish in distant lakes and streams create the same emotions as the possibility of radiation release in one's immediate neighborhood.

Yet another problem raised by the subjective nature of risk perception is that the public generally finds meaningless "orders of magnitude" talk, such as one in a million, one in a billion, or one in trillion, chances of an accident. It should not be expected, then, that redesigning a power plant so as to lower the probability of a meltdown from, say, 10 (-9) to 10 (-12) will excite the public. As far as most people care, when dealing with numbers of this size, a small probability is a small probability, and that's that.

On the other hand, at a certain threshold probability ceases to be an abstract number, and becomes real and tangible, as illustrated in the Surry nuclear plant case. In mid-October of 1991, Virginia Power told the NRC that for every year of operation of its Surry plant there was a one-in-one-thousand chance of a water pipe rupture that would lead to a core meltdown and subsequent radiation leak.

While Virginia Power had apparently thought of this as a somewhat matter-of-fact statement of probabilities, in fact it was an astonishing admission, since one chance in a thousand seems, to the normal person, as a palpable reality. How many people, for example, would engage in any activity -- skydiving, skiing, smoking, drinking, or whatever -- that they thought had a one-in-one-thousand chance of killing them within the year? Very few, it might be surmised. Yet Virginia Power had announced that there were just these same odds of nuclear meltdown and radiation release, an accident that most people equate with a catastrophe.

The company soon discovered its mistake, and in less than a week announced that new repairs and inspections would lower the probability from 1/1,000 to 1/10,000, still hardly reassuring, but at least no longer in the "Oh, my god!" category. [Washington Post, Oct. 26, 1991 (p. B1) and Nov. 1, 1991 (p. A19)].

This chapter has addressed perceptions of risk of a nuclear accident, but risk is also important as it relates to radiation exposure. A radiation "overdose" is not automatically damaging to the body. It is all a matter of probability -- that is, of risk. We study survivors of Hiroshima and Nagasaki for clues as to health risks associated with radiation exposure, and no-one yet knows how many people exposed to Chernobyl-generated radiation will suffer ill-effects.

Considerable data exist regarding the effects of exposure to medical X-rays and to the sun's rays, and studies of Hiroshima and Nagasaki radiation victims provide additional data. There is, then, a factual basis for evaluating the risks of radiation exposure, and the U.S. government, along with governments of other industrial nations, has established standards for maximum radiation exposure. These standards are generally accepted as reasonable by both the public and workers directly involved.

In effect, everyone has accepted the probabilistic approach in this case, so the three perspectives we discussed above are not particularly applicable. Nevertheless, it is interesting that exposure maximums in this and other countries for nuclear plant workers are orders of magnitude higher than for the general citizenry. This would seem to reflect, at least in part, our distinction between I'm-in-charge and you-are-in-charge perceptions of risk.

To summarize, perception of risk of a nuclear accident fall into three categories: the probabilistic view of managers, regulators and other professionals involved in the day-to-day operations of nuclear power; the absolutist, held by nuclear critics who, in effect, argue that any level of risk is unacceptable; and the common sense, held by the general public. The common sense view can be quite subjective, and makes sharp distinctions among I'm-in-charge, you're-in-charge, and nature's-in-charge situations.

V

THE NUCLEAR POWER LIFECYCLE:

SITING, DESIGN, AND CONSTRUCTION

While the federal regulatory process tends to treat plant siting, design, and construction as phases in an integrated systems engineering process, the public takes a more fragmented perspective of these steps.

On the one hand, the public tends to have very strong feelings on siting matters, in particular, opposing nuclear plants in its own neighborhood. This NIMBY attitude is so powerful that environmental groups we interviewed were frank to acknowledge that nuclear power is an essentially localized issue for them, and that they mobilize public opinion around site-specific issues, rather than national or state level issues. One environmental organization characterized itself as a clearinghouse for hundreds of local organizations around the country which are oriented to "home town" issues.

On the other hand, the public seems rather unconcerned with the specific design of nuclear power plants, once the site is determined. Lacking any technical frame of reference, the public finds matters like cooling systems, heat transfer mechanisms and the like beyond its ken. Indeed, a public opinion expert we interviewed indicated the public does not even think the size of a nuclear plant has any bearing on its safety, reasoning, "A nuclear plant is a nuclear plant".

Nor did our research suggest any particular public concern with construction issues, although the lack of any construction activity for a decade leaves this pretty much a moot matter. Obviously, any revelations of shoddy construction practices, as have occasionally occurred in the past, would negatively impact public opinion.

There is one design issue, however, which may have real significance to the public, and that is whether or not a reactor is surrounded by a containment vessel. This concern may reflect the widely publicized lack of containment vessels for Chernobyl-type reactors, and it may also reflect the simple notion that something dangerous should be enclosed.

Some leaders in the nuclear power industry have shown considerable concern with how to describe the advantages of the next generation of reactors -- particularly the added safety features. We attach as Appendix B a recent article by public opinion experts Ann Bisconti and Robert Livingston of the U.S. Committee on Energy Awareness (USCEA) on this topic. Particularly noteworthy are that a scant quarter (26%) of respondents to the poll discussed in the article found the description "inherently safe" to "mean something good", compared with nearly twice as many (49%) who found the word "safe" meant something good. The public seems to be saying, as discussed more fully in the next chapter on "Operations", that industry may reasonably try to promote the notion of a safer reactor design, but will not be credible if it tries to sell an "inherently safe", "fail safe", or "goof proof" design.

Regulatory reform

Federal safety regulation is focused largely in the phases of the nuclear power lifecycle discussed in this chapter: siting, design, and construction. And it is towards this area that the major efforts for regulatory reform are directed.
The primary focus of such efforts is on streamlining the process by which a plant's construction is approved and its operating license granted. It is at these stages that a utility has already invested billions of dollars, and therefore finds protracted regulatory wrangling particularly costly. The most often discussed reforms involve limiting changes to the plant design that regulators can impose once the initial design has been approved, and setting firm guidelines for public participation at the licensing hearings. Other reform proposals involved "banking" of site approvals; securing a joint construction permit and operating license; and, looking well in the future, establishing special regulatory procedures for in-factory, modular construction of reactors.

Attitudes towards regulatory reform among the general public and special constituencies differ sharply. The public generally pays very little attention to the issue.

Indeed, a public opinion expert we interviewed observed that people generally approve of regulatory reform because that means "nuclear plants will be regulated".

Anti-nuclear activists and industry, on the other hand, are deeply involved in the subject. At the heart of the nuclear critics' position is intense and abiding distrust both of industry and of government regulators. One nationally prominent nuclear critic spoke to us at length and with great passion about the dishonesty and corruption among NRC regulators, believing that most of them, despite the mandate of their agency, are actually committed to promoting nuclear power, and to doing so without reference to the truth.

An example of this distrust emerged in the debate over the extension of Yankee Rowe's operating licensing. Nuclear opponents have generally dismissed as self-interested propaganda all statements from engineers at the utility about the quality of the containment vessel in question, and viewed with almost as much distrust the NRC's approach towards the matter. (It should be noted that the NRC's reversal of its position in this case has probably reinforced their critics' belief that the agency lacks principle and objectivity.)

In a revealing article for Policy Review magazine, Audubon Society official and nuclear skeptic Jan Beyea stated that nuclear opponents would never feel comfortable with nuclear power unless the key government jobs involving the regulation and promoting of nuclear power were held by nuclear critics.

Given these attitudes, nuclear critics naturally oppose any efforts to limit public participation in the licensing process, which is their primary vehicle for affecting regulation. And they oppose any effort at streamlining procedures, which they see as simply a backdoor way of limiting criticism of plant design and construction. As one nuclear critic we interviewed argued, "Given the record of the nuclear power industry and its regulators, we want the maximum number of opportunities to probe and challenge safety problems in nuclear plants under construction".

Industry, for its part, strongly opposes the seemingly endless regulator-mandated changes in plants under construction. More than one of our interviewees argued that NRC staffers demand such changes largely because they think that is necessary to justify their jobs. Of course, the continual pressure of anti-nuclear intervenors encourages just such micro-managing.

While some pro-industry interviewees granted that a nuclear power plant can always be somewhat improved, like any complex technology, they made the point that the cost-benefit tradeoffs of such improvements are all too often ignored by public intervenors and regulators. This problem reflects the differences in risk perception discussed in the last chapter. Industry's "probabilistic" approach is pitted against the critics' "absolutist" view.

One nuclear advocate we interviewed suggested that, in a sense, industry brought the change-order problems on itself. In years past, he observed, industry tried to secure NRC approval of quite generalized designs, wanting to get projects underway promptly, and intending to fill in design details as construction proceeded. While understandable, this approach opened itself up to extensive regulatory and public intervention during the construction process. Another pro-industry interviewee supported the concept of standardized plant design that aims to secure streamlined regulatory approval, but observed that a significant portion of plant design must be site-specific, and does not lend itself to standardization. One important divergence of opinion within the industry is worth noting. Utilities owning several nuclear plants place high priority on achieving standardization of regulation. They can achieve major economies of scale if all reactors have standard parts and procedures, and NRC change-orders directed at individual reactors largely erode these potential economies of scale. On the other hand, those utilities with only a single reactor, or share of a reactor, will be less concerned with this standardization issue, and more concerned with wanting to secure the most up-to-date design available.

Congress's potential role in regulatory reform has been highlighted by the current debate over Senator Johnston's sweeping energy policy legislation. For the purposes of our study, the most important lesson of this debate is the difficulty nuclear power has isolating itself from the more general topic of energy.

The Bush Administration and Senate leadership calculated that a package approach to energy legislation seemed the most promising. This strategy suffered an initial setback, but, at the time of this writing, a compromise solution seems likely that will also be a package, including nuclear regulatory reform. The fate of this package legislation reflects the comments made in Chapter I of this study that public attitudes towards nuclear power are closely related to attitudes regarding electric power in general.

Within Congress, we were told by interviewees, attitudes towards nuclear power are divided, with the edge going to proponents. One interviewee estimated that some twenty Congressmen are seriously interested in nuclear energy, and that slightly over half of these are pro-nuclear. And, the same source said, the majority of Congressional staff are pro-nuclear, notwithstanding their perception that the public, and their own colleagues, are overwhelmingly anti-nuclear. Our interviewee attributed this anomaly to a highly biased Washington press corps that portrays the country as anti-nuclear.

To summarize, the public is highly concerned with siting of nuclear plants, taking a generally NIMBY position. It is not concerned with design and construction issues, with the exception that it seems to want containment vessels surrounding reactors.

Regulatory reform is not of much interest to the general public, but of intense concern to nuclear critics and industry. Critics, deeply suspicious of both industry and government, want maximum opportunity to intervene in the regulatory process, whereas industry wants reform to limit NRC change-orders and intervenor-generated delays.

The recent Congressional debate on energy legislation shows that nuclear power's fortunes are closely tied to more general energy issues.

VI

THE NUCLEAR POWER LIFECYLE:

OPERATIONS, MAINTENANCE, AND DECOMMISSIONING

Operations. This chapter addresses the safety aspects of operations, leaving to the final chapter comments about operating efficiency.

The public is not generally nervous about current nuclear power operations. Some hundred nuclear power plants are now in operation around the country, with no evidence of widespread popular resistance. In none of our interviews did we hear of complaints about current operating practices.

A recent poll found 59% of Americans think nuclear plants are operated safely, while a scant 12% did not think so. And by an even larger ratio -- 70% to 13% -- Americans think future nuclear plants will be safer still. Both these findings may reflect public response to yet a third question in this same poll: more than one-third (38%) of Americans felt more confident about nuclear power operations as a result of seeing their country's successful operation of high technology in the Gulf war [R. H. Bruskin Associates poll, reported in May 1991 USCEA bulletin]. And virtually all opinion polls on the subject find that the overwhelming majority of Americans think nuclear power plants now in existence should be permitted to continue operating.

The one caveat that must be issued, however, was expressed by a pro-industry attorney who, after outlining his generally optimistic view of prospects for nuclear power, added, "All this, of course, goes out the window if there's another TMI."

It is also important to understand that, notwithstanding its basic faith in the safety of nuclear plant operations, the public is quite skeptical that error-free operations are possible. The public knows that operator errors caused both the TMI and Chernobyl accidents, and continues to read of operators asleep on the job or absent from their duty stations. Well aware of human fallibility, the public is unlikely to be persuaded that nuclear plants can ever be immunized totally against operator error. As noted in the preceding chapter, industry promises of "inherently safe" plants therefore receive quite a cool reception.

It is interesting that industry has chosen to publicize neither the excellent contributions towards operator training made by its Institute for Nuclear Power Operations (INPO), nor the extensive research being conducted to improve user-friendliness of control rooms, in response to evidence that the TMI accident was due to a confusing set of monitors in the control room. Industry may worry that such publicity would simply call attention to the dangers inherent in reactor operations. Yet this may be a case of undue modesty, and the public may be left unaware of genuine progress being made towards safer operations.

Maintenance. The issue of maintenance is coming to the fore as the first generation of nuclear reactors are beginning to reach the end of their licensed life. The recent controversy about containment vessel embrittlement at Yankee Rowe is certainly just the opening round in what will become an increasingly sharp series of debates on the safety of aging power plants. The issue is of particular importance since, with new plant construction not yet a politically realistic option, the future of nuclear power lies in maintaining, refurbishing, and re-licensing of existing plants.

The nature of the Yankee Power debate was almost certainly typical of things to come, in the sense that the question at stake is very much a matter of judgment, and not amenable to scientific tests. No-one really knows whether the sudden release of cooling water into the 25-year-old containment vessel would so shock the embrittled steel vessel as to fracture it, or how useful as a cautionary measure it would be to warm the cooling water. The NRC's reversal of itself on this issue underscores the uncertainties involved. In such situations, the debate is more likely to reflect emotional and philosophical perspectives than technical facts.

Decommissioning. Decommissioning has received far more scholarly inquiry than public attention, since the first actual case is still years in the future. But once it does come to the fore, decommissioning will raise highly emotional issues. On the one hand, prompt and full removal from a plant's site of all irradiated components will likely be adamantly demanded by local residents and anti-nuclear activists. On the other hand, such an approach would pose vastly greater health threats to clean-up workers than the alternative -- allowing a carefully-controlled venting of radioactivity from the plant over a period of years, and only then removing remaining radioactive elements.

It is certainly not too soon to start thinking about these problems, particularly since opposition to relicensing of aging reactors may force decommissioning of plants sooner than industry wants or anticipates.

To summarize, nuclear plant operations do not currently raise serious concerns among most Americans, who, nonetheless, are not prepared to accept the notion that such operations can be fail-safe. A single major accident would have an enormous impact on public opinion, and, in all likelihood, prevent for the foreseeable future any revival of nuclear power in this country.

Plant maintenance is an increasingly important issue, as the first generation of reactors reach the end of their licensed lives. Plant decommissioning, while not yet an emotional issue, could become one in the not too distant future.

VII

THE NUCLEAR POWER LIFECYCLE:

WASTE DISPOSAL

We were told over and over again in our interviews, by nuclear advocates and opponents alike, that the public is so preoccupied with waste disposal that it cannot look independently at other nuclear power issues, such as reactor safety. The waste disposal issue has three basic aspects: high level commercial waste, low level commercial waste, and nuclear weapons waste. Each of these involves distinct public opinion issues.

High level commercial waste. Far and away the most important nuclear waste issue from a public opinion standpoint is high level commercial waste. Such waste is, for the most part, spent fuel, although one anti-nuclear activist we interviewed argued that other waste elements now labelled low-level should be reclassified as high level.

DOE's chosen disposal site, Yucca Mountain, Nevada, has, of course become highly controversial, not only in Nevada, which is going to extraordinary lengths to blocks its use, but also around the nation. The site has become a national lightning rod for issues such as geological stability, retrieveability, transportation to the site, and, perhaps most emotional, the concept of safety storage for 10,000 years, or some 300 generations of human beings.

Compelling as all these issues may be to some, it is important to maintain perspective. In a recent poll, 75% of Americans answered Yes to the question, "Do you think the United States has the scientific and technical expertise to construct a safe and reliable nuclear waste disposal facility?" [Cambridge Reports/Research International March 1991 poll.] And underlying all these volatile waste disposal issues is a simple fact: Organized opposition to Yucca Mountain outside the state of Nevada is largely a function of opposition to nuclear power in general. Yucca Mountain opponents well understand that, if DOE can solve the high level waste disposal problem, nuclear power will get an enormous boost forward. It is not surprising that anti-nuclear activists are waging an intense campaign against Yucca Mountain.

Indeed, when we explored alternatives approaches to waste disposal in our interviews, we found very little support from nuclear critics. Transmutation of long half-life waste into much shorter-lived waste is a promising technology being pursued by DOE. Yet the nuclear critics we asked about this pooh-poohed the idea, arguing that the energy required for the process is so much greater than that produced by the fuel involved that the technology will never get off the lab bench.

We also raised the prospect of fuel reprocessing as a solution to waste disposal -- an approach the French are carrying out with great success. Opposition to this concept was vehement, and nuclear critics pointed with great agitation to the alleged danger of proliferation of the reprocessed fuel, which is bomb-grade material.

This proliferation issue is, indeed, very serious. A top priority of U.S. foreign policy is to control the spread of nuclear material that might be used in bombs -- particularly by regimes like Iraq and Libya -- an issue frequently in the newspapers today. And Japan's plans to import reprocessed fuel from France -- requiring shipment across two oceans, and portions of two continents -- has generated substantial opposition around the world.

Yet the fact remains that, properly managed, fuel reprocessing is a viable solution to the high level waste problem. The refusal of nuclear critics we interviewed even to consider this, and other, options suggests that their real goal is not in guaranteeing safe waste disposal, but rather in exploiting an issue that will frustrate the viability of nuclear power in general.

The high level commercial waste disposal issue has become so intense, and so politicized, that one nuclear proponent we interviewed mused that perhaps it had been a mistake to entrust waste disposal to the government. Conceivably, he suggested, the private sector could have navigated these troubled political waters better. While a provocative notion, exploring it might yield some interesting insights as to the management of other waste issues, such as that discussed in the following section.

Low level commercial waste. The Radioactive Waste Policy Act of 1980, as amended in 1985, devolved to regional pacts of states the responsibility for siting, building, and managing low level waste disposal facilities. The process has gotten off to a slow start, plagued by endless wrangling within the pacts about dump locations. While the regional groupings of states have usually been able to agree on general guidelines for siting, whenever a particular site has been selected, the state in question has rejected the choice.

From the standpoint of public perceptions, it may be useful to think of low level waste sites as toxic chemical dumps. No-one expects of these sites the elaborate precautions being pursued at Yucca Mountain, and there do not seem to be the emotions associated with 10,000 years of radioactive decay, retrieveability, and all the other special technology issues of high level waste. Instead, the concerns seem to be of a more general nature -- perhaps akin to those associated with Love Canal and the other superfund sites.

This is something of a mixed blessing for nuclear advocates. On the one hand, the complex of concerns associated with Yucca Mountain need not be addressed. On the other hand, nuclear power may find itself tied into an issue which touches the life of virtually every American, through lead battery and motor oil disposal, rodent poisons, weed killers, and a host of other everyday chemicals.

Nuclear weapons waste. While DOE's choice for a Waste Isolation Pilot Plant (WIPP) in New Mexico has of course been strongly opposed in that state, the matter does not seem to have caught fire as a national issue among anti-nuclear activists to anywhere near the degree that Yucca Mountain has.

There are probably two reason for this. The more important, discussed above, is that Yucca Mountain symbolizes a bright future for commercial nuclear power -- an anathema to nuclear critics -- whereas WIPP symbolizes U.S. strategic military strength, an issue the environmental movement in this country has generally chosen to avoid.

The second reason for the relatively muted response to WIPP is the practical fact that current bomb waste is a pressing environmental problem and obviously needs prompt attention. To oppose WIPP would put environmentalists in a very awkward position. By contrast, current methods for temporary storage of commercial nuclear waste are, comparatively speaking, reasonably acceptable to environmentalists.

To summarize, the three basic categories of waste disposal -- high level commercial, low level commercial and weapons production -- are quite distinct in the public mind. High level commercial is clearly the most emotional issue. The public may see low level commercials nuclear waste as somewhat akin to toxic chemicals. And bomb waste disposal, while controversial around the WIPP site, has been relatively non-controversial nationwide.

VIII

FINANCES

While most of this study has dealt with health and safety issues surrounding nuclear power, public perceptions about the financial position of the industry are an important part of nuclear power's overall image. Indeed, even if the industry satisfactorily addressed all its health and safety issues, it could still face difficulties in capital markets if its financial image were tarnished.

Nuclear critics, of course, have set about to argue that nuclear power is uneconomic. Their most potent weapon is the retrospective "prudency" hearings being conducted by various state utility commissions, which disallow from a utility's rate base some or all of the investment in a nuclear power plant deemed to have been "imprudent".

Such "Monday morning quarterbacking" of course discourages investors, who see in the process a low ceiling on profits and no floor under losses. Indeed, one of our interviewees argued that the state utility commission hearings are a considerably greater impediment to the revival of nuclear power than are federal safety regulations. And another interviewee called it fully as great a barrier. Besides discouraging investors, such retrospective prudency hearings are a powerful propaganda tool for promoting the prejudice that nuclear power is managed by a group of financial incompetents.

Another theme nuclear critics are fond of using is the charge that industry is dependent on federal subsidies, and incapable of self-sufficiency. We heard this charge from various interviewees, and it is often seen in the media, including, for example, the new movie, "Naked Gun 2 1/2".

In fact, the federal subsidies provided through R&D and fuel processing are not significantly different from those accorded the rail, airline, aerospace, and computer industries in their early days. Government support for infant industries is hardly an extraordinary phenomenon.

There is, however, one indirect subsidy that is quite unusual, and that is the Price-Anderson Act's limitation on liability claims for the industry. There are some very good reasons for this limitation -- including the extraordinary difficulties in identifying the full extent of radiation damage from a nuclear plant accident in any reasonable amount of time. But Price Anderson is a sign of nuclear power's special legal status, and a reminder of the special risks associated with nuclear power.

Beyond these issues, Wall Street has its own financial concerns about nuclear power. Most obvious is the length and unpredictability of federal regulator proceedings need to secure construction and operating permits, and the state rate hearings discussed above. In addition, according to one of our interviewees, who had spoken with several Wall Street investors, Wall Street grossly overestimates the technical difficulties of waste disposal and of decommissioning. Our interviewee attributed this problem to technical ignorance, and was guardedly hopeful that a well-planned education program for the Street might counteract this particular source of pessimism.

In addition, Wall Street's strong interest in quarterly financial results works to the disadvantage of huge, multi-year investments like those required to build nuclear power plants. Added to this, nuclear power plants in the United States have operated at a rather disappointingly low proportion of maximum capacity, some 60%, as compared to 79% in both France and Japan [Terence Price, Political Electricity: What Future for Nuclear Energy?, New York: Oxford University Press, 1990, pages 157 and 158]. Wall Street would naturally like to see an improvement in this ratio.

It is important, however, to keep this array of negative perceptions in perspective, and balance against it important positive factors. First, electricity is both a necessity of life and a driving force in the economy. As a result, it suffers from neither the vagaries of cyclical industries nor the "S-curve" flattening out of demand characteristic of so many emerging technologies.

A second financial advantage for nuclear power is the new federal clean air standards, which will add very considerably to the cost of coal-fired power plants, greatly diminishing the current difference in capital costs between coal and nuclear.

Finally, there is on the horizon the real possibility of new advanced technologies that could revolutionize the economics of nuclear power. In fact, one of these -- the High

Temperature Gas Cooled Reactor (HTGR) -- has produced considerable operating data. A variant of the HTGR, a modularized MHTGR, would likely operate at as little as 150 MeW, fundamentally changing the nature of nuclear power as "big and brawny" and requiring massive up-front investment. At 150 MeW, advanced reactor units such as the MHTGR could be added to each other as justified by incremental changes in demand, permitting financial flexibility lacking today in nuclear power.

Modular, in-factory production of reactors could lead to fundamental changes in the inspection/licensing process. With standardized design, each new unit might receive automatic approval of design, and inspection of production in the factory could immeasurably speed the review process. The combined effects of these factors could made such reactors quite attractive to Wall Street.

Beyond these considerations, advanced reactors offer major steps forward in reactor safety. For example, the MHTGR features automatic capping of reactor temperatures in case of emergency -- that is, an anti-meltdown guarantee -- and automatic induction cooling by gas in case of accident. The encapsulation of fuel into tiny, ceramic-coated pellets is a key element in the meltdown-free technology. Obviously, such a technology could go a long way towards reassuring the public, Congress, regulators and Wall Street about the safety of nuclear power.

To pursue this specific example, MHTGR is not without its difficulties. In the deployment of this technology in the United States, by General Atomics at Fort St. Vrain, Colorado, in the early 1980s, results were quite disappointing. The reactor was plagued with difficulties, and operated at only about 30% of maximum capacity. In Germany, HTGR plants have been burdened with high costs, and in Great Britain with operational problems.

Furthermore, HTGR skeptics argue that nuclear power lends itself to economies of scale -- in construction, in operations, and in compliance with regulations. Thus, the MHTGR "mini-reactors" could end up being cost ineffective. Even if this criticism proved invalid, it is undeniable that HTGRs would require a costly new network of parts suppliers and servicing organizations. And the NRC has already announced that it would require full prototypes for such advanced technologies as HTGR or LMR -- prototypes costing perhaps $1 billion apiece.

Two key critics of nuclear power, Robert Pollard of the Union of Concerned Scientists, and Jan Beyea of the Audubon Society, have suggested that the costs of making advanced reactors genuinely safe would be so high as to render them uneconomic. Beyea writes, "New, 'inherently safe' reactor designs have the theoretical potential to eliminate most of the meltdown risk, but ... it is questionable whether they compete economically with other energy sources for avoiding carbon-dioxide emissions, especially if they are built to reassure the public on safety and quality assurance." [Forum for Applied Research and Public Policy, Fall 1990, page 90.] And Pollard states, "A safe reactor can be built. An economic reactor can be built. But I am not convinced that both a safe and economic reactor can be built." [Interview with author of this report, June 6, 1991.]

Notwithstanding these reservations, HTGR is an intriguing technology with the potentiality for transforming both the reality, and the perception, of nuclear power's safety and financial viability. Likewise, although more speculative in nature, the other truly advanced reactor concepts offer some fascinating possibilities for modifying public concerns.

Indeed, when all the pros and cons for the nuclear power industry are wrapped up, it remains a fact that the overwhelming majority of Americans support nuclear power. A recent 1991 poll found that three-quarters of all Americans (73%) believe nuclear power should play either a "very important" or "somewhat important" role in meeting America's future energy needs -- a significant increase over the 65% in the same categories in a 1990 poll. Of major significance, nearly the same proportion of "green consumers" -- 70% -- support nuclear power; green consumers are those who identify themselves as environmentalists and have donated to or been active in a group working to protect the environment over the past year. [Gallup poll, July-August, 1991, as reported in USCEA Sept. 1991 bulletin].

To summarize, nuclear power's image as financially viable suffers from state utility commission retrospective prudency hearings; from the charge of excessive dependency on federal subsidies and Price-Anderson Act liability protection; and from Wall Street concerns about high up-front capital costs, regulatory delays, and waste disposal and decommissioning costs. Set against these negatives are the electric power industry's relative freedom from business cycles and the new product "S-curve" syndrome, and major new costs for coal plants mandated by recent clean air legislation.

Advanced reactors, especially the modular high temperature gas reactor (MHTGR) in the nearer term, offer possibilities for major breakthroughs in nuclear power economics, through smaller, modularly-built plants permitting greater financial flexibility and speedier regulatory approval. Safety features, most notably a meltdown-free technology, could dramatically improve public acceptance of nuclear power. HTGRs, however, have had operational problems in the past, and would face heavy start-up costs.

Recent polls show that three-quarters of Americans are supportive of nuclear power, a proportion that is up from two-thirds last year, and includes 70% of Americans who identify themselves as environmentalists.

CONCLUSION

In this paper we have outlined, as comprehensively as possible, public concerns with nuclear power, and we have ventured to indicate, wherever possible, the relative importance of these various issues. The range of topics is very substantial, touching profound emotions, and a breadth of economic, political, and health and safety issues. This study aims to satisfy several elements of GMU's proposal, "An Examination of the Factors Defining the Regulatory Process for Advanced Nuclear Reactors", and is meant to be directly responsive to our Advisory Group's April 26, 1991 instructions to focus on methods for analyzing public opinion regarding nuclear power.

We do not include straw man poll questions at this stage, as we believe further sharpening of study objectives should come first. Our hope is that the Department of Energy and our Advisory Group will review this study, and then determine specific topics we should pursue through public opinion surveys and focus groups. We would then develop straw man questions for these topics.

It might be determined, for example, that we should pursue public attitudes in the area of radiation, or of linkages between nuclear power and nuclear weapons. Again, we might explore attitudes bearing directly on features of advanced reactors, such as the HTGR's impossibility of meltdown. (Some aspects of advanced reactor design, such as standardized design and modular construction, are addressed in the article in Appendix B.) In addition, the Department might like us to develop survey research in support of programs of education relating to nuclear power. We have included in Appendix A concept for a possible education program.

If any single conclusion can be draw from our work, it is the vast range of public perceptions confronting nuclear power policy-makers. Ours has been called "the atomic age", and it not surprising that nuclear power touches a wide range of public attitudes involving our safety and security, our prosperity, the appropriate uses of technology, and, indeed, the future of science as the driving force of social progress.

Public controversy surrounding nuclear power will not quickly dissipate, whatever steps industry and government might take. The challenge is to deepen our understanding of the issues involved, and pursue a range of educational and policy initiatives that can both diminish public concerns and rationalize debate on the topic.

APPENDIX A

SAMPLE NUCLEAR POWER EDUCATION PROGRAM

The following pilot education program contains 8 four-hour sessions, or, in other words, a four day curriculum. As such, it could fairly easily be expanded to a week-long program, or contracted to a week-end program. It is designed to address nuclear power issues most frequently discussed in the media, in legislative bodies, and in other public policy forums. It would probably be taught by a variety of different instructors, because of the wide diversity of topics involved. Considerable time for questions and answers should be provided.

Overview

Time allotted	Topic
4 hours	Demand for electric power
4	Financing power plants
8	Plant design and construction; emphasis on safety issues
4	Operations; emphasis on safety issues
8	Waste disposal, including mining and milling issues
4	Summary. Review of options for securing needed power

Individual sessions

Demand for electric power (4 hours)

Overall trends. Relationship of electric power to economic growth, and to population growth.

Trade-offs between electric power and direct combustion energy, in, for example, home heating.

Potential growth areas for electric power: electric cars, electric-powered process industries, etc.

Conservation: potentialities and limitations.

Alternative sources of electric power, such as solar and wind: potentialities and limitations.

Financing power plants (4 hours)

Construction stages. Capital flow requirements.

Return on capital considerations. Regulatory environment.

Risk considerations in determining cost and application of capital.

Capital markets. Investment trends and cycles. Role of interest rates.

Plant design and construction (8 hours)

Overview of conventional electric power plants, nuclear power plants, and advanced nuclear concepts.

Heat generation and heat transfer functions in nuclear plants.

Coolant functions.

Siting considerations: geology, proximity to water, waste disposal routes, evacuation.

Operations (4 hours)

Procedures for start-up and shut-down.

Procedures for fueling and refueling.

Monitoring systems.

Standard maintenance procedures.

Plant and equipment deterioration and maintenance.

Security procedures, with reference to both intruders and employees.

Waste disposal, including mining and milling (8 hours)

Mining and milling health, safety, and environmental issues for workers and nearby communities: tailings, refuse, and radiation exposure and measurement issues.

Spent fuel and other nuclear power plant wastes: high level vs. low level.

Volume and proximity requirements for waste disposal.

Desirable characteristics for sites.

Procedures for selecting sites.

Transportation of waste.

Deposition of waste.

Monitoring of waste.

Possible causes for retrieval.

Summary (4 hours)

Review of demand issues.

Review of alternative sources of power.

Economic comparison of alternatives.

APPENDIX C

INTERVIEWEES

Jan Beyea, Director, Environmental Policy Analysis Department, National Audubon Society, New York City

Ann Bisconti, Vice President, Research and Program Evaluation, U.S. Council for Energy Awareness, Washington, D.C.

Robert Bishop, attorney, Nuclear Management and Resources Council (NUMARC), Washington, D.C.

Paul Burkes, Director State Energy Office, State of Georgia

Tom Carpenter, Government Accountability Project, Washington, D.C.

Melinda Cassin, Environmental Defense Fund, Denver, Colorado

Alan Crane, Office of Technology Assessment, U.S. Congress, Washington, D.C.

David Hess, Director, Senate Environmental Resources and Energy Committee, State of Pennsylvania

Louise Jacobs, Council of State Governments, Washington, D.C.

K. P. Lau, Vice President, Technical, American Nuclear Energy Council, Washington, D.C.

Michael Marriott, Nuclear Information and Resource Service, Washington, D.C.

Mark Mills, President, Center for Science, Technology and Media, Chevy Chase, Maryland

Ray Ng, U.S. Committee for Energy Awareness, Washington, D.C.

Tom Pestorius, TPA, McLean, Virginia

Scott Pileski, Institute for Energy and Environmental Research, Takoma Park, Maryland

Robert Pollard, Union of Concerned Scientists, Washington, D.C.

Mark Rowdin, Attorney, Fried, Frank, Harris, Schriver, and Jacobson, Washington, D.C.

Jay E. Silberg, Attorney, Shaw, Pittman, Potts & Trowbridge, Washington, D.C.

Richard Sills, Senior Vice President, BNFL, Inc., Washington, D.C.

Jan Tretner, Director, Energy Committee, National Conference of State Legislatures, Washington, D.C.

APPENDIX A

Case Law and NRC Administrative Process
Data Collection and Analysis

APPENDIX B

Listing of Court Cases

The John Francis Co., Inc.
December 1991

APPENDIX A

Case Law and NRC Administrative Process Data Collection and Analysis

Table Of Contents

CHAPTER I

SCOPE OF THE REACTOR LITIGATION PORTION OF THE STUDY

A. INTRODUCTION

The George Mason University through its school of Information Technology and its subcontractor, The John Francis Co., Inc. conducted a study for the Department of Energy's Office of Energy Research which examined the regulatory process appropriate for the licensing of advanced nuclear reactors. One of the major thrusts of the study is the examination of the regulatory constraints and/or flexibility created as a result of the public's perception of the dangers and benefits of nuclear power and then to assess their impacts on the development and use of advanced nuclear reactors which possess superior safety and environmentally sound characteristics.

The premise of the study is that the superior technological characteristics of advanced reactors when compared to existing light water reactors will only be effective in expediting the licensing process if the public and its representatives in Congress and the regulatory agencies perceive that these enhanced safety characteristics meet the public's basic concern about health and safety. To the extent these fundamental public perceptions are met, then the regulatory structure can be put in place and expeditiously implemented. One of the objectives of this phase of the study is to identify the key reasons for public concern over the safety of nuclear power.

This inquiry into public perceptions has taken two different perspectives which we had hoped, and have subsequently found to be complementary and corroborative of each other. One path was a direct interaction with individual decision makers/opinion makers representing the power industry, the environmental movement and the government. These "one on one" subjective interviews represent an attempt to identify and describe "these perception". The other path was to examine the formal body of litigation, both at the Federal Courts of Appeal and at the NRC administrative process level, to determine if we could reach below the ostensible litigation questions to identify the more basic motivating issues/perceptions.

This part of the study presents our attempt to document the existence of these fundamental motivating factors, from the case law and administrative proceedings.

We have found that these two paths point in the same direction.

B. EVOLUTION OF THE ORIGINAL STUDY

The current research builds on and follows the original George Mason University School of Law study. The original study primarily involved an examination of federal court litigation involving the NRC nuclear licensing process. The original study also took, as axiomatic the fact that any technical question which results in protracted litigation at the Court of Appeals level is one of considerable social or political concern to the litigants. Therefore, analysis of the litigated decisions encapsulates the social and political concerns which led to the litigation. Hence, this body of nuclear "case law" represented a reasonable mirror of public social perception, albeit expressed in "legalize".

There have been literally thousands of technical questions that involved or concern the licensing of each of the approximately 100 reactors currently in operation in the United States. However, this myriad of technical issues have produced only about sixty-eight relevant Court of Appeals cases with written opinions. These handful of cases, although complex and multi-issued, have established the law of nuclear power.

The methodology of the original study was an effort to quantify or determine classes of technology that could be identified through investigation of the Court of Appeals cases chosen. The fifty-six technical criteria defined by NRC as their basis for licensing, 10 CFR Part 50, Appendix A, were used to define the categories within the classes of technology. Each case was examined to determine which of the NRC criteria were involved. Examination and analysis of these cases revealed that approximately 45 cases involved specific NRC licensing criteria, while many other cases involved purely procedural questions.

One of the most notable findings of the original study was that the issues of public concern contained within these cases did not focus on specific technical items, but rather on broader more basic issues in which the specific technical question was merely the vehicle for expressing a more fundamental discontent. For example, in one case the technical issue involved a question as to the correct mechanism and alignment for the piping system penetration of the containment vessel, which was also a specific licensing criteria. However the actual issue being litigated was a broader concern for the integrity of the containment system and whether potential hazards were created to the surrounding environment by any violation of containment integrity.

Consequently, in an effort to synthesize the 56 NRC technical licensing criteria to correspond more faithfully to the public's perception of the litigated issues, the authors identified four categories; (1) cataclysmic events (2) technical system performance and integrity (3) waste removal and environmental impact and (4) mystic energy. These composite categories were abstractly named "Simplified Technical Concerns" by the authors of the Law School study.

CHAPTER II

METHODOLOGY

A. **FOCUS OF THE CURRENT STUDY**

The present research adopts the classification system developed in the previous study using the four "Simplified Technical Concern" categories as a method of classifying areas of public concern. While the original study made a complete examination of the litigated cases (see Appendix B) it also made an examination of seven reactor licensing files in the NRC data base. The seven reactors were chosen in a subjective fashion to span the available commercial technologies; they were geographically dispersed, covered a broad licensing time period and various types of safety concerns. The original study suggested that subsequent studies might more comprehensively examine the NRC licensing files in an effort to give more substance to the case law litigation data base and attempt to corroborate it. The "licensing files" describe interactions and concerns not subject to the rigorous constraints of formal litigation and are hence more directly expressive of public concerns and perceptions. The current study has acted upon this suggestion and has chosen to examine the last ten most recent reactor units to come into commercial operation.

B. CHOOSING REACTORS

To determine which reactors actively were the last 10 reactors to come on line the listing in the NRC's 1990 information digest (NUREG-1350 Vol. 2, 01/31/90) was used. The NRC lists the reactor units by name, NRC region, containment type, license type, maximum capacity, megawatts thermal or electrical; the dates when the construction permit was issued, the issuance of the operating license and type (i.e. fuel load, full power or low power) the date of commercial operation, and the expiration date of the operating license.

The initiation of commercial operations date was used to determine the 10 reactor units considered as the last 10 "on-line" commercial reactors in the United States. However, three of the commercial reactors initially chosen, Vogtle Unit 2, Braidwood Unit and South Texas Unit 2 contained duplicate documentation where the majority of contentions asserted against the Unit I reactor were also asserted against the second Unit at the site. While there were some proceedings documented within the files which distinguished the units at a site, there was not enough diversity of data for our purposes to compile separate files for Units I and 2 from these sites. Therefore, to obtain data on a total of 10 commercial reactors "on-line" additional reactor units were chosen; Perry Unit I, Fermi Unit 2 and an alternate Beaver Valley 2. The revised list of 10 "different" reactors considered as the last "on-line" commercial reactors in the United States were:

Case No.#	Reactor	Owner	Operation Date
1	Limerick 2	Philadelphia Elec.	1/08/90
2	Fermi 2	Detroit Edison Co.	1/23/88
3	Palo Verde 3	Arizona Pub. Serv. Co.	1/08/88
4	Nine Mi. Pt. 2	Niagara Mohawk Power Co.	3/11/88
5	South TX I	Houston Lt. & Power Co.	8/25/88
6	Braidwood I	Commonwealth Edison Co.	7/29/88
7	Vogtle I	Georgia Power Co.	6/01/87
8	Byron 2	Commonwealth Edison Co.	8/21/87
9	Clinton	Illinois Power co.	11/24/87
10	Perry I	Cleveland Elec. Illum.	11/18/87
11	Beaver Valley 2 (alt. selection)	Duquesne Light Co.	11/17/87

While these reactors represent the most recent units to come on line they do not necessarily represent the reactors with the latest operations expiration dates. This is because the NRC regulations on the duration of license, 10 C.F.R. § 50.51 allow a license to be "issued for a fixed period to be specified in the license but in no case to exceed 40 years from the date of issuance...the license (may be) for the term requested by the applicant or for the estimated useful life of the facility" as the Commission so determines. As a result, not all reactors are issued licenses for the same period of time.

C. NRC FILE SEARCHES

As of June 1, 1988 the NRC dockets contained 1.1 million records which are updated, on average, by 350 data records per day. The index into the NRC file system is accessed by computer. The NRC's Bibliographical Retrieval System (BRS) data base, an on-line index, covers virtually the entire regulatory process. This data bases consists of descriptive citations to documents on micro-fiche of the vast majority of documents filed with the NRC after October 1978. Access to citations of older documents, those predating 1978, are limited and are cataloged under a different information system. Since examination of those NRC records which predate 1978 is not timely and more difficult to assess, the research for this study was limited to those files generated subsequent to October 1978.

The NRC File Classification System, NUREG/BR-0052 Rev. 1, August 1986, divides documents by Docket file. A "Docket File" is defined according to the nuclear activity being licensed and regulated by NRC, e.g., medical facilities, nuclear power plants, waste treatment facilities, etc. NRC's category "Docket 50 - Nuclear Reactors and Fuel Reprocessing Plants" generally contains documentation concerning the domestic licensing of production and utilization facilities...i.e. reactors. Licenses issued under § 50 (of Title 10 Code of Federal Regulations) cover commercial nuclear power plants; experimental research and test reactors; fuel fabrication facilities; and standardized plant applications.

Each Docket-50 file is further divided into twenty-six additional categories that pertain either to different aspects of the licensing process or to document types.

Of the twenty-six Docket-50 categories, four potentially related to public perceptions and were chosen for research purposes. They are as follows:

Category D - Legal and Adjudicatory Correspondence

This category contains all non-antitrust legal and adjudicatory documentation including;

1. Atomic Safety and Licensing Board (ASLB) and Atomic Safety and Licensing Appeal Board (ASLAB) hearing related documents

2. Federal Register notices regarding hearings

3. Requests to make appearances at hearings

4. Motions, briefs, arguments, statements and related correspondence filed by participants for hearings

5. Transmittal of supporting documents (e.g., SER, FES) to the Boards

6. Correspondence to and from intervenors

7. Board orders and decisions

8. Petitions for Commission action

9. Legal filings and Commission orders and decisions resulting from item 8

Category H - General Correspondence

This category includes documents with little or no bearing on the status of the application or license. These are items that have no substantive technical content and are generally administrative documents. They include, among others:

1. Correspondence from public requesting information about the facility and NRC responses

2. Letters of support, concern or opposition to the facility

3. Constituent, organizational or utility correspondence forwarded by Congressman to NRC for response

4. Resolutions passed by State and local governing bodies (e.g., town councils)

CATEGORY O - ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS) REPORTS AND CORRESPONDENCE

This category contains plant-specific documents pertaining to ACRS safety reviews. It includes, among others:

1. ACRS reports relating to facility license applications

2. Statements and written testimony by ACRS Members or by individuals at ACRS proceedings relating to both facility license applications and safety-related matters

3. Technical correspondence, and memoranda to and from ACRS.

Category U - Congressional;/Executive Correspondence

This category includes, among others:

1. Statements and testimony before Congress or before bodies/committees appointed by the Executive or Legislative Branches

2. Information supplied for the record of Congressional hearings

3. Correspondence to and from Congress and the Executive Branch on other than constituent response matters

4. Correspondence to or from State Legislative bodies

NRC has assigned each reactor a docket number. Once the docket number is accessed, the computer will tell how many "hits" it has under a reactor name. Thereafter, a key word and/or file category search can be used to narrow the field of inquiry. For example: The Braidwood Unit I reactor has been given a NRC docket number of 50456 and the file category of legal correspondence has been designated the letter "G". Therefore, entering "DKT=50456-G", the computer registers 1314 hits. Since the field to be search is very broad, key words can be used to narrow the field of inquiry. So the key words="petitions" or "contentions", and "intervenors" were used to narrow the field of inquiry. Typically "documents" cited in the NRC records contained a series of papers covering a particular issue, therefore one "document" could contain one page or hundreds of pages. Many times the use of key words to narrow the search was not successful and the researcher had to "plow" through all or part of the citations listed with the file.

D. CATEGORIZING THE NRC DATA

The legal correspondence file, Category D, of Docket-50 was chosen since an initial examination indicated that Category D provided the majority of information needed to extract public opinion. Specifically, the documentation of petitions for leave to intervene, Applicant's Response and/or NRC staff response to such petitions or amendments thereto are vehicles to articulate concerns. Also collected from this file was relevant information obtained from Advisory Safety Licensing Board orders ruling on issues of a particular proceeding. The remainder of useful data was obtained from Category U...the Congressional/Executive Correspondence file of Docket-50 which was generally comprised of Congressional letters of inquiry and NRC staff responses thereto, considered by the authors as a realistic mirror of public concern. No data was collected from either the General Correspondence file or the Advisory Committee on Reactor Safeguards Correspondence file.

A total of 54 documents from eleven reactor files were collected and compiled in summary abstract form. The majority of summaries extracted/created by the researcher are direct quotes and/or string quotes of the information contained within the documents chosen from the NRC files. These summaries are NOT subjective or digested paraphrases but rather are severely edited direct quotes.

Data was classified into seven categories which were considered to be "Simplified Technical Concerns". Four of these categories, (1) Cataclysmic events (2) Technical System Performance, (3) Waste Removal and Environmental Impact and (4) Mystic energy were previously defined in the first study. (See Arbitrary NRC Grouping of categories, Appendix A) Three additional categories, (5) Economic Impact, (6) Oversight and (7) NIMBY have been created because of the pervasive concern in a number of files reviewed.

The seven categories under the Simplified Technical Concern issues are defined to include the following:

I. <u>CATACLYSMIC EVENTS</u>

- mass population mortality
- substantial radiation leak
- pervasive health and safety danger
- fear of meltdown or reactor vessel rupture
- emergency preparedness, anticipation of a cataclysmic event
- probabilistic assessment of a worst case scenario

II. <u>TECHNICAL SYSTEM PERFORMANCE</u>

- Do failures in minor components lead to major failures
- Are components or subsystem designs working as planned
- Quality operations and Maintenance
- Q.A., Q.C., Testing, Inspection
- Emergency systems

- Structural design/Natural Phenomena
- Redundancy

III. WASTE REMOVAL AND ENVIRONMENTAL IMPACT

- generation and disposal
- long and short term
- low and high level
- method of disposal and/or storage
- Transportation concerns fuel/waste
- Disturbances of Ecological/Biological systems
- Compliance with Federal and state environmental laws

IV. MYSTIC ENERGY

- any level of radiation will ultimately produce harm
- nuclear is last option
- nuclear is never an option
- alternate energy sources
- cumulative inductive proof

V. NIMBY

- put it somewhere else (out of sight out of mind)
- understands the need but not here
- argues all but the "kitchen sink", contentions target the entire licensing process

VI. ECONOMIC IMPACT

- Need for power
- Rate Increase
- cost delays, litigation

- Market suppliers for Industry
- Anti-trust concerns

VII. OVERSIGHT

- States/public right to participate
- intervenor asserts hearing rights
- public right to open record
- state/municipal right to participate

CHAPTER III

FINDINGS

A. <u>DATA ANALYSIS</u>

(1) NRC Files

The data collected from the NRC files were organized in chronological order for each particular reactor unit. The document summaries which were created were then categorized or filed by their particular Simplified Technical Concern. A total of 53 issues were identified from the 54 documents. Often a reactor unit file contained a number of issues which fell within the same Simplified Technical Concern category. For example: The Study's Palo Verde 3 file contains five documents that are relevant to the study. Of these, two challenge the adequacy of the consideration of environmental impacts in the applicable licensing proceedings. However, each of those two assert "different reasons" for its challenge. Hence, for the purposes of this study these different contentions were tabulated as two separate issues categorized under the same heading "Environmental Impacts".

Many contentions within a reactors file were re-asserted or amended by the same individual/or group of individuals. When this was the case, contentions were reviewed carefully to determine whether or not the re-asserted and/or amended contentions contained new information. If so, then the amended version of contentions was considered a new issue and categorized under the appropriate Simplified Technical Concern. If the amended contentions did not contain any new information then the data was considered duplicative and was not tabulated.

(2) Petitioners/Intervenors

The individuals which petitioned to intervene and/or were granted the right to intervene in the NRC proceeding were mainly comprised of citizen action groups, both incorporated and unincorporated, local and nationwide. This group also consisted of individuals asserting contentions on their own behalf. No group of intervenors was eliminated nor was motivation or remoteness considered. The study utilized documents from such intervenors as (1) prisoners asserting the inadequacy of training for evacuation of personnel in an emergency situation and (2) an unincorporated association of industrial consumers of energy with plants located within a state asserting a need for a secure supply of reasonably priced electric energy.

(3) Contentions/Assertions

Contentions asserted in a particular proceeding before the NRC encompassed a broad range of arguments. Some contentions were highly detailed, supported by complex data and "expert" opinion. Other contentions were so generally asserted, and unspecific that the argument could have also been asserted against any generic power generator. Some documents did not clearly delineate contentions and were really assertions, vaguely stated without basis for the allegation.

Generally, contentions could be readily categorized under a particular Simplified Technical Concern. However, we experienced difficulty in categorizing some of these documents because the manner of presentation was not clear as to the contentions asserted. The regulators simply refuse to admit contentions without basis or relevance. We, on the other hand, wanted this data as a direct expression of public perception. So, in some cases, we had to decipher or impute meaning.

A petitioner could not merely assert a "fear" of nuclear power as a reason for requesting the revocation of a nuclear power plant license before a NRC regulatory board. His "contention" had to assert a basis for such fear, not merely an assertion. Consequently, several documents reviewed often referenced over 100 contentions or listed a broad range of contentions which covered all of the categories and ranged from very technical to extremely vague, unspecific assertions. This situation often forced the researcher to subjectively choose between the NIMBY and the Mystic Energy categories since such broad all-encompassing contentions were usually a paraphrase for NIMBY or were an expression of basic fear. Differentiating between NIMBY and Mystic Energy proved to be a difficult task because it could not be determined whether (1) the intervenor would accept the nuclear option "elsewhere" and was asserting every possible argument before the NRC in the hope that one or more contentions would ultimately reverse or terminate "this" licensing process; or whether (2) the intervenor believes that by asserting every possible argument, the NRC will "validate" one or more of them in the hope that nuclear reactors will not be operated.

B. OBSERVATIONS

1. Cataclysmic Events

The cataclysmic events category consists of public concerns which relate to the fear of mass population mortality due to the uncontrolled release of large quantities of radioactive material into the environment. This category included: severe loss-of-coolant accidents involving the reactor vessel, overwhelming (but unexplained) fear that the containment is grossly inadequate, or a core-melt down scenario, and allegations of inadequate spent-fuel storage methods but only in situations or in contentions which could somehow create a situation where the criticality of the spent-fuel would become a probability.

The most common concern in creating the data files under this category was the issue of emergency preparedness in anticipation of a cataclysmic event. Petitioners/intervenors repeatedly questioned NRC's decision to finalize operating license applications when petitioners felt that all worst case scenarios or risk assessments had not been considered. The most emotional arguments in the litigation data base were the charges of "severe psychological damage" asserted before the court in an attempt to prevent the start up, restart or continued operations of a particular reactor.

2. Technical System Performance

Both the NRC files and the litigation files exhibited similar concerns in this category. Overall, both sets of data are replete with concern for core-cooling system components and designs, reactor design capabilities, seismic activity zones, and containment vessel components and designs. The NRC files contained many detailed contentions alleging very specific design flaws or technical problems which could lead to inadequate performance of a variety of technical systems. The concerns actively litigated in court generally attacked the rule makings of the agency or questioned the agency's judgment and discretion on these issues.

3. Waste Removal and Environmental Impact

This was a big concern as evidenced by the sheer number of entries in the NRC files, and as evidenced by the number of times it appears as an issue in the court case files, where it appeared more often than any other issue. These concerns were generally expressed on a range from very specific allegations of insufficient data to inadequate agency procedures relating to environmental protection activities. We believe that this category would have appeared even more often in the NRC files had it not been for the change in the NRC regulations disallowing contentions as to the general waste removal issue when dealing with a particular license operation. NRC disallowed these contentions because the DOE has been mandated by the Congress to solve the long-term waste removal issue. This may explain the absence of data after 1984 on this issue in the NRC files.

Generally, this category covers generation, removal, storage, treatment, disposal and transportation of radioactive wastes, for short or long term periods. It also covers the potential disturbance of ecological, biological and geological systems and discharges of radioactive material into the air, water, and soil. In the litigation files these issues were expressed by the petitioners assertion that the law, policy, guidance or agency action or inaction lacked the adequate protection mechanisms necessary to prevent environmental damage. Thus, the litigation asserted contentions ranging from the unconstitutionality of the Price-Anderson Act and adequately protecting/compensating persons from potential nuclear disasters to requests for the clarification of the requirements of the federal environmental laws, and objections to NRC policies.

4. <u>Economic Impact</u>

This new category (which was added subsequent to the Law School study) repeated citations in the NRC files of arguments against the licensing of a particular reactor unit because there was no need for additional power. It is interesting to note that such arguments are not properly admitted in a NRC licensing proceeding as the NRC regulations prohibit such contentions other than as assertions that the applicant had not met the NRC financial qualifications.

A variety of economic arguments were asserted by petitioners/intervenors to NRC proceedings such as: undue financial hardships on utilities due to the cost of delays and litigation initiated by environmental groups, congressional inquiry as to antitrust concerns, the licensing applicant lacked the necessary funds to safety operate the nuclear project, cheaper alternative non-nuclear energy sources exist, rate increases and/ or cost-overruns associated with reactors coming on line create an undue burden on rate payers, etc., etc. One of the most interesting arguments in the NRC files was a request to alter the design of nuclear plant which was 90% complete into a coal fired facility because the intervenor believed it would be a more economical source of energy.

In the litigation files the economic arguments ranged from allegations that a utility didn't have enough financial capability to address the alleged safety violations to a review of NRC generic rule makings. The court review of NRC rulemaking involved issues such as charges of bias in applying NRC rules favoring cost over safety, or the inequity of the NRC rule for allocation costs among utilities for development/construction of nuclear waste repositories. Thus arguments associated with cost impacts on the utilities, the nuclear industry or the rate payers have been included in this category.

5. Oversight

Most contentions/allegations sought some type of outside review of the NRC decision making process. However, we have included in this category only instances where specific oversight relief was requested, such as: the right to a public hearing on a particular issue, state oversight/consultation before NRC acted, NRC refusal to re-open a record, the agency's inclination to shut the public out of the decision making process purportedly in abrogation of Congressional mandate, etc.

6. NIMBY

Generally, the NIMBY syndrome is loosely defined as "...put it somewhere else, ...an out of sight out of mind philosophy...", even though the need for power, even nuclear power is understood. The "not in my backyard" syndrome category could be readily identified within the litigation cases. These cases dealt with the enactment of state, municipal, or local laws which prohibited the importation of spent nuclear fuel into a town or state for storage, treatment or disposal. The data in the NRC files were not as clear cut. Although no documents straight forwardly stated that either (1) the intervenor/petitioner would not accept the nuclear option or (2) the intervenor did not want the nuclear facility operating in his backyard, there were some documents which asserted every possible anti-nuclear argument. The researcher categorized these "kitchen sink" arguments as NIMBY issues.

7. Mystic Energy

This category dealt with arguments which indicated that the petitioner/intervenor believed that any level of radiation will ultimately produce harm and therefore nuclear is never an option as a source of electric generation. Unlike the environmental impact category which dealt with the potential environmental damage due to radioactive material releases, this category addresses the fear that <u>any</u> radiation can cause or has caused damage which is irreparable because "man-kind" is unable to control such releases.

The court litigation contained no issues in this category which could readily be identified. In the NRC files identification of this concern was very subjective analysis. It is easily inferred in many documents but was only unmistakenly identified once. In the NRC files for the Beaver Valley reactor, statements of unsubstantiated allegations inferred that the petitioner/intervenor feared any form of radiation. For example, from the Beaver Valley Unit 2 file:

> "The radiation from farther away Beaver Valley No. 1 containment [sic] has been so great on my property that it reddens my face skin and has caused me to develop facial cancer."

C. TRENDS

The study organized the Simplified Technical Concerns into three approximate time periods. This time scale was arbitrarily defined as T(+) a period from 1965-1976, when an optimistic view of nuclear power and its promise prevailed; T(0) a period from 1977 to 1980, defined as an era in which a critical view of nuclear power was taken and when expansion of nuclear power was stopped and the nuclear option called into question; T(-) a period from 1981 to 1990 during which no new nuclear projects have been initiated, although three new reactor units are currently scheduled for completion by 1995.

Chart #1 Represents the eleven reactors in the licensing process, a period which averaged 13.0909 yrs. The licensing period was defined as the time period from the date of the issuance of the construction permit to the Commercial Operation Date. All but two reactor units, Perry 1 and Palo Verde 3, encompassed all three time periods defined earlier. These two reactor units began construction in the T(0) time period, a period in which a critical view of nuclear power was taken.

Chart #2 Highlights the seven simplified concerns and expresses the 53 NRC file issues raised over the time period between 1978 and 1991. Because of the difficulties in researching reactor unit files prior to 1978, (see discussion in Section C, NRC File Searches), the T(+) period is not represented.

Chart #3 Represents the fifty-three NRC file issues raised in the seven Simplified Technical Concern categories displayed by reactor unit. The totals represent the number of times issues were raised per reactor unit. Note that the NIMBY category represents an area in which all, or almost all, issues were raised.

Chart #4 Represents the number of times an issue was cited in the NRC files reviewed. This is expressed in a percentage of the data base of the 53 issues raised.

Chart #5 Is an expression of the number of legal correspondence documents identified in the NRC documentation for each reactor unit. This represents the total number of documents before word searches, and documents review began. It is important to remember that not all documents in this file provided relevant data for this study. For example: Limerick had some 2591 "apparently" relevant documents in the legal correspondence file. However, after narrowing the search through key word cross referencing, the list was reduced to 45 documents of which only about 7 to 10 documents actually represent original unamended contentions.

Chart #6 Is an expression of the number of Congressional Inquires and Response documents in the NRC documentation for each reactor unit. This represents a total number of documents before word searches and document review began.

Chart #7 Highlights the seven simplified concerns as expressed in the 85 issues of the litigation files raised over a period between 1967 to 1990.

Chart #8 Represents the 85 litigation issues raised in the seven simplified technical concerns categories.

Charts #9 and #10 Express the number of construction permits issued per year by the NRC and, #10 indicates the number of reactor units which were cancelled after the construction permit was issued by the NRC.

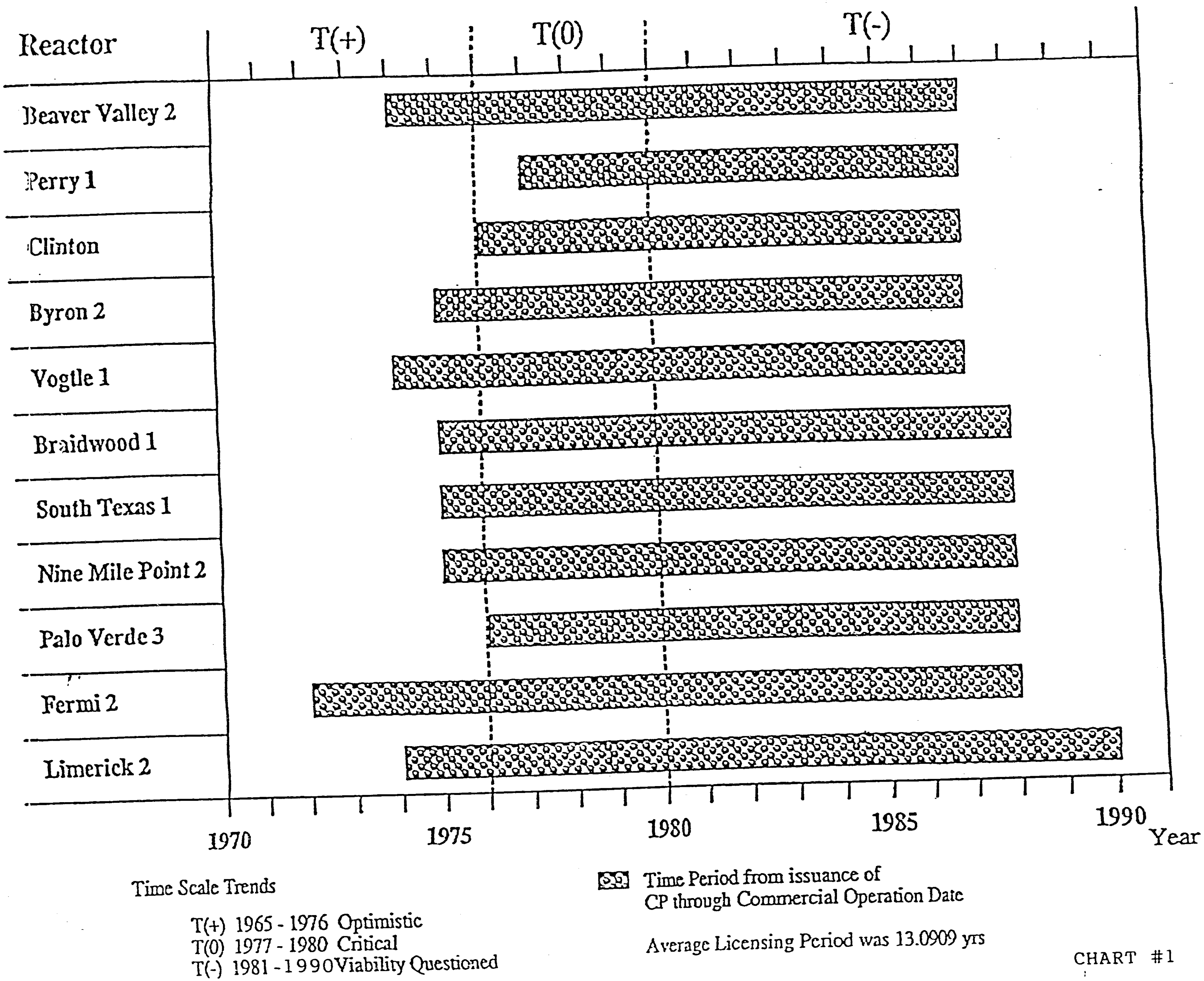
Reactor
T(+)
T(0)
T(-)
Beaver Valley 2
Perry 1
Clinton
Byron 2
Vogtle 1
Braidwood 1
South Texas 1
Nine Mile Point 2
Palo Verde 3
Fermi 2
Limerick 2
1970
1975
1980
1985
1990
Year
Time Scale Trends
T(+) 1965 - 1976 Optimistic
T(0) 1977 - 1980 Critical
T(-) 1981 - 1990 Viability Questioned
Time Period from issuance of CP through Commercial Operation Date
Average Licensing Period was 13.0909 yrs

CHART #1

Categories

T(0) (1978–1980) T(-) (1981–1992)

Categories	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Technical System Performance	●	●●		●●●		●●	●●●	●●			●●●		●	●●	
Waste Removal Environmental Impact	●●	●●			●●●	●	●								
Cataclysmic Events				●		●	●●	●				●			
Mystic Energy						●									
Economic Impact					●	●●●	●●●●●		●		●		●		
NIMBY	●		●●												
Oversight		●				●							●		

● = Indicates the number of times an issue was raised

CHART #2

Time Scale Trends

T(+) 1965 - 1976 Optimistic
T(0) 1977 - 1980 Critical
T(-) 1981 - 1990 Viability Questioned

Categories	Limerick 2	Fermi 2	Palo Verde 3	Nine Mile Point 2	South Texas 1	Braidwood 1	Vogtle 1	Byron 2	Clinton	Perry 1	Beaver Valley 2	
Technical System Performance	●		●●	●●	●●●●●●	●	●●●		●●	●●		19
Waste Removal Environmental Impact	●		●●	●●●	●					●	●	9
Cataclysmic Events	●●●●	●							●			6
Mystic Energy											●	1
Economic Impact	●			●●		●	●●●	●	●	●	●●	12
NIMBY		●						●●				3
Oversight				●●						●		3
Total	7	2	4	9	7	2	6	4	4	5	3	53

CHART #3

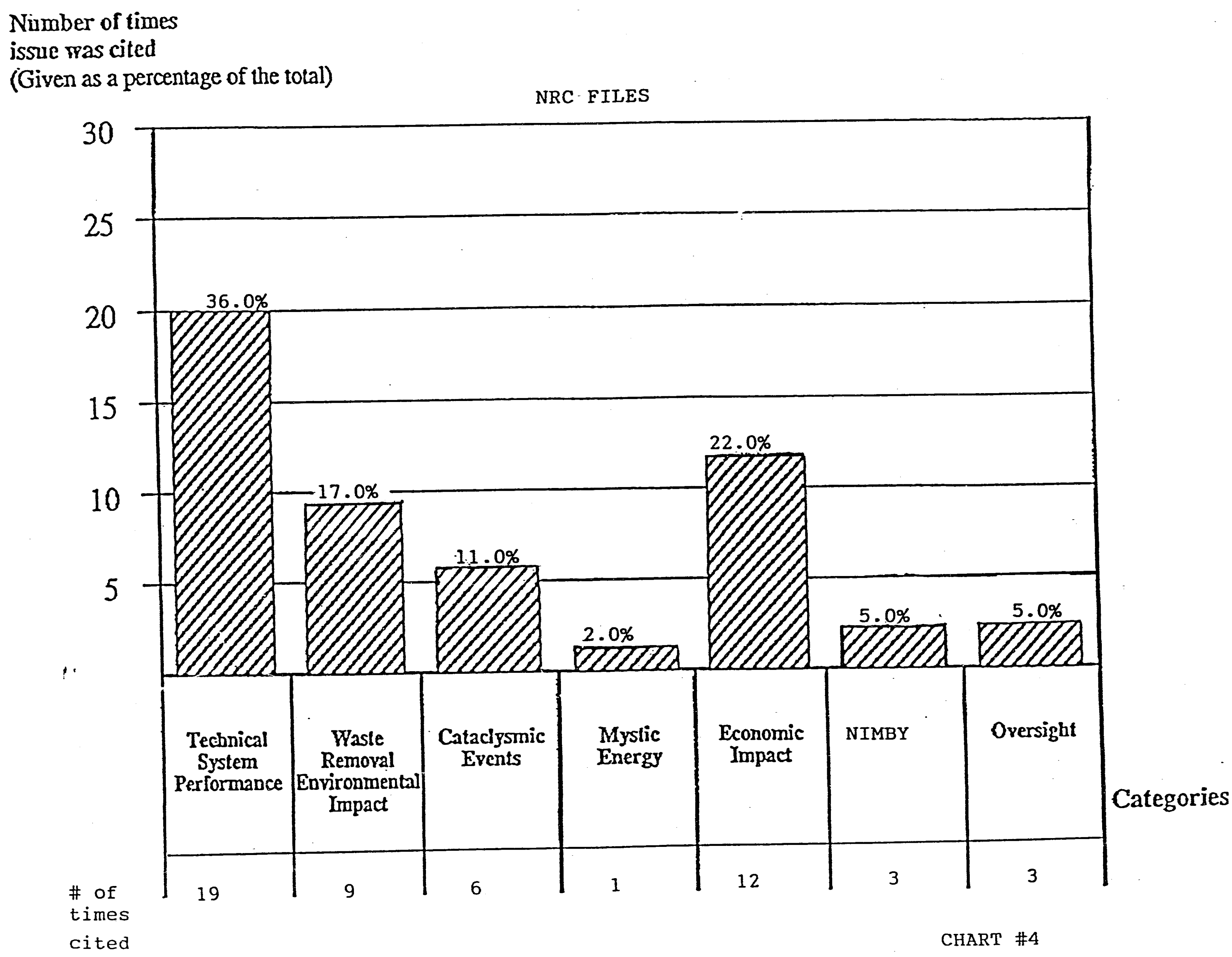
Number of times
issue was cited
(Given as a percentage of the total)
NRC FILES
30
25
20
15
10
5
36.0%
17.0%
11.0%
2.0%
22.0%
5.0%
5.0%
Technical System Performance
Waste Removal Environmental Impact
Cataclysmic Events
Mystic Energy
Economic Impact
NIMBY
Oversight
Categories
# of times cited
19
9
6
1
12
3
3

CHART #4

Legal Correspondence

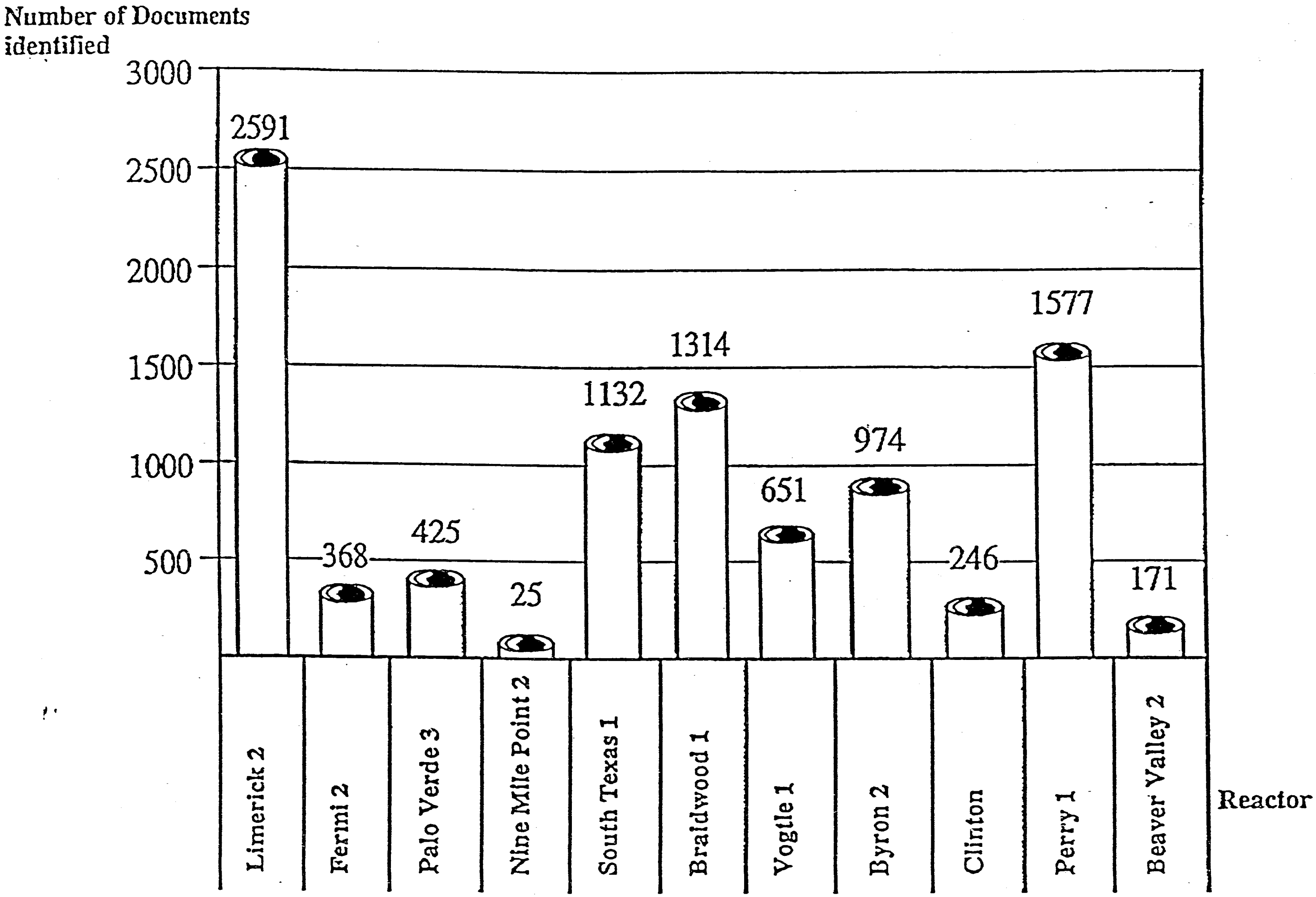

CHART #5

Congressional Inquiries and Responses

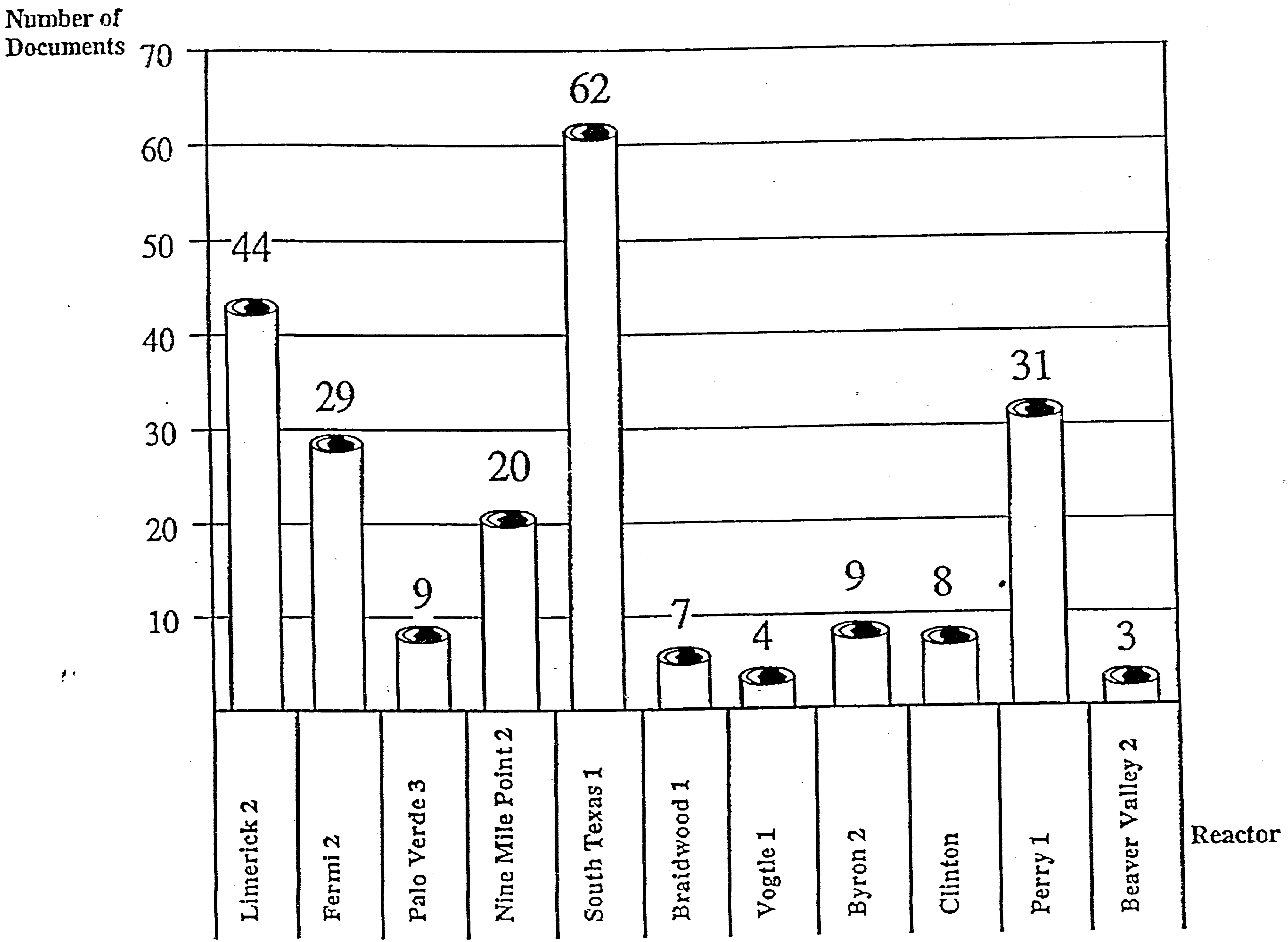

CHART # 6

Categories

LITIGATION FILES

T(+) || T (0) || T (-)

Categories	1965		1967		1969		1971		1973		1975		1977		1979		1981		1983		1985		1987		1989		1991
Technical System Performance							●●		●●					●	●	●	●	●	●		●●	●●	●	●			
Waste Removal Environmental			●	●	●	●	●	●	●●		●●	●	●●●	●●●	●●●	●●			●		●			●		●●	
Cataclysmic Events								●	●						●●	●		●	●		●	●●	●●	●●			
Mystic Energy																											
Economic Impact														●		●						●	●●	●			
NIMBY															●	●				●	●					●	
Oversight			●					●						●	●	●			●	●	●●●	●●●●	●			●●	

CHART 7

Time Scale Trends

T(+) 1965 - 1976 Optimistic
T(0) 1977 - 1980 Critical
T(-) 1981 - 1990 Viability Questioned

● = Indicates the number of times an issue was raised

LITIGATION FILES

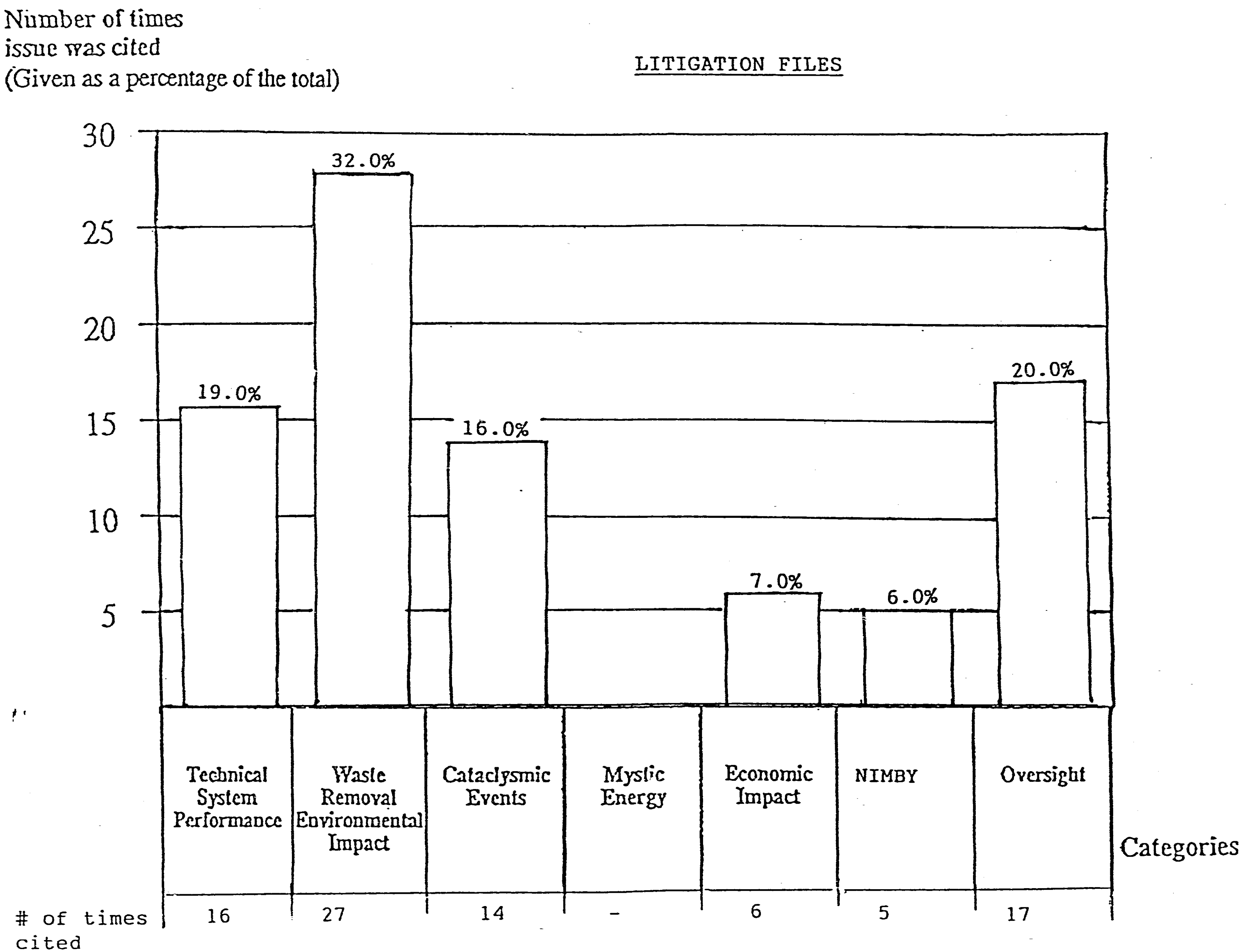

CHART #8

Construction Permits Issued Each Year

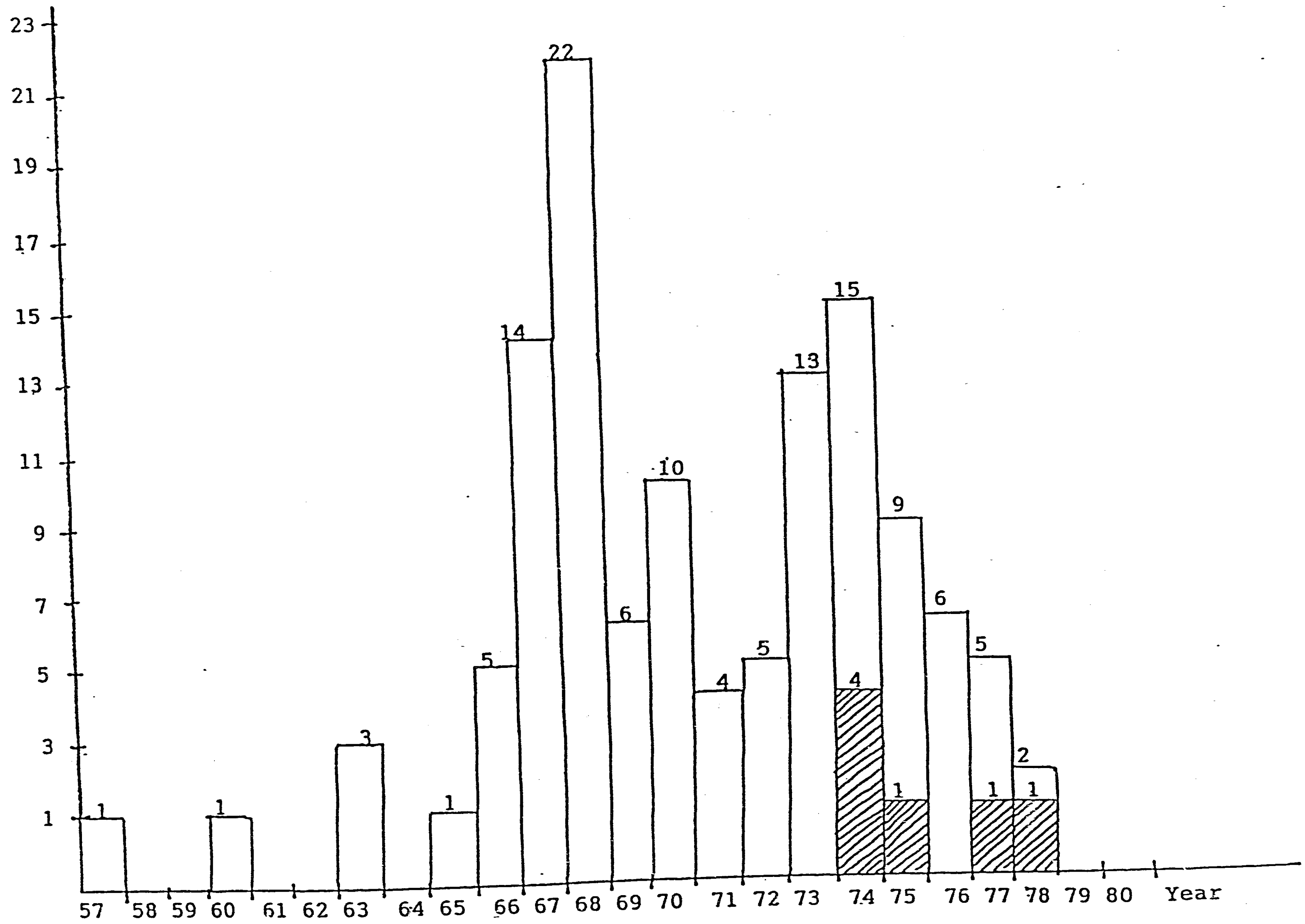

CHART 9

=Permit Deferred

Totals: 115 CP's issued of which 7 CP's are currently on deferred status

REACTOR UNIT CANCELLATIONS AFTER CONSTRUCTION PERMIT ISSUED

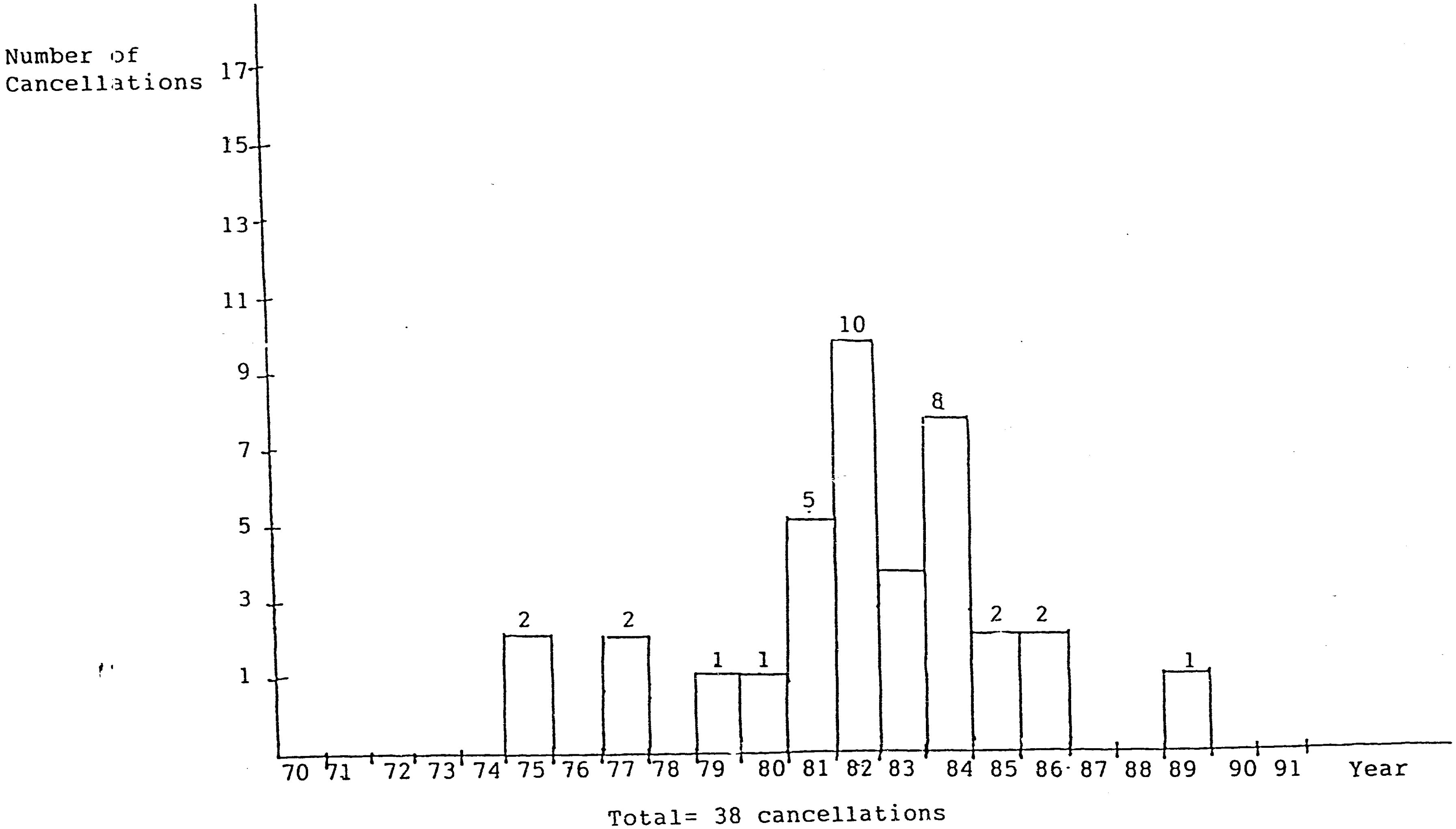

CHART #10

D. CONCLUSION

More than half the reactors examined by the original Law School study came on line in the mid-1970's. The current study, however, contains documents during a time period some 10-15 years later. As a result the regulatory focus has shifted somewhat. For example, as noted earlier, NRC in the early 1980's to some degree banned contentions involving certain environmental waste issues in particular those regarding the long term treatment, storage and disposal of high-level radioactive wastes. Public concerns on this issue continue to be significant as it ranks as the number one concern in the litigation files. However, because of this "formal" NRC policy, this real public concern is now statistically dispersed under several other categories where it might be legitimately articulated, i.e., need for more oversight of nuclear environmental compliance or fear of cataclysmic events due to alleged unsafe spent fuel storage methods. This change of agency focus appears to have created confusion and anger for a public that does not see or understand the interactive roles of DOE and NRC in the nuclear process. Instead, a portion of the public appears to perceive NRC as unresponsive and inclined to shut the public out of the decision making process.

The trends also point to a high degree of public concern over the potential failure of the technical integrity of the system which could lead to a cataclysmic event. The majority of the concerns targeted two areas: (1) reactor vessel failures, (2) and emergency system failures. A third small but growing concern in this area is the issue of spent fuel storage capacities of commercial reactors and the potential cataclysmic events related to spent fuel storage methods. This concern will undoubtedly continue to rise as reactor sites close and await decommissioning. In essence the public concern about potential cataclysmic events is no longer limited to operating reactors.

The cataclysmic events category has two distinct divisions. The first is the quantitative physical, health or environmental damage. This could be readily identified and is closely linked with the technical system performance category. The second division includes those concerns which were purely emotional reactions, closely linked to the mystic energy category and can be appropriately labeled as fear of radiation. While the majority of the concerns in this category were generated under the first division, some of which could be addressed by the technical innovations of advanced reactors, the second division concerns can only be properly addressed through education or not at all.

The public concern over the economic impact of nuclear power is an area which may yield to quantitative assessment. The major areas of concern were: (1) questioning the need for nuclear power at this time and price; and (2) questioning whether nuclear power was in fact a reasonably priced source of electrical generation as compared to other forms of energy sources, i.e. coal and conservation methods.

Another economic impact area which appears to cause some confusion for petitioners and intervenors to the NRC proceedings was the lack of understanding that NRC licensing proceedings are not the proper forum for rate payer arguments. Indeed petitioners were very frustrated because their contentions asserting the "sticker price shock" of bringing reactor units on-line, or even worse, delays in the construction or changes in projected costs which precipitated increased rate payer costs were not admitted in the NRC proceedings, but only in state proceedings.

Akin to the confusion which was noted over the high-level waste disposal concerns and the lack of understanding of the interactive roles of NRC and DOE, the public appears to have no awareness of the various types of electric utilities in the United States or the fact that the majority of the electric utilities are investor-owned companies regulated by the states, subject to FERC jurisdiction only for all interstate sales.

There are several areas in which advanced reactors can have a significant impact on the viability of the nuclear industry. However, DOE, as the developer of advanced nuclear technologies, must sell more than a new safer nuclear technology. DOE must also: (1) address the general public misconceptions about radiation; (2) assist the public in understanding how several federal agencies and state entities collectively regulate the nuclear industry; and (3) highlight the progress DOE is making in the environmental impact arena. There are no distinctively black and white answers, but we believe that the 7 categories of public concern developed in this and the original Law School study have adequately defined the parameters of public concerns. We anticipate that this quantitative examination of the court litigation and licensing files, when combined with the decision-maker/opinion-maker interviews and survey will allow us to better understand the relative importance of these concerns and to develop methodologies to enable DOE to develop appropriate policies and management practices.

APPENDIX B

LISTING OF LITIGATION CASES

Case No: 1 **Year Filed:** 1981 **Time Scale:** T(-)

Case/Citation: Florida Power and Light Co. v. U.S. NRC
105 S. CT. 1598 (1985)

Case No: 2 **Year Filed:** 1972 **Time Scale:** T(+)

Case/Citation: Baltimore Gas and Electric v. NRDC
103 S. Ct. 2246 (1983)

Case No: 3 **Year Filed:** 1978 **Time Scale:** T(0)

Case/Citation: Pac. Gas and Elec. v. St. Energy Resources Conserv. and Development Commission
103 S. Ct. 1713 (1983)

Case No: 4 **Year Filed:** 1979 **Time Scale:** T(0)

Case/Citation: Metro Edison Co. V. People Against Nuclear Energy
103 S. Ct. 1556 (1983)

Case No: 5 **Year Filed:** 1973 **Time Scale:** T(+)

Case/Citation: Duke Power Co. v. Carolina Environmental Study Group
98 S. Ct. 2620 (1978)

Case No: 6 **Year Filed:** 1986 **Time Scale:** T(-)

Case/Citation: State of Ohio v. Nuclear Regulatory Commission
814 F.2d 258 (6th Cir. 1987)

Case No: 7 **Year Filed:** 1985 **Time Scale:** T(-)

Case/Citation: State of Tenn. v. Herrington
806 F.2d 642 (6th Cir. 1986)

Case No: 8 **Year Filed:** 1986 **Time Scale:** T(-)

Case/Citation: San Luis Obispo Mothers for Peace v. U.S. NRC
799 F.2d 1268 (9th Cir. 1986)
789 F.2d 26 (D.C. Cir. 1986)
Dissent: 804 F.2d 523 (9th Cir. 1986)

Case No: 9 **Year Filed:** 1985 **Time Scale:** T(-)

Case/Citation: Oyster Shell Alliance v. U.S. NRC
800 F.2d 1201 (D.C. Cir. 1986)

<u>Case No:</u> 10 **Year Filed:** 1984 **Time Scale:** T(-)

Case/Citation: Jersey Power and Light Co. v. Lacey TP.
772 F.2d 1103 (1985)
Companion Case: New Jersey Turnpike Authority v. Jersey Central Power and Light 772 F.2d 25 (3rd. Cir.1985)
Note: State DOT prohibiting Spent Fuel Transport

<u>Case No:</u> 11 **Year Filed:** 1985 **Time Scale:** T(-)

Case/Citation: In Re Three Mile Island Alert, Inc.
771 F.2d 720 (1985)

<u>Case No:</u> 12 **Year Filed:** 1985 **Time Scale:** T(-)

Case/Citation: Cuomo v. United States Nuclear Regulatory Comm.
772 F.2d 972 (1985)

<u>Case No:</u> 13 **Year Filed:** 1984 **Time Scale:** T(-)

Case/Citation: Duke Power Co., v. Nuclear Reg. Comm.
770 F.2d 386 (1985)

<u>Case No:</u> 14 **Year Filed:** 1982 **Time Scale:** T(-)

Case/Citation: Guard v. U.S. NRC
733 F.2d 1144 (1985)

<u>Case No:</u> 15 **Year Filed:** 1979 **Time Scale:** T(0)

Case/Citation: People of Three Mile Island v. NRC
747 F.2d 139 (1984)

<u>Case No:</u> 16 **Year Filed:** 1979 **Time Scale:** T(0)

Case/Citation: General Public Utilities Corp. v. United States
745 F.2d 239 (1984)

<u>Case No:</u> 17 **Year Filed:** 1983 **Time Scale:** T(-)

Case/Citation: Carstens v. Nuclear Regulatory Comm.
742 F.2d 1546 (1984)

<u>Case No:</u> 18 **Year Filed:** 1982 **Time Scale:** T(-)

Case/Citation: Union of Concerned Scientists v. Nuclear Regulatory Comm. 711 F.2d 370 (1983)

Case No: 19 **Year Filed:** 1983 **Time Scale:** T(-)

Case/Citation: County of Rockland v. U.S. NRC
709 F.2d 766 (1983)

Case No: 20 **Year Filed:** 1979 **Time Scale:** T(0)

Case/Citation: Seacoast Anti-Pollution, Etc. v. Nuclear Reg. Comm.
690 F.2d 1025 (1982)

Case No: 21 **Year Filed:** 1978 **Time Scale:** T(0)

Case/Citation: Lower Alloways Creek TP. v. Public Service Elec. and Gas Company
687 F.2d 732 (1982)

Case No: 22 **Year Filed:** 1978 **Time Scale:** T(0)

Case/Citation: Potomac Alliance v. U.S. Nuclear Regulatory Comm.
682 F.2d 1030 (1982)

Case No: 23 **Year Filed:** 1980 **Time Scale:** T(0)

Case/Citation: People of State of Ill. v. General Electric Co.
683 F.2d 206 (1982)

Case No: 24 **Year Filed:** 1980 **Time Scale:** T(0)

Case/Citation: Rockford League of Women Voters v. U.S. NRC
679 F.2d 1218 (1982)

Case No: 25 **Year Filed:** 1980 **Time Scale:** T(0)

Case/Citation: Conn. Light and Power Co., v.NRC
673 F.2d 525 (1982)

Case No: 26 **Year Filed:** 1978 **Time Scale:** T(0)

Case/Citation: Nat. Resources Defense Council v. NRC
666 F.2d 595 (1981)

Case No: 27 **Year Filed:** 1980 **Time Scale:** T(0)

Case/Citation: Simmons v. Arkansas Power and Light Co.
655 F.2d 131 (1981)

Case No: 28 **Year Filed:** 1980 **Time Scale:** T(0)

Case/Citation: Massachusetts Coalition of Citizens with Disabilities v. Civil Defense Agency 649 F.2d 71 (1981)

Case No: 29 **Year Filed:** 1979 **Time Scale:** T(0)

Case/Citation: Susquehanna Valley Alliance v. Three Mile Island
616 F.2d 231 (1980)

Case No: 30 **Year Filed:** 1978 **Time Scale:** T(0)

Case/Citation: Porter County Chapter v. NRC
606 F.2d 1363 (1979)

Case No: 31 **Year Filed:** 1976 **Time Scale:** T(+)

Case/Citation: Natural Resources Defense Council v. U.S.
NRC 606 F.2d 1261 (1979)

Case No: 32 **Year File:** 1977 **Time Scale:** T(0)

Case/Citation: State of Minn. v. U.S. NRC
602 F.2d 412 (1979)

Case No: 33 **Year Filed:** 1977 **Time Scale:** T(0)

Case/Citation: Westinghouse Elec. corp. v. United States NRC
598 F.2d 759 (1979)

Case No: 34 **Year Filed:** 1977 **Time Scale:** T(0)

Case/Citation: People of the State of Ill. v. Nuclear Reg. Comm.
591 F.2d 12 (1979)

Case No: 35 **Year Filed:** 1975 **Time Scale:** T(+)

Case/Citation: NRDC v. NRC
539 F.2d 824 (1976)

Case No: 36 **Year Filed:** 1971 **Time Scale:** T(+)

Case/Citation: North Anna Environmental Coalition v. U.S. NRC
533 F.2d 655 (1976)

Case No: 37 **Year Filed:** 1975 **Time Scale:** T(+)

Case/Citation: York Committee for a Safe Envir. v. NRC
527 F.2D 812 (1975)

Case No: 38 **Year Filed:** 1973 **Time Scale:** T(+)

Case/Citation: Nader v. NRC
513 F.2d 1045 (1975)

Case No: 39 **Year Filed:** 1971 **Time Scale:** T(+)

Case/Citation: Union of Concerned Scientist v. AEC
499 F.2d 1069 (1974)

Case No: 40 **Year Filed:** 1973 **Time Scale:** T(+)

Case/Citation: Friends of the Earth v. United States AEC
485 F.2d 1031 (1973)

Case No: 41 **Year Filed:** 1972 **Time Scale:** T(+)

Case/Citation: Morningside Renewal Council v. U.S. AEC
482 F.2d 234 (1973)

Case No: 42 **Year Filed:** 1968 **Time Scale:** T(+) ?

Case/Citation: Scientist's Institute For Public Information v. AEC
481 F.2d 1079 (1973)

Case No: 43 **Year Filed:** 1972 **Time Scale:** T(+)

Case/Citation: Brooks v. AEC
476 F.2d 924 (1973)

Case No: 44 **Year Filed:** 1969 **Time Scale:** T(+)

Case/Citation: Northern States Power Company v. State of Minn.
447 F.2d 1143 (1971)

Case No: 45 **Year Filed:** 1970 **Time Scale:** T(+)

Case/Citation: Calvert Cliffs Coord. Comm. v. U.S. AEC
449 F.2d 1109 (1971)

Case No: 46 **Year Filed:** 1967 **Time Scale:** T(+)

Case/Citation: State of New Hampshire v. AEC
406 F.2d 170 (1969)

Case No: 47 **Year Filed:** 1967 **Time Scale:** T(+)

Case/Citation: Siegel v. AEC
400 F.2d 778 (1968)

Case No: 48 **Year Filed:** 1986 **Time Scale:** T(-)

Case/Citation: NRDC v. Herrington
637 F Supp. 116 (D.D.C. 1986)

Case No: 49 **Year Filed:** 1983 **Time Scale:** T(-)

Case/Citation: Center for Nuclear Responsibility v. U.S. Nuclear Reg. Comm.
586 F. Supp. 579 (1984)

Case No: 50 **Year Filed:** 1980 **Time Scale:** T(0)

Case/Citation: UNC Resources, Inc. v. Benally
518 F. Supp. 1046 (1981)

Case No: 51 **Year Filed:** 1979 **Time Scale:** T(0)

Case/Citation: Virginia Sunshine Alliance v. Hendrie and Baltimore Gas and Elec. Co.
477 F. Supp. 68 (1979)

Case No: 52 **Year Filed:** 1978 **Time Scale:** T(0)

Case/Citation: Hunt v. Nuclear Regulatory Comm.
468 F. Supp. 817 (1979)

Case No: 53 **Year Filed:** 1973 (?) **Time Scale:** T(+)

Case/Citation: Colorado Public Interest Research Group, Inc. v. Train
373 F. Supp. 991 (1974)

Case No: 54 **Year Filed:** 1971 **Time Scale:** T(+)

Case/Citation: United States v. Florida Power and Light Company
53 F.R.D. 249 (1971)

Case No: 55 **Year Filed:** 1990(?) **Time Scale:** T(-)

Case/Citation: Nuclear Information and Resource Service et al v. U.S. NRC
918 F.2d 189 (D.C. Cir. 1990)

Case No: 56 **Year Filed:** 1988 **Time Scale:** T(-)

Case/Citation: Limerick Ecology Action, Inc. v. U.S. NRC
869 F.2d 719 (3rd Cir. 1989)

Case No: 57 **Year Filed:** 1988 **Time Scale:** T(-)

Case/Citation: Sierra Club v. U.S. NRC
862 F.2d 222 (9th Cir. 1988)

Case No: 58 **Year Filed:** 1987 **Time Scale:** T(-)

Case/Citation: Arnow v. U.S. NRC
868 F.2d 223 (7th Cir. 1989)

Case No: 59 **Year Filed:** 1986 **Time Scale:** T(-)

Case/Citation: State of Ohio v. U.S. NRC
868 F.2d 810 (6th Cir. 1989)

Case No: 60 **Year Filed:** 1987 **Time Scale:** T(-)

Case/Citation: Commonwealth of Massachusetts v. U.S. NRC
856 F.2d 378 (1st Cir. 1988)

Case No: 61 **Year Filed:** 1987 **Time Scale:** T(-)

Case/Citation: Union of Concerned Scientists v. U.S. NRC
880 F.2d 552 (D.C. Cir. 1989)
1st case: 824 F.2d 108 (1987)

Case No: 62 **Year Filed:** 1990 **Time Scale:** T(-)

Case/Citation: State of Nevada v. Watkins
914 F.2d 1545 (9th Cir. 1990)

Case No: 63 **Year Filed:** 1990 **Time Scale:** T(-)

Case/Citation: Kerr-McGee v. City of West Chicago
914 F.2d 820 (7th Cir. 1990)

Case No: 64 **Year Filed:** 1987 **Time Scale:** T(-)

Case/Citation: National Ass'n of Regulatory Utility Commissioners v. Department of Energy
851 F.2d 1424 (D.C. Cir. 1988)

Case No: 65 **Year Filed:** 1988 **Time Scale:** T(-)

Case/Citation: Dickinson v. Zech
846 F.2d 369 (6th Cir. 1988)

Case No: 66 **Year Filed:** 1986 (?) **Time Scale:** T(-)

Case/Citation: Florida Power and Light Co. v. U.S. NRC
846 F.2d 765 (D.C. Cir. 1988)

Case No: 67 **Year Filed:** 1985 **Time Scale:** T(-)

Case/Citation: Sierra Club v. U.S. NRC
825 F.2d 1356 (9th Cir. 1987)

Case No: 68 **Year Filed:** 1986 **Time Scale:** T(-)

Case/Citation: Citizens Association for Sound Energy v. U.S. NRC
821 F.2d 725 (D.C. Cir. 1987)

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