3E38XN0055 L/NIS-mf--4624

STABILITY IN LICENSING REQUIREMENTS: A TECHNICAL PERSPECTIVE *

Introduction

Complex problems sometimes mask the reasons for their continued existence. Unfortunately, the problems associated with the licensing of nuclear power plants in the United States fall into this category.

Leaders in industry and government have been looking for ways to unravel and resolve the current licensing situation. However, the priorities assigned to solution of each of the many problems licensing creates vary with the perceptions and backgrounds of the individuals, and organizations, who seek solutions.

Procedural reform measures are receiving considerable attention as a result of the proposed "Nuclear Siting and Licensing Act of 1978". However, the success of any of the procedural "fixes" will rest upon the ability to first achieve a licensing climate which allows stable design and siting requirements to be maintained.

This climate must be created through political and administrative actions so that technical issues can be subsequently resolved on their own merits. Put in simpler terms, clear direction must come from the top to resolve the major problems created at the bottom.

The Case for Reform

Historically, in the United States, siting and plant design requirements have been governed by the licensing process. The evolution of these crucial requirements can be characterized as a series of snapshots in which each succeeding picture has been given a different composition and makeup. Major problems have been created, however, because the earlier snapshots have been retouched over and over again. This re-editing process has profoundly affected the costs and schedules related to the design, construction, and operation of nuclear power plants.

The Forum's January, 1978 report, Licensing, Design, and Construction Problems: Priorities for Solution, reviewed the factors that contribute to the present extended durations for the design and construction of nuclear plants. It found that achieving stable licensing requirements is the clear target for any effort to obtain shorter and more predictable project durations.

By measuring the critical paths of hypothetical projects in a stable licensing environment against a schedule projected from current licensing experience, it was concluded that approximately three years are added to project durations following award of reactor contract. The slides of these cases (slides 1, 2, 3) are of particular interest since they approach the licensing process through its practical relationship to design and construction.

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* Presented by Robert A. Szalay, Manager, Licensing and Safety Projects, Atomic Industrial Forum, on May 17, 1978, at the International Conference on Regulating Nuclear Energy, Brussels, Belgium.

Changes in critical design criteria during the plant design phase can reverse the progress toward design completion, either extending the time to reach a specific percent design completion, or reducing the amount of design completed at the start of construction. This reduction in the percentage of design completed adversely affects construction progress.

Design changes imposed following start of construction can alter the construction sequence, affect critical component delivery dates, and can even cause completed work to be "ripped out" in extreme circumstances. In addition to the resultant cost penalties that these changes engender (from both the additional expense of new equipment and the cost of money for extended schedules), the effect of loss in productivity of demoralized craft labor is another negative result.

Expanding regulatory requirements have added a new dimension to the engineering effort required to support design. An exhibit (slide 4) from the January, 1978 report illustrates the vast increase that has occurred in the NRC's Regulatory Guides and Branch Technical Positions. As shown in this exhibit, plants being designed during 1972 were subject to 32 Regulatory Guides. In 1973 alone, an additional 32 Regulatory Guides were issued, thereby doubling the total in 1 year. The number has continued to increase at an astounding rate. Today there are 250 Regulatory Guides and Branch Technical Positions either in existence or under development.

In this regard, the growth in building quantities due to these expanding regulatory requirements has contributed significantly to design and construction problems. An exhibit from the January 1978 report provides some perspective by comparing the growth in quantities as a function of time (see slide 5). After taking into account the effect of increased Mw ratings, the most significant reasons for the trend in increased quantities can be attributed to regulatory criteria escalations. In the 1960's, as larger plants were built, expected economies of scale were realized; however, in the 1970's, the additional regulatory requirements reversed this trend.

The ever-expanding design and regulatory requirements have significantly increased design and construction time. The added requirements and particularly their <u>time of implementation</u> have been extremely costly. A counter-argument is sometimes made that changes in NRC Staff positions and the degree of review necessary in the detailed engineering stages would be lessened if utility applicants supplied sufficiently complete information early in the process. The reason for industry skepticism that this, in fact, would be the case is illustrated in another exhibit from the January, 1978 report (slide 6). This exhibit shows both the progressive increase in the amount of information supplied to the NRC Staff and the exponential increase in the numbers of questions asked as more information is provided. It is particularly interesting to note that although the information requested in questions on previous applications had been incorporated into succeeding applications, it nonetheless set the stage for an expanded list of subsequent detailed questions.

This trend offers a fundamental disincentive to providing detailed information early with the expectation of future advantage. In this regard, it is particularly relevant to standardization and early site reviews, which require detailed information submittals in advance of the utility's construction permit review.

The benefits of standardization and early site reviews depend on the predictability they will add and their ability to reduce cost impacts by stabilizing requirements. However, the current licensing environment in the United States which now protracts project schedules can also adversely affect separate early site review and standardized plant design reviews.

Slides 7 and 8 were taken from a recent paper on standardization by an NRC director.[1] They present a summary of the NRC Staff experience on standardization reviews. These show that "when the number of questions and man-years for standard plant reviews are prorated over the individual CP reviews, there is indication of a net inefficiency." This is not necessarily the fault of either the procedures in use or the NRC management -- in fact, recent NRC Staff management proposals on standardization show their commitment to its effective use -- it is part of a much deeper problem, which will be discussed later in this paper.

In a similar context, utility experience with limited early site reviews has not been totally encouraging. A recent presentation by a utility manager[2] concluded that "taking into consideration all factors concerning the early site review process, it remains to be proven whether the process will, in the long run, facilitate nuclear power plant licensing".

Just as form cannot replace substance, procedures cannot replace the underlying policy that will allow their effective implementation. Without recognition of this and action by senior policy-makers, increased standardization and early site approval may not result and the outlook for improvement will continue to be clouded.

Understanding Regulatory Staff Inertia

While the importance of stabilizing licensing requirements has been forcefully pronounced, it is difficult to appreciate the inertia with which this goal is resisted unless the current regulatory staff situation in the United States is understood. With this understanding, however, practical methods for improving the situation can be evaluated.

Efforts have been initiated in an attempt to bring a sense of order to the licensing process. The Nuclear Regulatory Commission (NRC), and recently the Administration, have proposed as solutions procedures for separating site reviews from plant reviews and to encourage the development of approved standardized designs. Additionally, the NRC has attempted to obtain internal management control through the development of Standard Review Plans, improved procedures for issuing Regulatory Guides, and the efforts of the Regulatory Requirements Review Committee. Despite these apparently genuine efforts to add order to the licensing process, there is limited confidence that stability will result from these collective measures.

The NRC Staff review process encompasses literally hundreds of issues on each succeeding plant application and involves the judgment of scores of individual reviewers. The outcome of such reviews frequently results in new regulatory guidance. This leads to the situation of "ratcheting".

Since each succeeding review of plant applications involves reviewers who, by human nature, feel compelled to explore beyond the requirements of the previous application review, it is not surprising that, in the earlier years, the licensing process progressively grew more complicated and burdensome. However, the Atomic Energy Commission (AEC) then more closely embraced the philosophy that the owner/applicant had primary responsibility for the safety of the plant, and that the regulator's function was to assure the applicant complied with general design criteria and requirements.

Because of the general nature of this review, the Staff reviewers relied upon some general and rather arbitrary assumptions; for example, the double-ended severance of the major reactor coolant pipe was postulated as a design basis accident. However, as the reviews became more detailed, these general assumptions were extrapolated to additional systems or to additional situations to achieve a sense of consistency (which, because of the arbitrariness of the earlier assumptions, was sometimes inappropriate).

As regulatory review of engineering details became the rule, rather than the generalized review of whether criteria had been met, the problems related to extrapolating arbitrary requirements became even more prominent. With each vintage of plant design, the possiblities for change have expanded and are still growing.

Because of the momentum thus created, attempts to arrive at a stable set of licensing requirements have been less than successful, particularly due to the difficulty of holding the Staff to the requirements they had previously set on even the most recent application approval. Regulatory Guides, Branch Technical Positions, and Standard Review Plans have been touted as a mechanism for stabilizing design -- but they in themselves have become an institutionalized way for perpetuating change.

By utilizing the latest NRC Staff requirement on the latest plant as a benchmark for what is called "current practice", other plants are forced to reconsider their design requirements in light of the latest interpretation. This leads to a situation where a plant, which was once approved based on the current vintage of regulatory guides, standard review plans, branch technical positions and regulations, is open to question based upon new considerations, in which the safety value of change is often not justified.

The Reference Framework

The previous discussion suggests that a reference framework for licensing decision-making exists, while a means to control expansion of its requirements does not. The reference framework for current Standard Review Plans, Regulatory Guides and Branch Technical Positions is an historically developed list of "design basis events". In essence, acceptability of nuclear power plant design is demonstrated by documenting that an acceptable analysis of design basis events has been completed.

Through a formalized treatment of design basis events, potential radioactive releases are calculated to assure that the conservatively calculated resultant dose to an individual who resides at defined boundaries near the plant (alternatively at an exclusion area boundary and at the low population zone) would not exceed the exposure guidelines set forth in the U. S. Code of Federal

Regulations, Part 100. Notwithstanding other population density considerations set forth in these regulations and other regulatory guidance, this approach provides a common benchmark against which risks to individuals at various sites can be judged.

The design features of the plant have, in many instances, developed from the application of these regulations. Therefore, it is important to recognize that relationships exist between current exposure guidelines, accident definitions, and the plant design requirements they have dictated. This recognition is particularly important when considering the applicability of the Reactor Safety Study and its methodology to the licensing process.

The deterministic licensing framework that has evolved in the United States differs from the one constructed in the Reactor Safety Study. However, the careful application of Reactor Safety Study results and methods to licensing offers one of the few hopes for ultimately controlling design changes. With the starting premise that current plant designs have been shown to be very safe, further discrete changes to current deterministic criteria can be based on a showing of significant reduction in overall risk at a cost that is reasonable and acceptable. Additionally, new events which do not appreciably alter overall risk can be excluded from further consideration. This "value-impact" approach has been encouraged in previous AIF statements,[3,4] and will be discussed later in this paper.

External Influences

At this international conference, where countries represented may have less obstructive licensing systems, it would be valid to ask why changes in requirements made by NRC Staff cannot be better controlled. A large part of this answer relates to the external influences in the United States which make internal NRC management difficult.

In the 1969-1971 period, another dimension was added to the licensing instability problem -- the politicalization of technical issues. This evolved through the combined effects of the Calvert Cliffs decision (NEPA implementation), the Emergency Core Cooling System (ECCS rule-making hearing, and the active use of the hearing process and the judicial system as a means to delay plant approvals. In particular, the latter was used as a vehicle to try to reverse the national policy decision to utilize nuclear power plants. This added social and political dimension had a profound influence on regulatory management and, more importantly, on the technical reviewer "exposed" to this new climate.

In this new climate, the technical reviewer found himself in a less "patriotic" position. Previously, public responsibility was relegated to his judgement on whether the owner/applicant had proposed a safe plant design; now, he was placed in a position where his judgement required meticulous justification in a judicial setting against hostile adversaries. Again, human nature took its toll. The best technical judgement was no longer an available option if it could not be defended conclusively. Since truly conclusive data is elusive in almost any highly technical endeavor, this new climate encouraged review decisions to be biased in the highly conservative direction.

On the surface, one might argue that it is in the best interest of the public to be conservative in decision-making. This would be true if the impacts of individual conservatisms were judged in the context of their collective effects. However, as mentioned before, literally hundreds of issues are being explored in increasing detail by scores of specialists in different disciplines. The impacts of senseless conservatisms in all these directions have had a paralyzing effect on the design and construction of plants, and its scheduling and planning. The irony, however, is that it is not clear that plants are being moved in the safer direction through these cumulative escalations. This is because no mechanism has been established for judging the effect of these changes on the overall safety margin.

Yet another complexity has been added to the technical review process in the last two years -- internal staff dissent and the oversight of technical decisions with an "inquisitional" flair. "Defectors" from the NRC (and industry) have gained wide public exposure and have brought to the public attention highly technical issues that appear ominous at first sight. Despite refutations by the NRC Staff (which literally take man-months to develop) the very technical nature of the issues biases opinion in favor of the detractor -- particularly, in an atmosphere in which the public has been encouraged to distrust the government. This places the regulator, particularly the technical reviewer, in a defensive posture -- not only must his judgements be conservative, they must also have no trappings which would implicate him with a "pro-nuclear" bias. The atmosphere this creates is evidenced in recent Congressional hearings in which senior government staff are publicly accused, with some drama, of dishonesty and intrigue.

The picture is further clouded by the myopic insistence that regulatory functions must be totally isolated from other decision-making. This notion of "independence" fails to recognize realities:

- Regulatory decisions cannot be segregated from the national energy policy context within which they are promulgated.
- Regulatory policy and its implementation are influenced by political pressure-- "independence" also implies freedom from anti-nuclear pressure and cannot be narrowly defined.
- Regulatory decisions have economic impacts which in the extreme can preclude the use of the entity being regulated.

Test Cases

While policy-makers deliberate on possible licensing reform measures, the direction licensing will take in the near future can be gauged by viewing NRC Staff positions on current licensing issues. Prominent among these issues will be Anticipated Transients Without Scram (ATWS) and the handling of backfitting issues through the Systematic Evaluation Program (SEP).

The value-impact approach to licensing will be tested through resolution of the ATWS issue. The NRC Staff has taken a positive step forward by setting a frequency of 10^{-6} per reactor year as a safety goal. This logical extension of the lessons learned from the Reactor Safety Study would allow non-significant contributors to risk to be excluded from further design consideration. However, the Staff has thus far disallowed credit for probabilistic analyses which show this safety goal can be met by current plant designs; rather, they have developed deterministic criteria which, if met, will assure that the safety goal has been met. Significant industry concern has been raised by this proposed NRC Staff approach, which appears to have a predisposition to system hardware change factored into its formulation. Close scrutiny will be given to the value-impact analysis the NRC Staff performed on this policy recommendation, and significant debate can be expected.

The tenacity of NRC management will be judged through the implementation of the Systematic Evaluation Program. This program involves the re-evaluation of previously approved plants to document the adequacy of their safety design basis in light of new information subsequent to their licenses. The task is cumbersome and will depend on considerable management control and technical judgement.

The designs of eleven early plants will be reviewed in the context of a predetermined list of topics. Conceptually, the review is intended to concentrate on the demonstration that each facility will respond reliably to design basis events without exceeding acceptable guidelines. After reviewing each design basis event (and related topics), potential "corrective measures" for each individual event evaluated would then be examined to determine the integrated effect of the preliminary assessment from all design basis events. The resulting judgements would then form the basis for a backfit decision. While this orderly process has been envisioned, early experience shows that actual implementation of the program is moving toward fuller consideration of current licensing requirements.

In this regard, there is significant apprehension over both the basis and the outcome of the Systematic Evaluation Program. Supported by the excellent safety record produced by these early plants, industry concern derives from the belief that plants that have been operating safely over the last decade, with the benefit of rectification through operational feedback, are safe in a real and practical sense; however, the intricate super-position of new licensing requirements on a design licensed under a different framework, in itself, forebodes bureaucratic difficulties.

On these and other licensing issues, the Regulatory Requirements Review Committee (an NRC management review group which oversees the disposition of new licensing requirements) could play a prominent role in stabilizing requirements. However, the potential effectiveness of this committee in stabilizing licensing requirements will depend on the strength of their mandate to do so.

Points for Specific Consideration

It is important to recognize that arbitrary changes in requirements have a severe influence on nuclear power plant costs and schedules. With a clear perception of this influence and the reasons for its existence, political support must be given to NRC management to help them control change. Administration support must include public expression of the need for nuclear power plants, and a recognition that current plant designs are based on an established and mature technology.

The NRC Commissioners, with the support of this pronouncement (and hopefully, a fifth Commissioner), have the authority to direct NRC Staff management to take measures to control changes. Understanding that the health and safety of the public is still paramount, NRC managers can encourage repeatability in approved designs and the safety advantages these provide. Real improvements in these designs would be weighed deliberately through the use of "value-impact" judgements. These value impact judgements would be mandatory, comprehensive, and predicated on the general adequacy of current plant designs. NRC Staff middle management could thus work with senior management to assure that changes to existing requirements are justified and safety-effective.

This procedure would accomplish the safety mandate of the Nuclear Regulatory Commission in two ways:

- It would assure that proven plant designs are being improved in the direction of increased overall safety margins

- It would remove much of the unpredictability and unnecessary project delay from the nuclear option and thus increase its availability; this would allow nuclear power plants to compete freely with other alternatives that have greater adverse health, environmental, and economic effects but shorter and more predictable durations.

Both the external influences and the potential for changing requirements that resides in any bureaucracy have made the NRC management tools--Standard Review Plans, Regulatory Guides, the Regulatory Requirements Review Committee, and standardization and site review procedures -- less effective than they should be. Administration support can strengthen management resolve to enforce Staff discipline. Without support from above, changes will proliferate from the bottom up and licensing improvements will be made only rhetorically.

References

1. Standardization's Value: A Regulatory Staff Perspective, Roger J. Mattson, NRC - presented at AIF Workshop on Reactor Licensing and Safety, April, 1978

2. The Potential and Realities of Early Site Review, Robert C. Burt, LADWP-- presented at AIF Workshop on Reactor Licensing and Safety, April, 1978

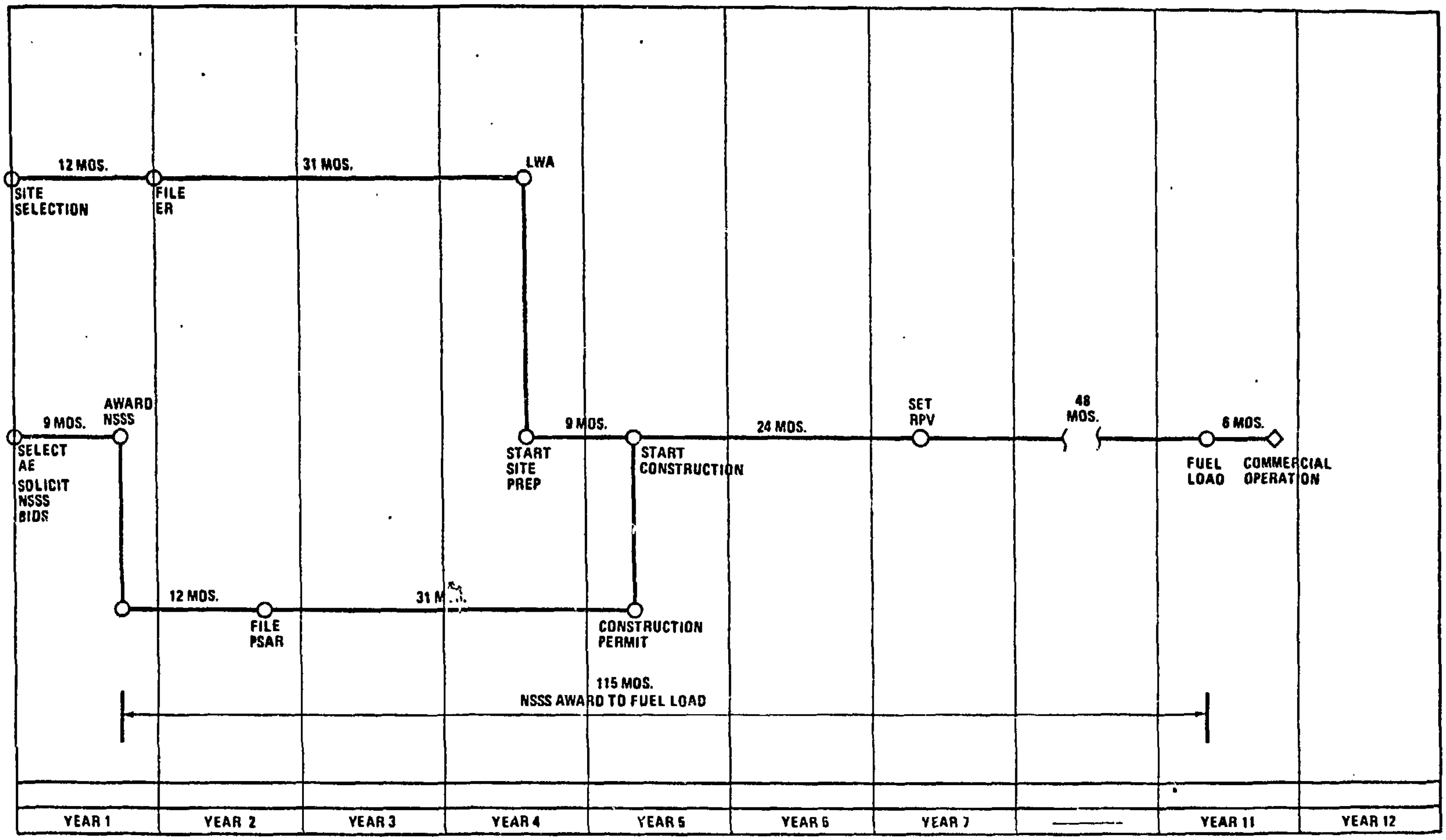
3. AIF Statement on Reactor Licensing, November, 1976

4. AIF Statement on Licensing Reform, June 1977

(SLIDE 1)

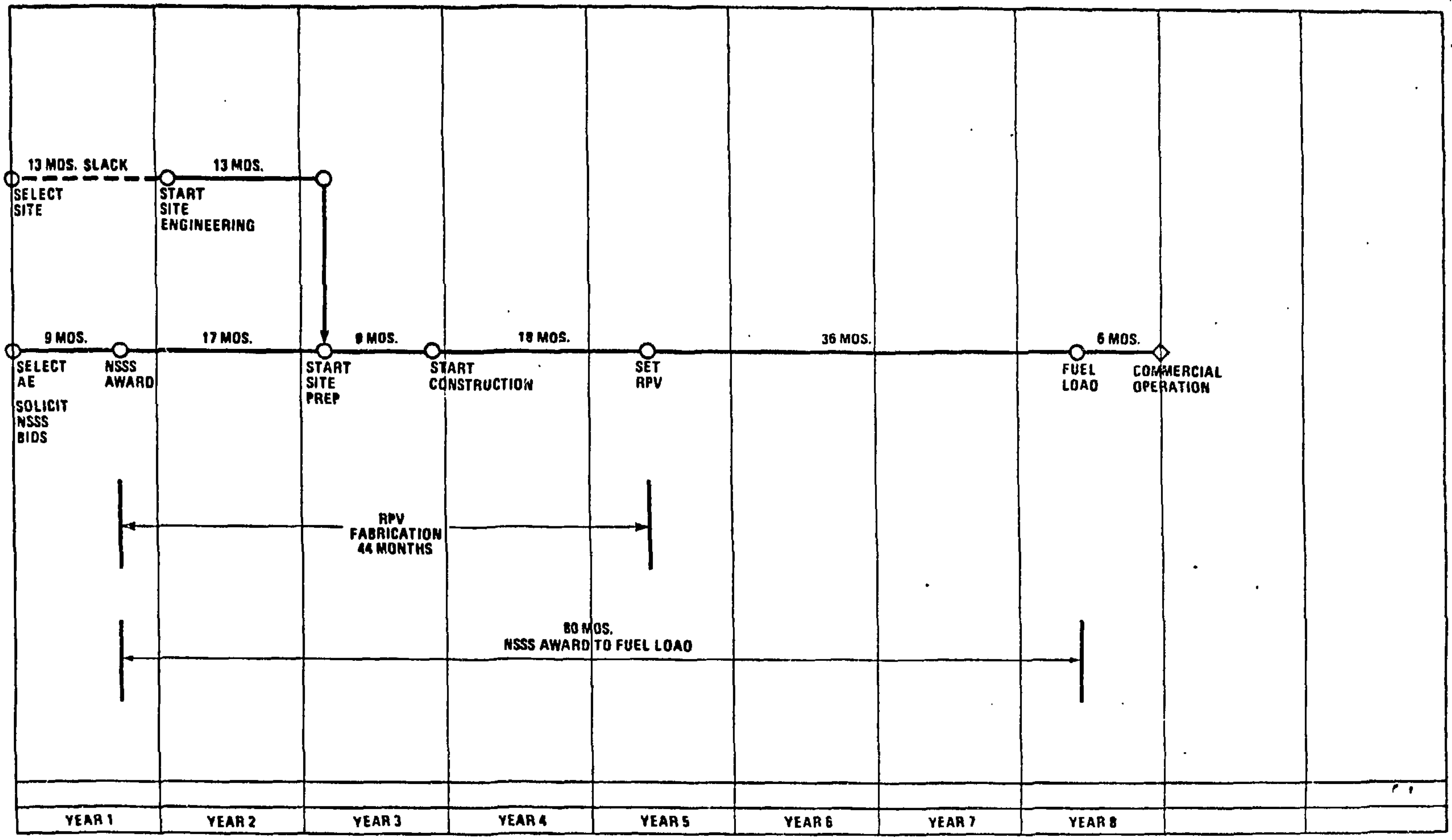
Exhibit 13

1100 MWe
CURRENT - ENGINEERING/CONSTRUCTION
FEDERAL LICENSING INCLUDED



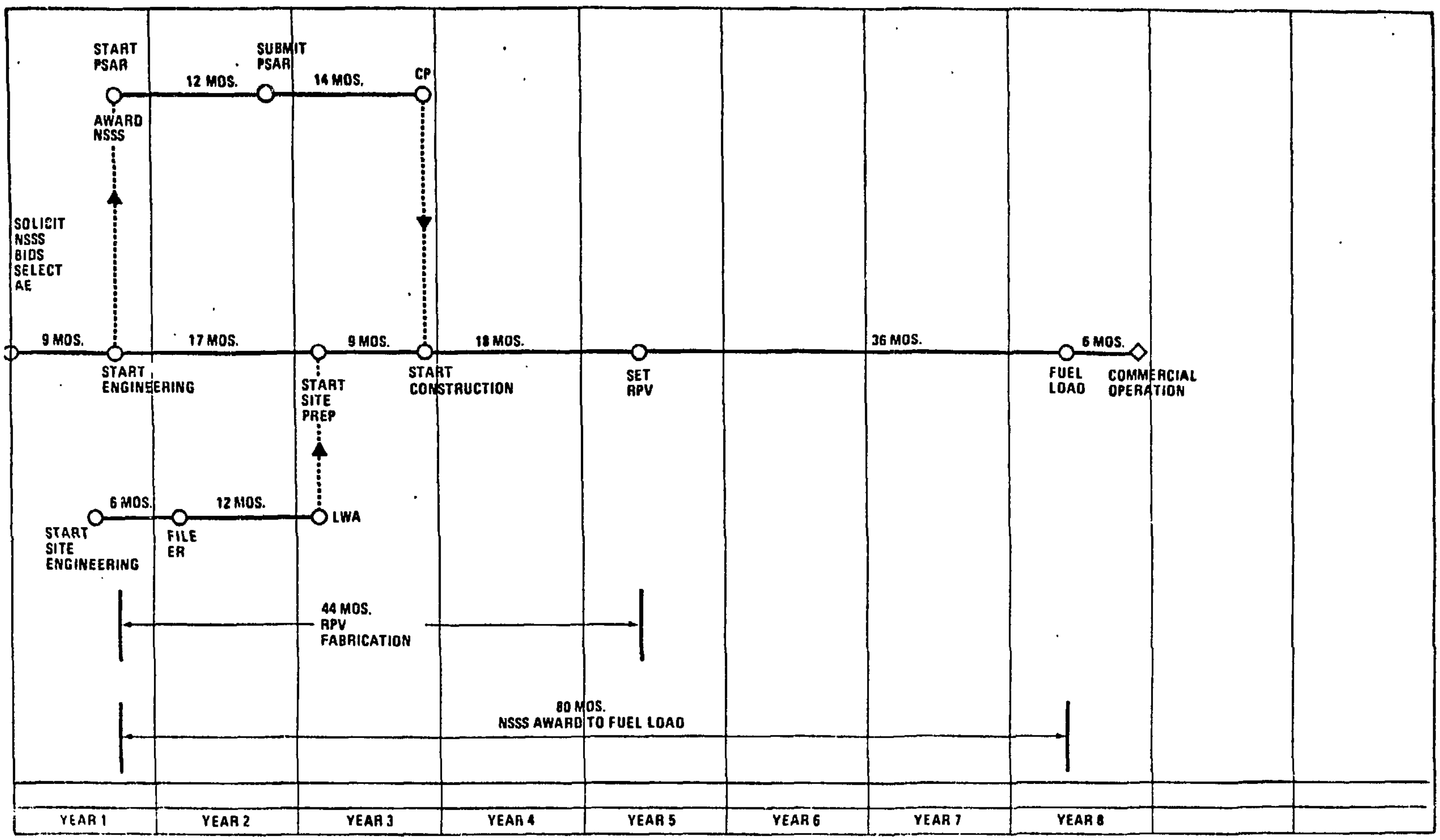
(SLIDE 2)

Exhibit 14
1100 MWe
CURRENT - ENGINEERING/CONSTRUCTION
NO LICENSING CONSTRAINTS



(SLIDE 3)

Exhibit 15
1100 MWe
PROPOSED SCHEDULE
WITH LICENSING REFORM
(PREAPPROVED SITES &
ADJUDICATED PREAPPROVED DESIGNS)



(SLIDE 4)

Exhibit 7

CUMULATIVE TOTALS OF DIVISION 1 REGULATORY GUIDES AND BRANCH TECHNICAL POSITIONS ISSUED BY NRC TO DATE

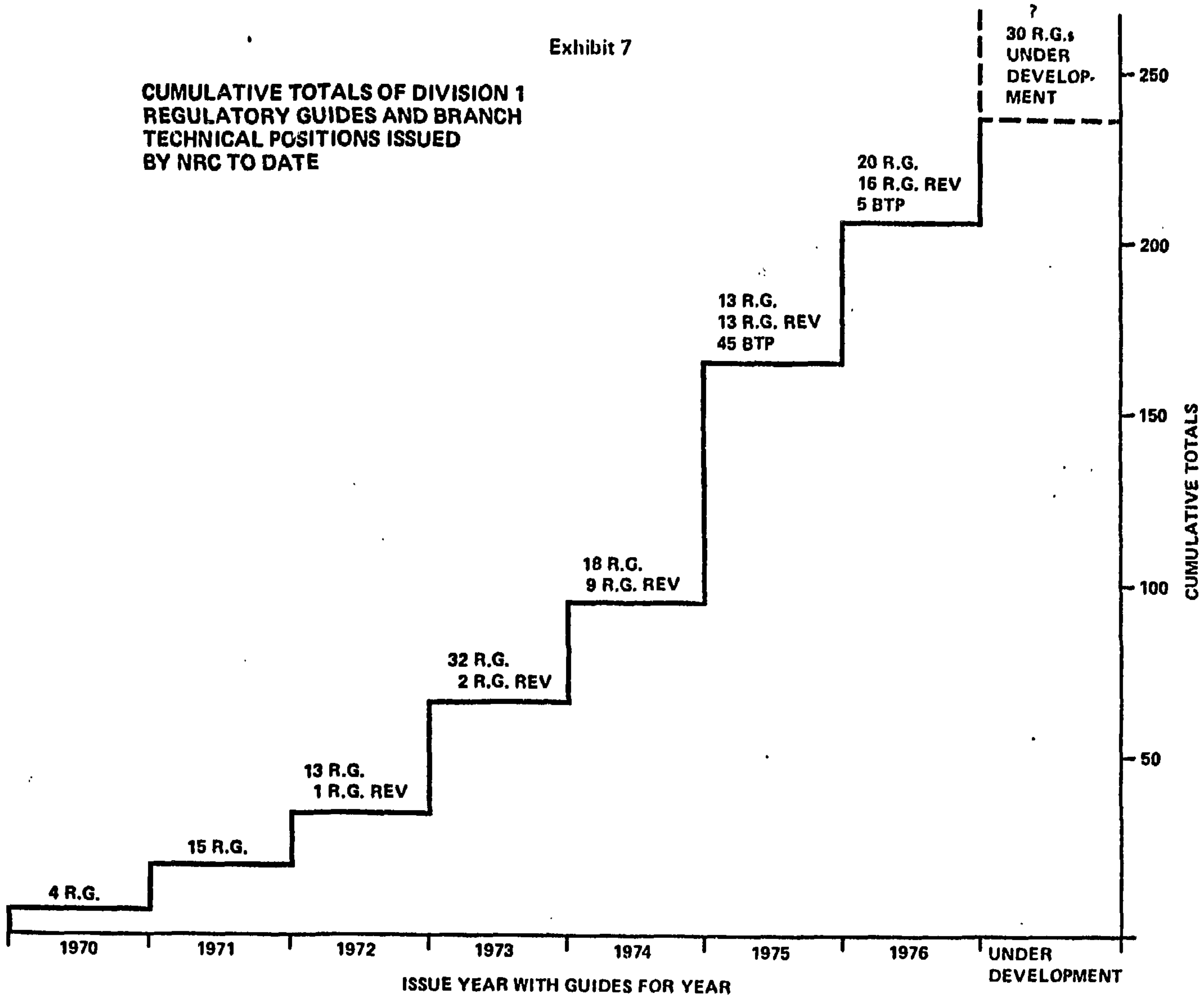


Exhibit 1
GROWTH IN BUILDING QUANTITIES

	Early 1960's	Late 1960's	Early 1970's	Mid 1970's
• Plant Size (MW)	450	800	1,100	1,200
• Major Quantities				
– Concrete (1,000 cubic yards (CY))	30	90	120	170
– Structural Steel (tons (TN))	2,000	3,000	9,000	11,500
– Piping (1,000 linear feet (LF))	90	150	200	250
– Wire (1,000 linear feet (LF))	1,500	2,300	3,000	4,500
• Building Volume (1,000 cubic feet (CF))	3,000	8,000	12,000	16,000
• Quantity Ratios				
– Concrete (CY/KW)	.07	.11	.11	.14
– Structural Steel (TN/MW)	4.3	3.7	8.5	9.1
– Piping (LF/KW)	.20	.19	.18	.21
– Wire (LF/KW)	3.0	2.9	2.7	3.7
• Construction Labor (Manhours/KW)	5.3	5.1	10.4	12.4

Exhibit 10
TREND OF NRC LICENSING REVIEW ACTIVITY

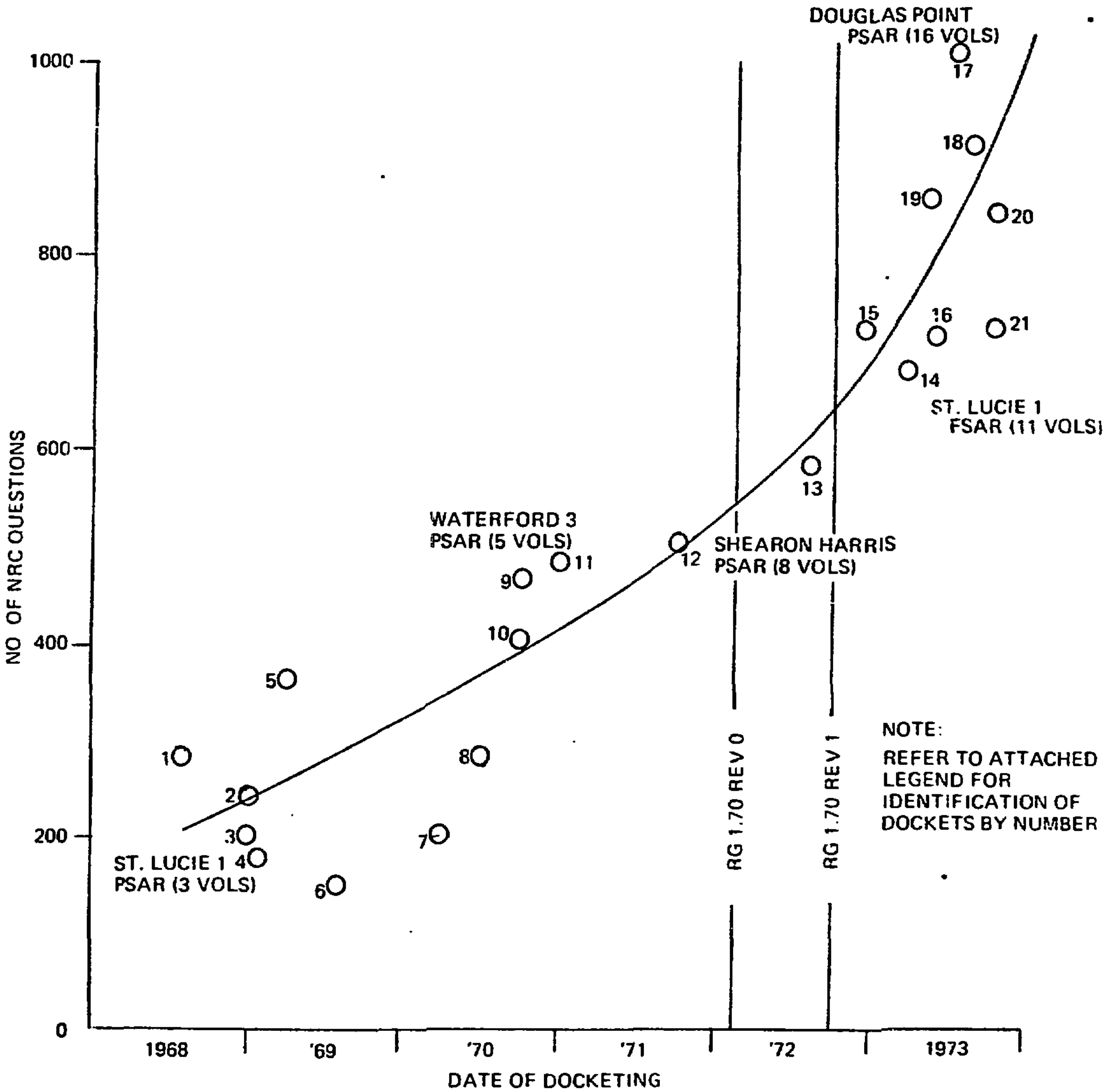


Exhibit 10 (continued)
LEGEND

No.	Application	CP Date
1	Brunswick PSAR	2-7-70
2	Beaver Valley PSAR	6-26-70
3	Fitzpatrick PSAR	5-20-70
4	St. Lucie 1 PSAR	7-1-70
5	North Anna 1 & 2 PSAR	2-19-71
6	Davis-Besse PSAR	3-24-71
7	Zimmer PSAR	10-27-72
3	Farley PSAR	8-16-72
9	Arkansas 1 FSAR	5-21-74 (OL)
10	Bailly PSAR	5-2-74
11	Waterford 3 PSAR	11-14-74
12	Shearon Harris PSAR	Pending
13	Vogtle PSAR	6-28-74
14	St. Lucie 1 FSAR	3-1-76 (OL)
15	Grand Gulf PSAR	9-4-74
16	Greenwood PSAR	Pending
17	Douglas Point PSAR	Pending
18	Riverbend PSAR	9-3-75 (LWA)
19	Perry PSAR	10-21-74 (LWA)
20	Allens Creek PSAR	Pending
21	Byron/Braidwood PSAR	12-31-75

(SLIDE-7)

TABLE 6

SUMMARY OF INFORMATION

	Average Number of Questions	Average Safety Review Man-Years	Note
Custom Plant CP	700	6.3	6 Applications
Duplicate CP	300	3.2	8 Applications
Replicate CP	350	4.5	2 Applications
Nuclear Island CP	260 (840)*	4.4 (10.1)**	2 Applications
Cessar CP	570 (725)	6.0 (8.0)	4 Applications
Resar-41 CP	635 (1060)	5.9 (12.6)	1 Application
Gessar-238 CP	446 (527)	6.7 (7.7)	1 Application

$$* \text{ Number in Parentheses} = \frac{\text{CP Applications Questions + PDA Questions}}{\text{Number of Applications}}$$

$$** \text{ Number in Parentheses} = \frac{\text{CP Applications Man-Years + PDA Man-Years}}{\text{Number of Applications}}$$

(SLIDE 8)

TABLE 7

OVERALL STANDARDIZATION EXPERIENCE*

	Questions	Man-Years	CP Applications	Average/Application	
				Questions	Man-Years
Replication	685	8.9	2	340	4.5
Duplication	2,324	23.6	8	290	3.0
Reference NI	1,681	20.1	2	840	10.1
Reference NSSS	5,817	56.9	6	970	11.3
Reference BOP	914	10.0	0	—	—
Reference TI	146	1.6	0	—	—
Total	11,567	121.1	18	640	6.7
			Custom CP	700	6.3

*Data complete through mid-1977; includes all reference system applications and CP applications using them.