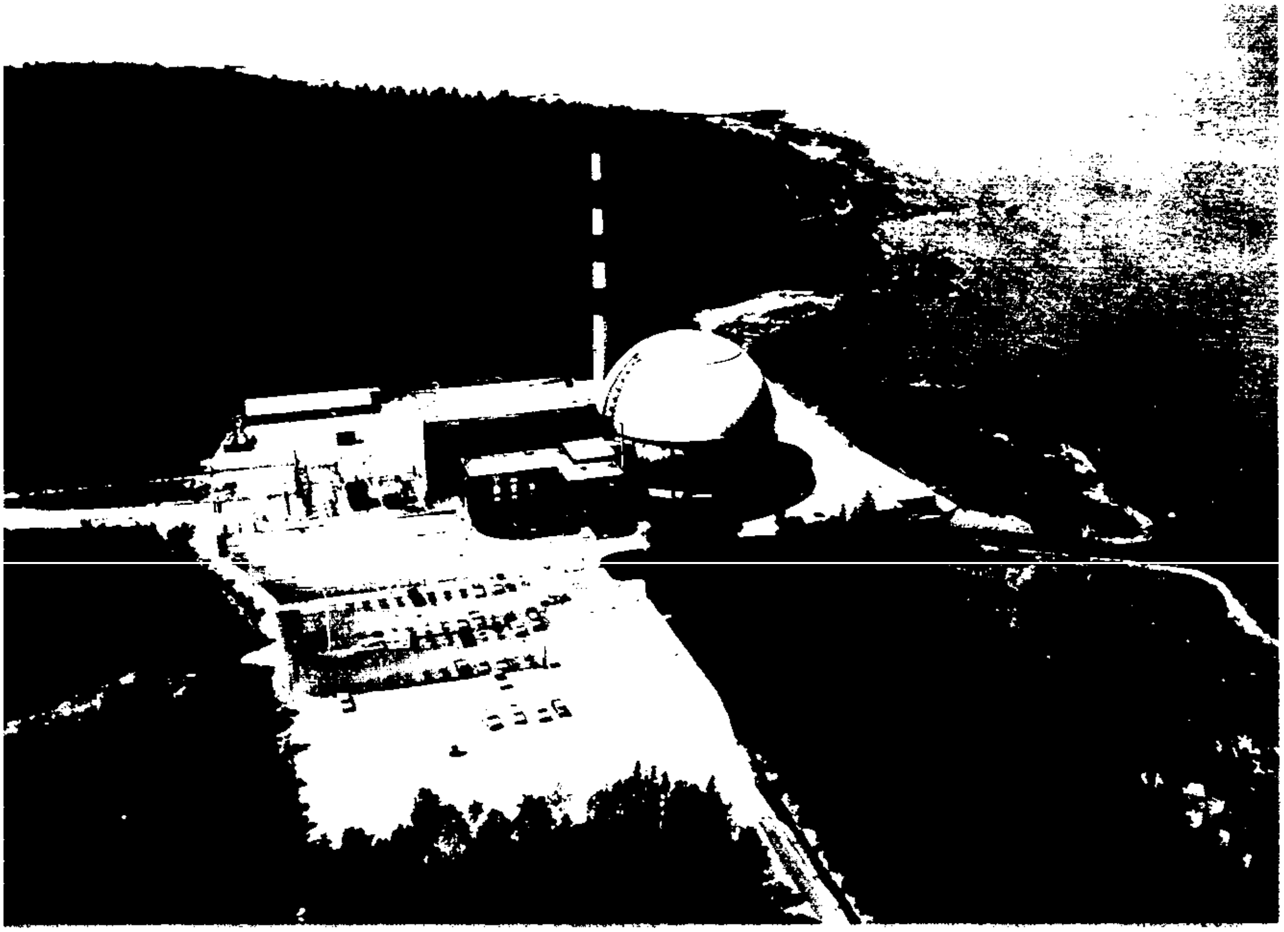
Chapter 1

SUMMARY



Big Rock Poi igh-Power Density, Boiling Water Reactor (70,300 kWe)
December 1962, Charlevoix, Lake Michigan

Chapter 1

SUMMARY

After 25 years of commercial development, nuclear power has entered a period of transition. The results of the accident at Three Mile Island (TMI) have introduced sufficient uncertainties into the industry's licensing and safety practices so that it makes it difficult, if not impossible, to get a new plant approved. At the same time, the unexpectedly low-growth rate that many utilities are encountering has deterred them from ordering any new nuclear plants for the immediate future. However, even zero growth of demand would require some new replacement facilities by the early 1990's to maintain the present generating capacity. If the uncertainties resulting from TM I are resolved soon, the nuclear industry will have a unique opportunity to reevaluate its direction and practices.

One of the peculiarities of the way that the industry has developed is that commercial reactors are built with an unusual degree of variability and diversity. Essentially every reactor, with a few exceptions to date, has been custom-designed and custom-built. The fact that almost every reactor is "one-of-a-kind" has led to excessive difficulty in verifying the safety of individual plants and identifying particular problems in transferring the safety lessons from one reactor to another. It may also account for the escalating costs and long lead-times associated with nuclear powerplants.

Many of these problems can be alleviated if the industry moves away from its "one-of-a-kind" practices toward a degree of standardization in its design, construction, operation, and licensing practices. Several types of standardization are possible, and this report examines them. Some trends in this direction are already occurring; the present lull could be used to lay the groundwork for future standardization.

A minimal level of standardization is the adoption of criteria for performance, reliability, and general design principles. This type of standardization is promoted by groups such as the American National Standards Institute and the American Society of Mechanical Engineers. At the other extreme, some fee l standardization means the selection of one complete nuclear reactor as the "standard" or model, according to which al l other reactors are to be built.

OTA evaluated four different approaches to standardization of the present generation of light water reactors (LWRS). These are:

- The acceleration *of present trends*. This wou Id entail revitalizing and streamlining the Nuclear Regulatory Commission's (NRC) current standardization program and emphasizing one-step I icensing.
- The *procedural standardization.* This means the use of universal "software practices" such as common terminology and format for plant procedures and similar requirements for the training of plant personnel.
- *The standardization of the powerplant's nuclear systern and those systerns critically necessary for the safe shutdown of the reactor— the safety-block concept.* This might include the development of similar designs for auxiliary feedwater and shutdown cooling systems.

  The selection of a single standardized design resulting from a fresh approach integrating the past 25 years of operating experience from various reactors.

This report considers these four representative approaches to standardization and examines the major advantages and disadvantages of each concept.

PRINCIPAL FINDINGS

Standardization *can be an essential element in maintaining a viable and safe program for nuclear energy.* There are relatively few plants built as examples of the approaches to standardization considered in this report, but the present trend in the nuclear industry is toward greater standardization.

Standardization yields safety benefits that are intuitive/y valid even if they cannot be demonstrated unambiguous/y. The common-sense nature of this benefit and its widespread acceptance in the nuclear industry more than counterbalance the paucity of data from the few relevant examples. However, the extreme, "single-design" approach to standardization could pose so many institutional difficulties and generic risks, that the problems would outweigh the safety benefits.

Standardization has c/ear potential for time and cost reductions and for gains in safety for new nuclear p/ants. Several utilities and utility groups have attempted to build standard plants in the hopes of shorter licensing time and reduced design and construction costs. Some improvements have been reported but there have also been problems.

Standardization is not a panacea, and the other elements needed for a safe and efficient nuclear program should not be ignored. Other elements include safe operating practices, programs for effective preventive maintenance, and direction by responsible technical managers.

Standardized plants constructed during different time periods have diverged from their original design due to the changing regulatory requirements, industrial standards, and utilities' preferences. The characteristics of different sites have dictated further divergence from original standardized designs.

The quality of the implementation of standardization is just as important as the concept itself in reaping potential benefits. A custom plant can be safer than a standard plant if it is operated and maintained in an exemplary fashion. Conversely, a standard plant will be safer only if the designers and operators are highly motivated, talented, and technically competent.

The present trends of the industry toward greater standardization will be great/y encouraged by the implementation of sing/e-stage licensing. Proposals have already been made for the one-step issuance of a standard design approval or "power-worthiness certificate" for nuclear plants, but they have not been implemented.

NRC is current/y devoting little time to the problem of nuclear powerplant standardization. The implementation of the rules and requirements resulting from the accident at TM I is occupying much of NRC's time. If standardization is to succeed at all, NRC must start planning for it now during this period of slack growth in nuclear power. They must develop plans for future standardization, including possible implementation of one-step licensing. In addition, the vendors should realize that domestic orders for nuclear steam supply systems (NSSS) may not occur over the next few years, and they should take this opportunity to review and improve their basic designs.

The adoption of *a* national safety goal is desirable. This would be a stated goal, agreed on by society through some institution — Congress, NRC — as the level of safety acceptable to the Nation. As such, it goes beyond the more general statement in the present law. The adequacy of NRC's response to the accident at TMI, in the absence of such a definition (i.e., how safe is safe enough), is impossible to assess and creates a large uncertainty in the licensing process. NRC must begin to manage its activities in a manner so that prompt and consistent decisions on safety issues can be made. Participants in the nuclear industry agree in principle, on the desirability of a safety goal.

Enhanced standardization increases the likelihood of accurate risk assessment. The only means to assure that a nuclear powerplant has achieved a quantitative safety goal is through the use of probabilistic risk assessment. Improved risk assessment under standardization is primarily due to the increased attention that can be given to a few well-defined assessments rather than many diversified ones.

The safety benefits of *improved procedures, through adoption of uniform reporting practices and industrywide participation in review of operating experience, can easily be obtained now.* Substantial benefits can also be obtained through standardization of training of plant personnel, even when considering the utility's responsibility for a diversity of plant types.

The four approaches to standardization are not necessarily mutualy exclusive and might be explored in parallel. The first two approaches– acceleration of present trends and procedural standard i z at ion — are already being pursued but could be further encouraged. They can be accomplished with little, if any, disruption of the present structure of the industry.

The second two approaches – the unification of "safety -block" systems and the adoption of a single "standard" plant design — could bring about significant and perhaps disruptive changes in the institutions of the commercial nuclear industry, The safety-block approach would transfer design responsibilities for certain safety systems — e.g., the containment — to a section of the industry not traditionally responsible for such systems. The single-standard plant approach would reduce the two major participants in the industry—vendors and architect-engineers (A Es) — to suppliers of components and engineering services for the single national design.

The second two approaches could establish more specific design criteria than currently exist and provide an "idea/" case for measuring future design criteria. The purpose would be served whether or not the more standardized plant design was actually implemented.

The U.S. Navy's experience with standardization is not directly applicable to the commercial nuclear power industry. The naval reactors program is the only U.S. example of a well-standardized program with considerable operating experience, but the principles applied in this program are not directly applicable to the commercial industry, which has a diversity of designers, AEs, and operators who function much more independently than the participants in the Navy program. The Navy's safety record is apparently due to strong central control and the greater attention that can be focused on a smaller number of reactor designs.

Standardization would aid the resolution of some of NRC's generic safety issues, while the resolution of others would be unaffected.

INSTITUTIONAL RESPONSES

Current Nuclear Industry

The tasks of design, construction, and operation are handled by diverse and independent organizations, each with its own distinctive style and mode of business. The 75 commercial reactors now operating in the United States reflect this variety. However, in recent years, the industry has begun to reduce this diversity as designs have matured and to some extent converged.

The two types of companies that together design the systems of a nuclear powerplant are the manufacturers of the NSSS and AE firms. The four NSSS vendors design and manufacture the nuclear-related systems such as the reactor vessel and core, primary cooling system, and reactor protective system. The AE firms (which number about 12) design the balance of the plant, including the piping and electrical layouts, auxiliary feedwater system, and the containment building. Both the NSSS vendor and the AE firm collaborate with the utility to produce a plant that meets the utility's specifications. In most cases, the AE firm also serves as contractor for the plant's construct ion.

In recent years, each NSSS vendor has evolved basically one design for an NSSS which varies little from one order to another. The current variety of designs is due to the larger number of AE firms than the NSSS vendors. Also, satisfying the different utilities' design specifications creates additional variety. Some AE firms have moved toward one design with an interface package to match each of the four NSSS designs. However, the designs have not moved toward greater similarity from one AE to the next. Standardization would reduce the design effort of the AEs. This wou ld not greatly reduce the total cost of the plant since such efforts account for only a low fraction of the component and construction costs, but it would affect the AE's business. Nevertheless, AEs also serve as contractors and accept some form of standardization as inevitable and in the best interests of the industry.

The NSSS vendors, AE firms, and utilities should continue to pursue a cooperative program of standardization, perhaps utilizing the current trade associations. An alternative would be the establishment of a joint utility organization that sets standards and design criteria which are more detailed than the current NRC regulations. Neither of these concepts will become a reality as long as the industry's resources are stretched to meet NRC requirements resulting from the accident at TMI.

Nuclear Regulatory Commission

Since 1973, NRC has had a program for licensing standard nuclear reactors according to one of four definitions of standardization. The industry and utilities have participated actively in hopes of a shorter and more predictable licensing process. The gains in time and manpower effort have only been marginal to date, although it may be premature to judge the program's success.

Industry observers believe that standardization will be hindered until NRC makes definitive rulings regarding which safety concerns are sufficient to warrant a design change in a standard reactor. Until that disciplined approach is achieved, no two "standard" reactors will remain alike.

The same basic criticism is leveled against NRC in both its licensing and regulatory role because it lacks clear direction for making safety rules. A long list of generic safety issues are before the Commission, and several key safety issues await the Commission's ruling. The outcomes will remain unpredictable until NRC establishes a safety goal to guide its decisions. Until regulatory and demand uncertainties are removed, no utility is likely to apply for a new license — custom or standard.

Another step NRC might consider to encourage standardization is the implementation of standard design approval, a concept for one-stage licensing (the current procedure is a two-stage process). NRC has considered the implementation of a standard design approval which would involve submittal of information that is significantly more developed than that now provided for a preliminary design, but somewhat less than that for a final design. The General Electric Co. has proposed a similar one-stage licensing program by which NRC would grant a "power-worthiness certificate" to an acceptable design.

Congressional Role

Although no legislation has emerged from Congress that directs a standardization effort, there remains considerable interest in whether standardization can improve nuclear safety. The findings of this study show that there is no quantifiable demonstration that standardization enhances safety but there is a strong "intuitive" feeling that it will. The issue then becomes the degree to which standardization should be pursued considering the tradeoffs between potential safety gains and possible costs as summarized above and discussed in this report.

If Congress chooses to pursue the third or fourth approaches to standardization, legislation will probably be necessary because neither the industry nor NRC will take these steps voluntarily. If Congress decides that the forces of the marketplace restrained by the numerous industrial standards are sufficient, then legislation mandating greater standardization is probably not necessary. Action that supports this goal, either by legislation encouraging it or setting-up incentives such as one-step licensing, could accelerate the trend and provide a clear policy statement about standardization and nuclear safety. In this connection, establishment of a nuclear safety goal, by Congress, could be an important step in encouraging standardization. Procedural or operational standardization is also being pursued by the industry and utilities. Congressional legislation is probably not necessary to achieve some degree of procedural standardization, but, again, could be encouraged by a congressional statement of national policy.

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