Chapter 5

# THE NUCLEAR INDUSTRY'S EXPERIENCE WITH STANDARDIZATION

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## THE NAVAL REACTOR PROGRAM

The Naval Reactors Program under Adm. Hyman Rickover has responsibility for 125 operating nuclear-powered ships, with 36 authorized or under construction. The U.S. Navy has attempted to maintain as much standardization as practicable, with particular emphasis on the similarity of control rooms, instrumentation, operating procedures, and training programs, All operators attend the same nuclear power school, and manuals used for training are of the same type as those on shipboard. However, the specific propulsion-plant designs may vary because of the different sizes and military functions of the vessels they must power. The Navy's nuclear-powered ships include attack submarines, ballistic missile submarines, aircraft carriers, and cruisers. At least 11 classes of ships are built or authorized under the Naval Nuclear Propulsion Program. Even within a single class, some variation has resulted as new technologies develop and become installed on later models of a given class.

The designs are formulated at one of two, Government-owned, contractor-run laboratories—the Bettis Atomic Power Laboratory (operated by Westinghouse) and the Knolls Atomic Power Laboratory (operated by General Electric (GE)). Designers at these laboratories must obtain the approval for their designs from Naval Reactors headquarters, and the designers are held responsible for study and improvements in the designs even after the reactor has been built. Presently, submarines are built at two commercial shipyards.

With regard to commercial nuclear powerplant standardization, Rickover made two observations before the President's Commission on the Accident at Three Mile Island on July 23, 1979. The first was on the desirability that the utilities "unite to establish a separate technical organization which could provide a more coordinated and expert technical input and control for the commercial nuclear power program than is presently possible for each utility with its limited staff. "

Among the things such an organization could do are:

- develop the standards and specifications utilities should require for design and construction of their plants;
- provide direct, indepth technical assistance to utilities in design, construction, and operational questions;
- establish recommended staffing requirements for operation of nuclear plants—e.g., at times there may be only a single operator with no supervision present in the control room of an operating plant. Also, that operators may be assigned and actually carry out unrelated duties while on watch. These are contrary to Navy practice;
- develop a comprehensive training and retraining program, including lesson plans, qualification requirements, etc., for utilities to use in training their people. This must be based on what is needed and not geared solely to passing licensing examinations. It should cover al l types of personnel, not just operators;
- provide trained technical teams to perform periodic audits of nuclear stations and critically evaluate the plants and the qualifications and performance of personnel; and
- advise utilities on technical safety questions.

In the same testimony before the Three Mile Island (TMI) Commission, Rickover recommended that "plant designs, equipment, control rooms, training, etc., should be standardized insofar as practicable. " Rickover noted that much more standardization seems practical on new plants than old ones (where it might nevertheless be possible to achieve some degree of standardization of control rooms, instrumentation, etc.), and that standardization should have two distinct benefits. First, he noted, that better designs should result because a larger number of engineering man-hours could be applied to standardized designs, and, with a larger number of identical operating systems, operational experience would "provide a valuable source of information that can be used to improve the design and procedures and establish a more effective preventive maintenance program for all plants." Second, he noted, the use of standard designs would make it possible to train operating and inspection personnel more effectively.

However, Rickover did not advocate the most extreme form of standardization. "In advocating more standardization I am not saying that there should be one single design. I have standardized in my program as far as practicable. Even then we have a number of designs to suit the different power ratings and ship types and to take advantage of new developments and technology which have become available."

With regard to a new technical organization, the utilities have jointly funded the Institute for Nuclear Power Operations (I NPO), which is undertaking to prepare models for operator training programs, and will establish training program criteria, accrediting industry training programs, and performing in-plant evaluations. INPO hopes these programs will be more specific than those of the Nuclear Regulatory Commission (NRC). The models will be recommendations, not requirements, for the utilities. Another collective organization funded by the utilities is the Nuclear Safety Analysis Center (N SAC), recently created by the Electric Power Research Institute to provide more technical assistance to the utilities. The commercial nuclear industry has, therefore, strengthened its organizations along the lines suggested by Rickover although none has the total authority that the Navy exercises over its reactors' program. The benefit of these organizations is difficult to judge because of preoccupation with the implementation of the requirements resulting from the accident at TM I and the short length of time (about 1 year) of their existence. Their success will depend on the quality of the personnel in the organization and the willingness of the utilities to accept their assistance responsibly.

With regard to standardized plant designs, the currently available standard designs docketed with NRC represent an improvement in decreasing the number of designs that are commercially offered. A greater reliance on a joint utility organization that sets design standards and criteria that are more detailed than those in NRC regulations is desirable. The implementations of such a concept in the near future may be extremely clifficult due to the current high level of regulatory activity in areas other than standardization.

## STANDARDIZED NUCLEAR UNIT POWERPLANT SYSTEM

The Standardized Nuclear Unit Power Plant System (S NUPPS) is a consortium of utilities organized to build identical nuclear plants at different sites across the country. It is the closest project to full standardization with plants under construction. SNUPPS project management is handled by a contractual arrangement with Nuclear Projects, Inc., and a hierarchy of utility companies. The five utility companies have entered into separate but nearly identical contracts with Bechtel Power Corp. (lead architect engineers (AE)), Westinghouse (supplier of the nuclear steam supply system (N SSS)), General Electric Co. (supplier of turbine generators), and Nuclear Projects, Inc.

SNUPPS originally was a consortium of power utilities that made an application for six units at four sites. One unit was withdrawn shortly after application. Another (the Sterling unit) was canceled because of a lessening of

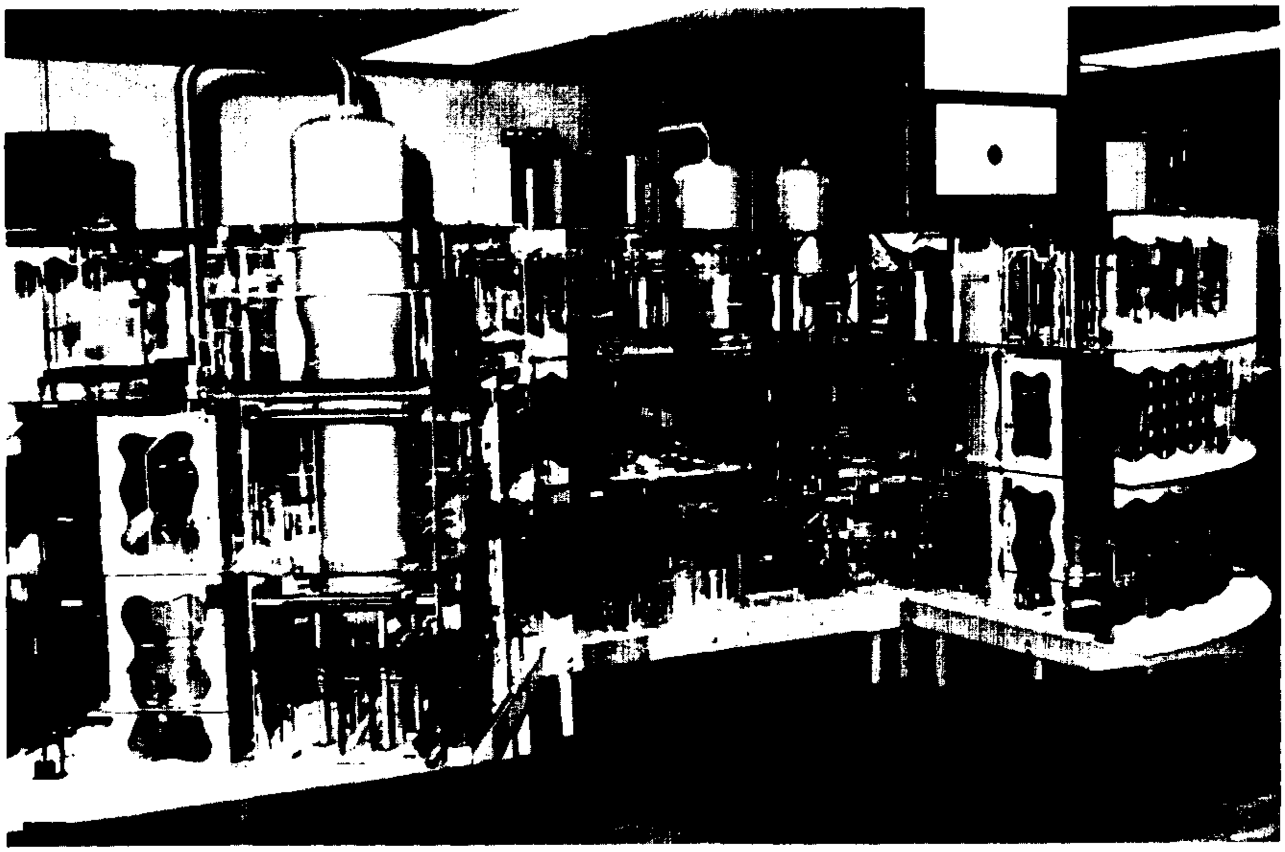

Photo credit Bechtel Power Corp

A mock-up of the equipment inside the containment is used to minimize problems with equipment layout and pipe or cable tray interference. It also serves as a planning aid during construction of the plant. The model seen here is of SNUPPS. The long cylindrical vessels with the "J" shaped tube at the top are the steam generators. The reactor vessel mock-up would be surrounded by the portion of the containment seen here

demand, restrictions of local governments, and uncertainties in the Federal regulatory procedures. The design and construction of both Callaway 1 and Wolf Creek units are over 60-percent complete, however, both have suffered time delays and substantial cost increases. The time delays have resulted from financial considerations and Federal regulatory concerns, while cost increases have occurred primarily due to recent unusually high inflation rates.

The SNUPPS project is based on identical units with no shared systems. If two units were to be constructed at the same site they would be identical but separate units. For each plant, Westinghouse produced a standard information package in order that Bechtel could design and engineer the balance of plant with minimum changes to the NSSS. This approach facilitates the orderly progression of design drawings and the ordering of equipment.

All plants will have identical portions called the "power block", this consists of the reactor building (containment), fuel building, turbine building, hot machine shop, auxiliary building, diesel generator building, control room building, and radwaste building. Structures and components outside the power block differ for the various plants and are not under control of SNUPPS.

In the licensing process, the project is managed by a single project manager and review team within NRC. In addition, the Advisory Committee on Reactor Safeguards assigned a subcommittee to review the standard portions of SNUPPS and when the Atomic Safety and Licensing Board hearing for two of the units were held, previously resolved issues were not re-reviewed. This sharing of licensing resources allows more licensing personnel to provide a greater indepth review than would have been possible with a customized application for several plants. In addition, there was a reduction in the questions asked by NRC from an average of 700 for a customized plant to an average of 150 per single SNUPPS unit.

During the procurement for the units, only proven materials, equipment, and systems are to be used; American National Standards institute and other appropriate standards are to be strictly followed. Power block purchases are centralized — i.e., with few exceptions the same supplier and the identical item for a particular function are used for all plants. This allows interchangeability of parts between plants. These are common industrial practices.

During construction, a considerable amount of standardization is maintained. Detailed models and photographs of the models of the standard plants are used in the construction effort. This method has eliminated much interference and many delays while providing a considerable surety of proper construction techniques. Construction equipment common to SNUPPS plants is shared by the construction crews.

Standard preoperational procedures, startup, and functional operating procedures are being prepared for the SNUPPS plants. Also, simulators will be available for the SNUPPS plants and operating experiences will be shared among SNUPPS utilities' personnel.

The participants in the SNUPPS program claim the SNUPPS plants will be built for about 1(1-percent less than if they were customized plants. Further, they feel the plants will be safer because of the standardization effort. However, there are no hard data to substantiate this claim, only an intuitive feeling that the more man-hours spent on a particular system design the safer it will be. '

**'NIcolax A Petrick, "Progress Report on the SNUPPS Nuclear Stat Ions," Nuclear Projects, Inc , Nuclear EngIneerIng Internatlonal, November 1977**

## THE FRENCH NUCLEAR PROGRAM

The French have developed a consensus of government energy policy makers that is supported, almost totally, by all four major political parties. The French nuclear program has some of the same problems as other nations — e.g., opposition by organized citizen groups, some difficult public relation situations, and some technological shortfalls; however, they have maintained a firm commitment to their policy of "tout nucleaire" (i. e., decommissioning oil-fired electricity generation plants and building coal-fired, hydrostorages and mostly nuclear powerplants). The French policy was formulated by their perception for the need to reduce dependence on foreign supply of oil (which in 1973 supplied France 67 percent of its energy needs). Further, the French have only very limited supplies of oil, natural gas, and coal within their boundaries. The French condition is quite different from the United States— i.e., there is no clear political consensus on the need for nuclear power in the United States, partly because there is an indigenous supply of oil, natural gas, and coal within U.S. borders.

The choice between the two commercial types of light water reactors —e. g. (boiling water reactor (BWR) and pressurized water reactor (PWR)) — using enriched uranium was made on the basis of price. The French entered into a competitive program between European holders of licenses for the manufacture of American designed plants. Framatome held a Westinghouse license and Alsthom, a GE license. The latter group had a significant dis-

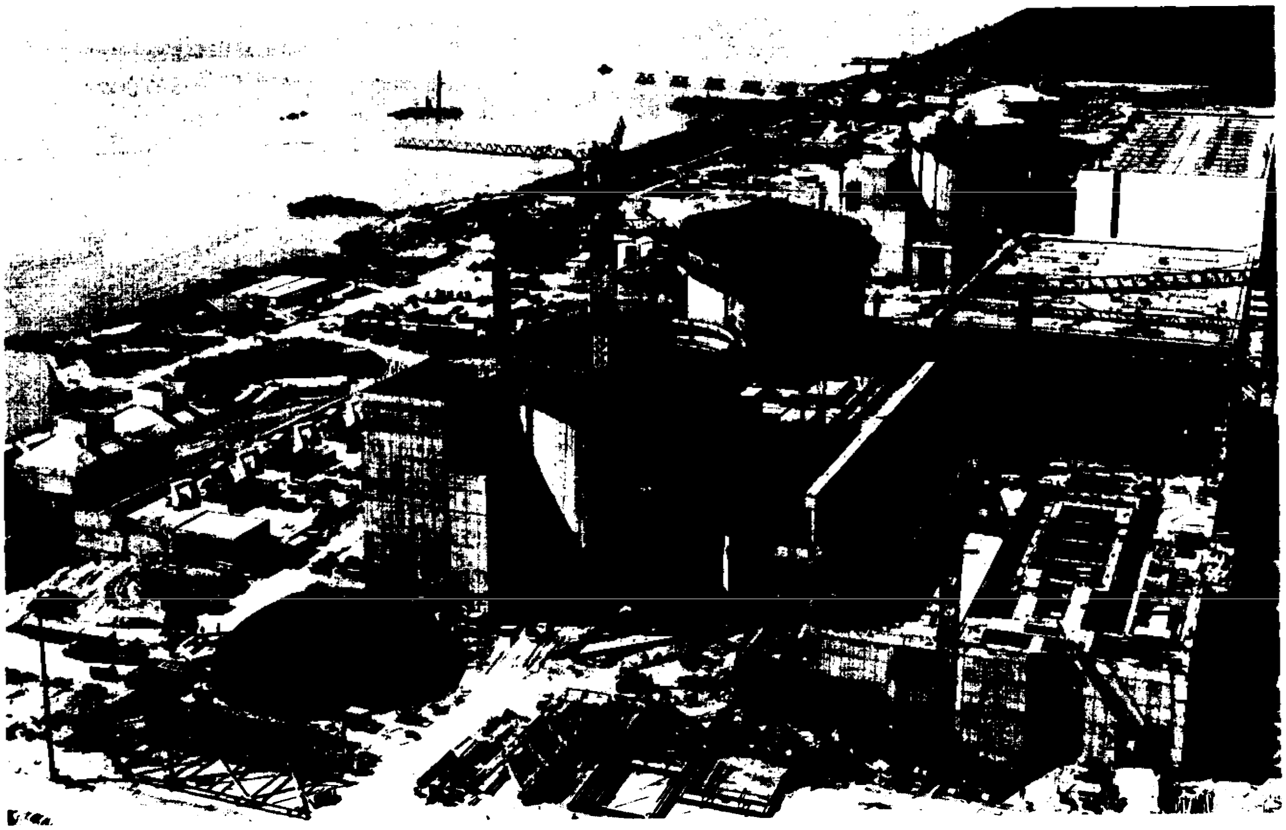

*Photo credit Electricite de France*

Four identical nuclear units are shown under construction in Blayais, France. The first unit, as seen in the background, is scheduled to produce electricity in 1981, just 6 years after construction started. By 1985 there will be 80 such units supplying 52,000 MWe for an area no larger than the State of Texas

advantage in the competition by the fact that it does not own heavy forging facilities for reactor vessel construction. For this reason, Alsthom either had to call upon their competitor, Framatome, or contract abroad. The BWR line was therefore dropped not because of the PWRS technical superiority but to ensure a sufficient workload for the French industrial group in charge of construction. The French industry was, therefore, restructured into one constructor of nuclear steam supply components (Framatome) and one constructor of turbine generators (Alsthom). In addition, the national electric utility is the only French AE, thereby making the standardization of nuclear powerplants easier in France than it would be in the United States.

The French recognize four major safety-related advantages for standardization:

1. a more thorough investigation of safety-related matters is possible when multiple units are involved;
2. experience in design, manufacture and construction, and operation can be transferred from unit to unit;
3. more designer time becomes available to spend time working with a new generation standardization series; and
4. regulators can spend more time inquiring about site-specific considerations, the need for new units, and the ability of the utility owner to operate the unit.

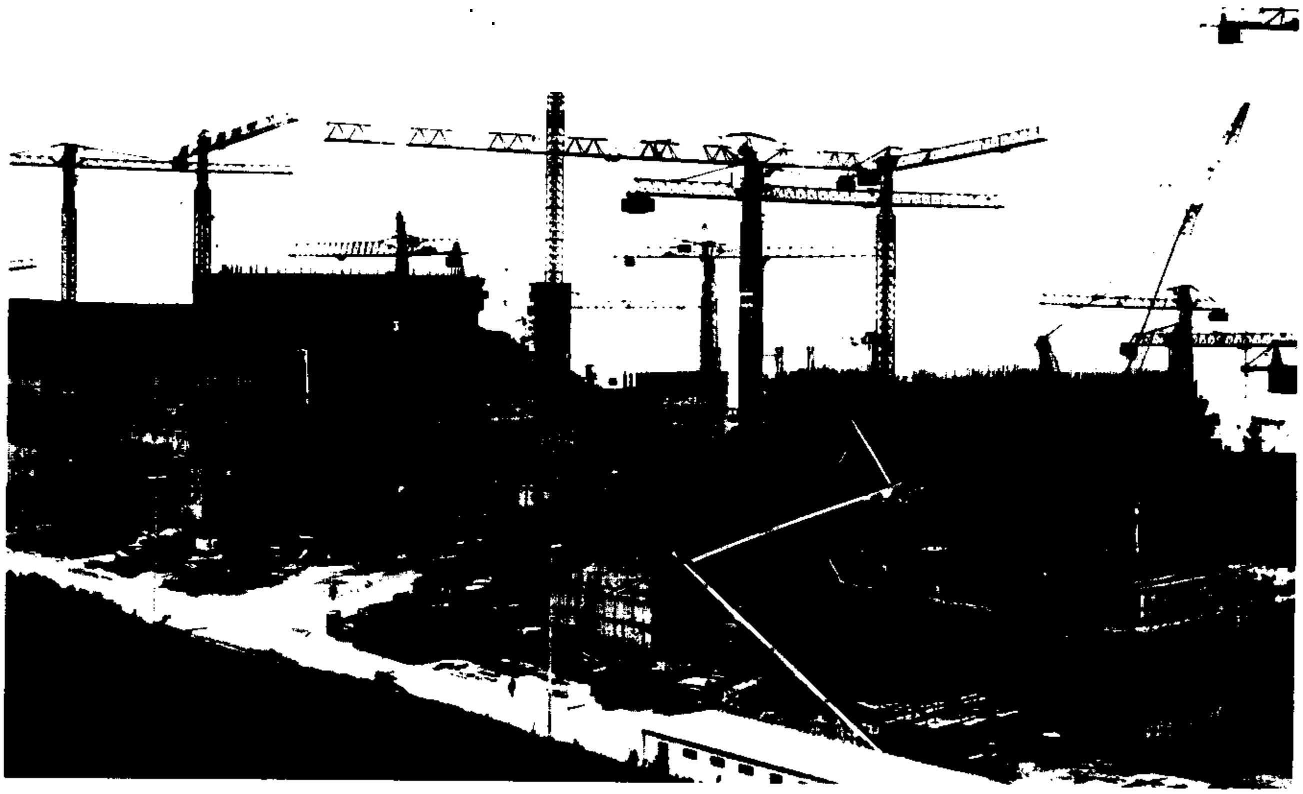

*Photo credit Electricite France*

The Paluel site, Normandy, France consists of four 1,300-MWe units. The concrete walls of the containment and auxiliary buildings were erected during the early stages of construction. The first unit should produce electricity y sometime in 1983

Also, the French recognize at least three major difficulties with standardization of nuclear powerplants:

1. problems involved with one unit of a series propagates to other units in the series and may require expensive and time-consuming redesign and back-fitting;
2. site considerations may require substantial design differences between units of a standardized series; and
3. the optimal balance between design stability and technological upgrading is difficult to determine (i. e., a definition is needed of safety enhancement or cost reduction required before a new technological achievement can be incorporated .2

Overall, the French are satisfied with their choice and consider that the advantage of standardization (especially those related to safety and economics) far outweighs those dif - ficulties.

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'Mlchel Pecgner, "How,One Organization Runs the Whole industry, " Commissarat a L Energle Atomique (CEA), Nuclear Englneerlng International, December 1976

# THE WEST GERMAN OPERATOR TRAINING PROGRAM

A possible model for standardization of training and certification of personnel in commercial nuclear powerplants is the West German program. The West Germans train and certify their operators for both conventional and nuclear powerplants in a powerplant school called the Kraftwerkschu le. This is a joint organization of owners of large powerplants with 116 members from six different countries. The primary purpose of the school is to provide professional and advanced training in six different technical areas for powerpl ant personnel in maintenance and operation. The school was founded by a parent organization called the Technical Association of Power Plant Operators, formed as a result of a severe boiler explosion in 1920.

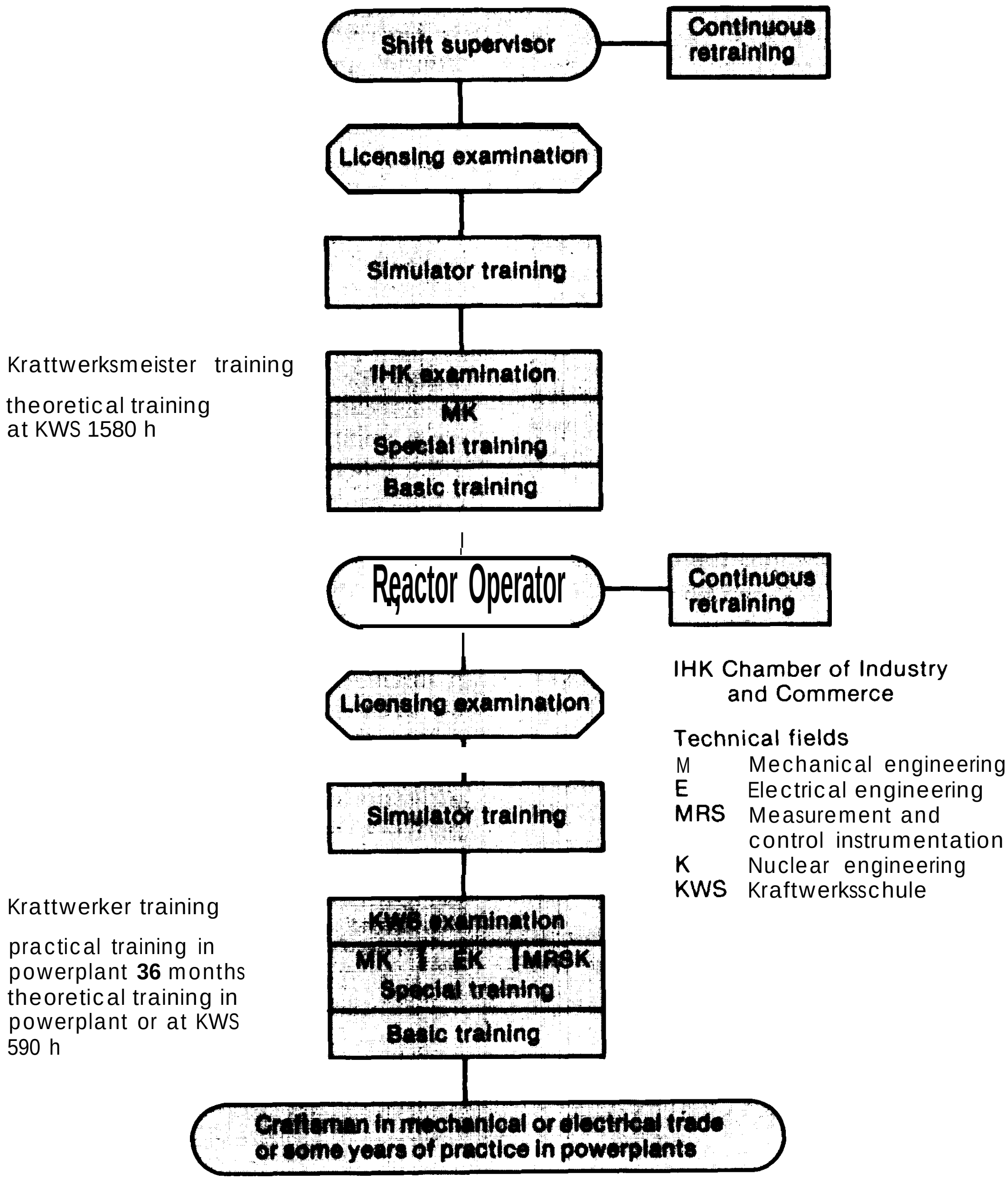
The formal training for a plantworker takes 3 years and is integrated into the operation of the powerpl ant. Training consists of theory and practice with a final exam for certification in the operation of powerplant systems. Figure 6 shows the progression for a nuclear plantworker from initial certification by the Kraftwerkshule to shift supervisor.

The professional competence of the operators and shift supervisor is regulated by official government guidelines. The minimum personnel complement for a nuclear powerplant control room is a shift supervisor, a deputy shift supervisor, and a powerplant reactor operator. The shift supervisor must be an engineer and his deputy must be at least qualified as a Kraftwerkmiester (see figure 6). All three require additional special nuclear training including simulator training, and practical nuclear powerplant experience.

As in the United States, the plant's superintendent is responsible for the selection and training of the powerplant team. The superintendent assesses the workers' capabilities and determines who will eventually be qualified as a plant attendant, plant operator, or shift supervisor. Unlike his counterpart in the United States, the West German superintendent picks his candidates from a pool of workers who have completed a standardized training program established by the owners of the powerplants under the guidelines of the government. In this country, the closest organization to the West German program that has uniform training and certification for its reactor operators is the U.S. Navy. Many utilities rely heavily on the Navy for qualified plant operators. This dependence can create manpower shortages in an area vital to the national defense and allows the utility to abrogate some of its responsibility for a complete and total training program for new operators with no nuclear experience.

'0 Schwarz and G Schiegel, "Combining Theory **and Practice in West German y,"** Nuclear Engineering International, March 1980

**Figure 6.—Training Patterns for a West German Reactor Operator**

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