REGULATORY INSPECTION PRACTICES FOR NUCLEAR POWER PLANTS IN THE FEDERAL REPUBLIC OF GERMANY

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Kurzfassung

Der Vortrag geht von der Verpflichtung der Betreiber und Genehmigungsbehörden aus, das von der Öffentlichkeit in die Qualität und Zuverlässigkeit ihres Umganges mit der Kernenergie gesetzte Vertrauen zu rechtfertigen. Es wird der gesetzliche Hintergrund und die Philosophie des Nachweis- und Kontrollsystems in der Bundesrepublik Deutschland beschrieben. Die Organisation, der Umfang und die Tiefe der vorzunehmenden Prüfungen während der Planung, des Baus und des Betriebs von Kernkraftwerken werden dargestellt. Dabei wird auch auf Prüfungen nach unerwarteten Ereignissen sowie auf einen Vergleich des Prüfaufwands in Relation zum Gesamtaufwand für ein Kernkraftwerk eingegangen.

Abstract

The paper begins with the duty of applicants and licensing authorities to justify the public trust in the quality and reliability of their handling of nuclear energy. The background of laws and philosophy concerning the system of regulatory inspections in the Federal Republic of Germany is described. Details are given about the organization, the objects and the quantity of inspections during planning, construction and operation of nuclear power plants. Inspections after unexpected events and a comparison of inspection costs in relation to the overall costs of a nuclear power plant are shown.

1. Introduction

The peaceful use of nuclear energy has to overcome wellestablished prejudices in the populations of nearly all western countries. There are three reasons, two of them are well known and often recognized: the semantic relationship to nuclear weapons and the proliferation problem. But concerning people's mind there is still another important phenomenon, the distrust against big industrial companies and a lack of confidence to governments, to parliaments to officials and to experts.

The safety of nuclear devices depends mainly on the techniques, control measures and human reliabilities involved. We are steadily improving inspection techniques, reliability and safety of nuclear power plants and in international exchange of experience harmonizing our requirements. So far this specialists meeting is very helpful. We all will have to think over how to gain or to gain back confidence of people, protection of which is our main task. A great part of the public acceptance of nuclear energy is an outcome of this confidence to the regulatory inspectors.

The following paper depicts the German approach to regulatory inspection. An introduction to the philosophy of regulatory inspections as a basis for all practical applications opens the way for detailed examples and descriptions of the inspection practices.

2. Philosophy of regulatory inspections in Germany

The German inspection philosophy may be characterized by three essential statements:

a) All administrative inspections are supposed to guarantee efficient selfcontrol of the nuclear industry.

b) Subject to regulatory inspections is primarily the source of potential danger: the individual plant.

c) There must be evidence, that the different regulatory inspections truly minimize the risk, the burden to the public.

a) The Enforcement of selfcontrol

According to section 7 of Nuclear Law (Atomgesetz) the licinsing applicant is responsible for taking all the measures necessary for the quality assurance of nuclear power plants. The applicant may delegate the responsibility to several contractors, who in turn may transfer it to other subcontractors - especially during construction - but the responsibility as a whole lies with the applicant.

On the other hand the Nuclear Law requires the approval of the highest state authority for the operation of a nuclear power plant. This presumes regulatory inspections during all periods of planning, construction, operation and shut down.

In general there are three independent inspecting powers: the specific manufacturer, the general contractor (applicant of the licence) and the state-authorized inspection authority (e.g. TÜV = Technical Inspection Associations). They all - with rising importance in coherence with the above mentioned count up - control each other's results, and compare them with their own inspection data. In this way the highest local authority has a tool to put some pressure on the quality and quantity of the selfcontrolling inspection activities of the private applicant.

The inspections done by the TÜVs are supposed to verify the results of the applicant. Sometimes they show divergent results as a consequence of other inspection methods or other interpretations of inspection regulations.

b) The physical main object of inspections

The source of potential danger is the specific power plant and its different components. It is the task of regulatory inspections to ensure the safety of this components, but not to warrant the technological potential of some involved suppliers. Thus the German regulatory inspections apply primarily to the specific component and quality assurance pays less attention to controlling the component-supplier.

This is a remarcable difference to U.S. practices. It gives greater freedom and flexibility in the choice of national or foreign suppliers and reduces the administrative expense. Nevertheless fabrication potential evaluations do occur of course but with less priority.

c) Regulatory inspections must minimize the risk

There are twoextreme attitudes how to cope with nuclear risks. They give the border line for the objectives of regulatory inspection:

1. simply accept the risks,
2. design the plant so expensively that it never will be built.

The definition of scope of regulatory inspection finally is a socio-oeconomic decision.

To make this decision in Germany, the Radiological Protection Ordinance, the governmental accomplishment of the Atomic Law, must be cited with two major statements. The first is the necessity to reduce all radiologial expositions or contaminations of persons (operators, labourers) and of the

public even beneath the licenced quantities as low as possible with careful consideration of all imaginable circumstanes (§ 28, Abs. 1, Abschn. 2). The second is the higher ranking position of public interest, especially overall environmental protection, during licencing procedure.

Both statements do indeed settle our work on regulatory inspection closer to borderline No. 2.

However, the public production capacity must not be misused to make an energy source run, that could be exploited in a much less expensive - and less wasting - way. In other words: a too much expensive design is not suitable economically and ecologically.

The ecological limits for safety design and inspection will be themes for future research in fullfillment of the Radiological Protection Ordinance and the Atomic Law.

In achieving quality assurance by high frequence and great number of in service inspections, the restriction is set up by the necessity to reduce all radiological expositions even for persons working in the power plant. For instance, the number of inspections of the whole primary circuit is restricted by the high dose for the inspectors. The German regulatory inspection philosophy has well taken into account this restriction by defining the dose commitments for working people in a nuclear power plant and by prescribing remote handling techniques.

3. Practice of regulatory inspections

a) The organization and system of regulatory inspections

The above mentioned philosophy of regulatory inspections reflected only the need of physical and overall environmental quality assurance. Like in every country, the practice of regulatory inspections has to fit to the governmental and public organization. In the Federal Republic of Germany, consisting of 11 states (Länder), the federal government, represented by the Ministry of Interior (BMI), has the highest supervision, regulation giving and suitability checking authority. On the other hand the different states and their highest governing bodies are responsible for the licence and supervision activities concerning to the individual nuclear power plants in their area.

In consequence of this the applier of a licence primarily has to contact the local government and it is the local government who initiates the regulatory inspections. The inspections are carried out by independent expert organizations, i.e. the State Authorized Technical Inspection Associations (Technische Überwachungs-Vereine TÜV) and the Association for Reactor Safety (GRS). The latter cares for theoretical examinations and super-ordinated questions whereas the TÜV do theoretical and field work. These

organisations are completely independent and only obliged to their own knowledge and expertise.

b) Rules and regulations

In defining the scope of regulatory inspections the authorities consider conventional rules and regulations as minimum requirements. In addition there are a lot of written criteria and guidelines which have to be applied:

The safety criteria of the Federal Minister of the Interior,
The RSK (Reactor Safety Commission) Guidelines,
The KTA-rules (some edited, more under way).

As not the whole spectrum of inspections is covered by these rules the licencing authorities decide on additional requirements case by case, based on the safety evaluation of the safety relevance of the component or the system performed by the expert's organization. Up to now even the RSK has reviewed each single nuclear power plant on request of the Federal Minister of the Interior and in all cases recommended additional safety measures.

c) The scope of regulatory inspections

i) During site evaluation and design

The following documents are inspected and critically reviewed:

- Technical specifications (component specifications)
- Design calculations
- Main drawings
- List of pieces
- Sequence checking plans on fabrication and inspection
- Plans of heat treatment
- Sampling plans and plans for material examination
- Plan for production schedule
- Plan for batch production
- Plans for welding
- Plans for repairing
- Plans for pressure tests

With these informations the following reviews are concluded /1/:

- Compliance with the licencing conditions
- Consideration of all loads
- Correspondence of system and component data
- Constructual design
- Dimensioning
- Materials relection
- Manufacturing procedures
- Circuitry

- Assembly
- Testability, maintenance and repair accessibility
- Instrumentation

This applies primarily to all nuclear related parts of the power plant, especially those listed beneath:

- Reactor physics
- Reactor pressure vessel with reactor internals including fuel elements and control organs
- All activity retaining systems and components
- All pressure vessels
- All engineered safeguards (containment vessels, emergency core cooling systems, spray and filter systems)
- Protection system
- Control system
- Transport and refueling system
- Emergency power supply

These inspections and controls during the planning time result in a couple of prerequisites that must be considered by the future licence applicant.

ii) During construction

Inspection during construction in Germany f. e. has to verify that the manufacturers are equipped with installations for welding of special pressure vessels or related pipes and that the personnel employed for welding has high and reliable qualification. As welding has turned out to be one of the most important failure sources, this special care for the manufacturer's ability was indicated. Nevertheless all safety-relevant components and weldings are tested nondestructively afterwards. Simultanous destructive tests with samples produced at the same time under the same conditions by the same employees are requested for additional information.

Besides this special problem of testing the weldings, during the installation of components at the power station the inspecting engineers of the TÜV conduct or control further tests like:

- Check of dimensional accuracy
- Pressure and leakage testing of the containment
- Pressure tests of vessels and whole systems
- High voltage electric busses
- Electronical circuits

and others. Again it is the basic idea to assure, that the constructors will first verify by themselves the quality that is described in the plans, drawings and licencing documents.

There are several steps during the production of components and construction that require off-site inspections in the producer's facilities

or in special laboratories. For instance the chemical contents of plates used for the pressure vessel, their cristallography and some more are checked far off the power plant's site.

The paper of Dr. Fendler and Mr. Dommke in Session II will provide moreinformation on the inspections during production and construction.

iii) During operation

During the first days of operation, as the commercial power-production begins, all operations and performances are controlled by TÜV-engineers who use these first really measured data to verify the formerly calculated results and relations. The neutron density within the core and at the pressure-vessel's wall, the radiological activity of the primary coolant and many other key-informations are measured and registered.

Other relevant parameters like f.i. the liquid radiological emissions have to be measured by the licence applicant and are controlled by measuring the activity of different liquid mixtures that have to be conserved during operation out of the emitted mass of water. These test mixtures are collected after certain periods and then inspected.

The normal operation period of a nuclear power plant depends on the type of reactor and the refueling strategy. During every planned close down several inspections take place. It is mainly the reactor pressure vessel and the weldings and plates of the primary system which are inspected nondestructively. Safety relevant secondury circuit components like heat exchangers, steam pipes and so on are tested with ultrasonic inspection techniques. The results of these tests are compared to those of the first measurements before plant operation in order to decide whether defects have grown. As ultrasonic inspection is difficult for some special positions, the comparison of results with those from first measurements (finger prints) is an aid to evaluate the quality of the measurement and the reliability of it's response spectra.

iv) After nondesired occurances

In Germany exist definitions for unexpected occurances that must be registered and described to the licencing authority immediately. They are divided in those which are severely safety relevant and need a reactor shut down and those during and after which the operation may continue. Both types have to be explained and evaluated by the applicant and by a central registration division under the leadership of the above cited Association for Reactor Safety (GRS).

It depends on the classification of the respected occurance, whether additional inspections will take place during the next planned shut down or whether general inspections and search for failure cause will be necessary. In the latter case tests comparable or even more restrictive than those

during construction will be recommended. And it is possible, that similar inspections of comparable components and systems in technically related other nuclear power plants even though they did not have such an failure occurance will be requested.

4. As a conclusion: Manpower for regulatory inspections

Besides the "classical" nuclear engineers, i.e. specialists for neutron physics, thermodynamics and materials, today many other disciplines have to contribute in the service of technical inspection associations. These are specialists for civil engineering, fire protection, terrorism, military, ecology, economy, chemistry, electronics and many others.

In the order of magnitude of 1.000 - 1.500 specialists are working for nuclear safety evaluations, radiation protection and inspection within the inspection associations and the Association for Reactor Safety. This is corresponding to about 20 operating commercial nuclear power plants and several nuclear research centers, the number of plants under construction is decreasing.

The total costs for supervision and control including the great amount for the selfcontrol measures of industry are about 8 % of the whole investment costs /2/. The costs for the regulatory inspections are charged to the industry and are contained within these number. They are about 1 - 2 % of the total investment costs.

In context with the high quality standard of nuclear power plants, these few numbers show, that the primary aim of the inspection philosophy is reached: Regulatory inspections should assure that selfcontrol and selfinspection under all relevant circumstances is performed by the applicants of licences.

Literature

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