ACCESSABILITY WITHIN A NUCLEAR POWER PLANT IN POST ACCIDENT SITUATIONS

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INTRODUCTION

The interest in how an accident with moderate to severe core damage will affect accessability within a nuclear power plant origins from the accident at TMI-2, where high radiation levels were obtained in the auxiliary building. The accessability was thereby seriously affected.

In correspondence with the American requirements, published as item 2.1.6b in NUREG 0578; TMI-2 Lessons Learned Task Force Status Report and Short Term Recommendations, the Swedish Nuclear Power Inspectorate in 1980 demanded that the accessability in post accident situations, within two of the Swedish State Power Board's (SSPB) nuclear power plants (one BWR, one PWR), should be investigated before allowing their initial loading. This kind of analysis have now been performed for all plants owned by the SSPB, namely four Asea Atom BWRs (Ringhals 1, Forsmark 1, 2 and 3) and three Westinghouse PWRs (Ringhals 2, 3 and 4).

Based on the findings in the basic investigations, a second step is now in progress, consisting of an action plan to improve the accessability in vital areas.

BASIC ANALYSES

The aim of these investigations was:

- To determine where in the reactor building (BWR)/auxiliary building (PWR) high radiation levels are obtained
- To determine the areas to which access is required after an accident
- To calculate the radiation doses as a function of time in these areas
- To serve as a basis for improving accessability in a post accident situation.

To begin with, the types of accidents involved and the amount of nuclides to be released from the core were specified. For BWRs the accident chosen is a large break in the primary system (LOCA). Based on Regulatory Guide 1.3 and early experiences from the accident at TMI-2 the following assumptions were made as to how large a fraction of the core inventory of different radionuclides is released:

100% of the noble gas inventory 2.5% of the iodine inventory	to the containment atmosphere
25% of the iodine inventory 10% of the inventory of Cs isotopes 1% of the inventory of a number of selected nuclides	to the containment water

The above assumed activity release is based on the TMI experiences that were available in the spring of 1980. Later analyses have indicated other release fractions as being more realistic, the most important being a 50% release of Cs. In our investigations, the same releases as in the table above have been used for all BWRs in order to be able to make comparisons. However, the influence of Cs on the doserates is listed separately, providing the possibility to adjust the figures according to higher release fractions.

For PWRs two main types of accidents were discussed, either a large LOCA or an accident where the primary system remains intact. In both cases it was assumed that the release of radioactive nuclides corresponds to the figures given in Regulatory Guide 1.4. Modified by the experiences from TMI-2 the final version is:

LOCA:	100% noble gases 2.5% iodine	to the containment atmosphere
	50% iodine 50% Cs 1% other nuclides	to the containment water
Intact primary system:	100% noble gases 50% iodine 50% Cs 1% other nuclides	to the reactor coolant

It was assumed that the entire release from the core takes place instantaneously and that the activity will be homogeneously distributed in the water and gas phases.

The next step in the basic investigations was to determine the systems, or parts of systems, which may become contaminated after an accident.

In selecting these systems, the intention was to cover as many operational cases as possible. In reality, the systems which will be utilized naturally depends on the circumstances surrounding the accident.

The following systems, or parts of systems, may circulate radioactive medium in the reactor/auxiliary building:

PWR: Residual Heat Removal, Containment Spray, Safety Injection, Chemical and Volume Control, Sampling, Containment Hydrogen Control, Vents and Drain, Waste Processing, Gaseous Waste Processing.

BWR: Residual Heat Removal, Containment Spray, Emergency Core Cooling, Sampling, Containment Hydrogen Control, Leakage Collection, Reactor Building Ventilation.

A review was then carried out, system by system, in order to establish in which rooms the systems are installed.

The next step was to determine to which rooms, and also at which point in time, access is required after an accident has occured. Apart from the rooms in which measures closely connected with the accident shall be taken, the access requirements are largely based on normal operational routines and thus confined to inspection rounds, some checks and minor system changes. In this phase no account was taken of any repairs or other non-routine measures.

The dose rates, for different times in the interval between one hour to one year after the accident, were then calculated for interesting areas, using computer programs based on the point-kernel method. The radiation levels in the reactor/auxiliary building were also illustrated by coloured lay-outs.

In general it was found that access is possible to most areas within a few days of the accident including the main control room for both BWRs and PWRs, where the radiation level will be less than 0.01 mSv/h (1 mrem/h) one hour after the accident due to direct radiation from the contaminated systems.

The main exceptions for both BWRs and PWRs are the rooms where the Residual Heat Removal (RH), the Containment Spray (SP) and the Safety Injection (SI) systems are installed. E.g. for PWRs the dose-rates in the RH- and SP-pumps rooms exceed 10 Sv/h (1000 rem/h) during the first week of the accident. Also the rooms where the charging pumps are located will be inaccessible during the following year, with a radiation level of 6 Sv/h (600 rem/h) an hour after the accident. The accessability to areas adjacent to the rooms discussed above is naturally also affected by the high radiation levels.

Another weak spot is the Sampling System since we, with the scenario described above, wouldn't be able to extract any representative samples of neither water nor gas from the containment, with the equipment presently installed.

Special studies in the LOCA case have also been made regarding containment penetrations, since the dose rate directly outside the penetrations can be considerably higher then the general radiation level.

SUBSEQUENT WORK

The findings of the basic investigations are now being used in the second step, which consists of an action plan either to improve the possibility of, or to eliminate the need for, access in a post accident situation.

Among the measures to be considered are shielding of certain strategic pipes, doors and penetrations, which would reduce the general radiation level in many areas.

Another measure discussed is to improve supervision of rooms with high doserates containing vital equipment, e.g. pumps, by means of television, lead glass or maybe relocation of interesting instrumentation to a more easily accessible area.

The use of robots in carrying different instruments to collect information from especially radioactive areas will also be taken into consideration.

The sampling systems are presently being redesigned at all units, in order to get a functioning system in a situation when severe core damage has occured. New sampling points, new laboratories and better analysing equipment are to be installed.

As a result of the findings in the basic investigations some changes in the manuals for post accident operation may be implemented, like bypassing of filters, different operation of certain pumps, etc.

In this second phase also maintenance and repair aspects are included to a certain degree. For instance some kind of "minimum required maintenance" of vital equipment is being considered. When discussing repairs, a vital step is to decontaminate the system or component in question. An important aspect in this work is therefore to investigate the possibilities of flushing the systems.

The measures exemplified above are to be thoroughly investigated. When discussing improvements concerning post accident situations one has to bear in mind that also normal operation in some parts will benefit.

As a continuation of the work concerning how an accident with severe core damage affects the accessability, the next step will be to study the effect these high radiation levels will have on existing materials in the contaminated systems, e.g. organics, lubricants and hydraulic fluids, in the long term perspective. This work has already been commenced on a small scale basis.

The aim of this work is to implement improvements concerning accessability during an accident, as well as to raise the general awareness of post accident situations among different categories of plant personnel. The subsequent work described in this paper is going to be continued within the next few years, in close connection with work on accident management presently in progress.