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Case 1: Fire by Sodium Coolant Leak at Prototype Fast Breeder Reactor, Monju

Author(s)

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Description

Case 1 of Teaching Case Studies of Accidents in Nuclear Energy Development in Japan describes a fire caused by a massive sodium coolant leak at the Monju fast breeder reactor.

Abstract

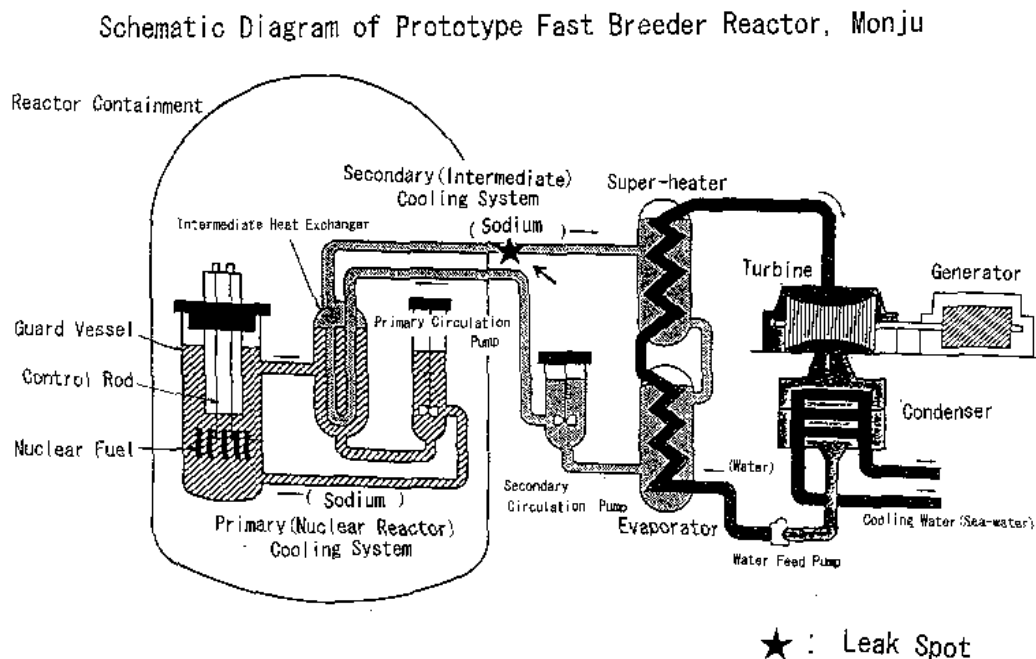
This case is an excerpt from [Three Teaching Case Studies of Accidents in Nuclear Energy Development in Japan](#).

Body

On December 8, 1995, a prototype fast breeder reactor, Monju, located in Tsuruga City, 350km west of Tokyo, was operating at 40% power. Refer to JNC's detailed technical explanation in English of Monju and the accident at <http://www.jnc.go.jp/zmonju/mjweb/index.htm>. The Power Reactor and Nuclear Fuel Development Corp (PNC), a government controlled organization, operated this reactor. At 19:47 high temperature liquid sodium coolant at one of the three secondary heat exchangers started leaking through a broken thermometer sheath (designed by IH Company, OD: 10mm, ID: 4mm, Length: 150mm) on the piping and it ignited on contact with air. As shown in Fig. 1, the primary heat exchangers are

designed to take heat out of the core of the reactor to the secondary heat exchangers, which then transfer the heat to steam generators for power. Because of this design, it was a simple fire caused by the leakage of chemically reactive but non-radioactive sodium coolant. But due to the delay in shutting down of the reactor, 640kg of the sodium leaked in 3 hours and caused some unexpected damage by the fire and chemical reactions to the surrounding structure.

Figure 1:



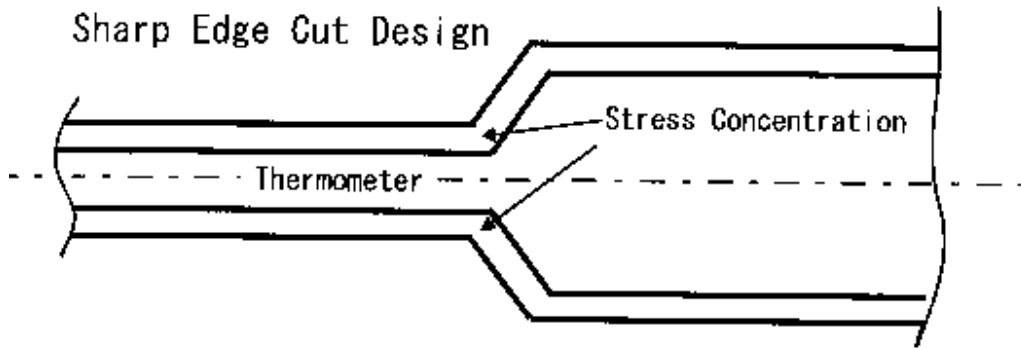
The sheath was found to have been broken by following design errors such as,

1. The sharp cut edge design of the sheath as shown in Fig. 2, which caused stress concentration and breakage,
 2. Neglect of newly established mechanical design analysis of vibration of the sheath parallel to the sodium flow and
 3. The IH company's failure to consider the fact that liquid sodium is 120 times more heat conductive than water and to use the another contractor's (the H company's) better and simpler design for those of the primary heat exchangers.
- See [Fig. 3](#).

Figure 2:

Design of Broken Thermometer Sheath (Cross Section)

Sharp Edge Cut Design



Tapered or Rounded Design

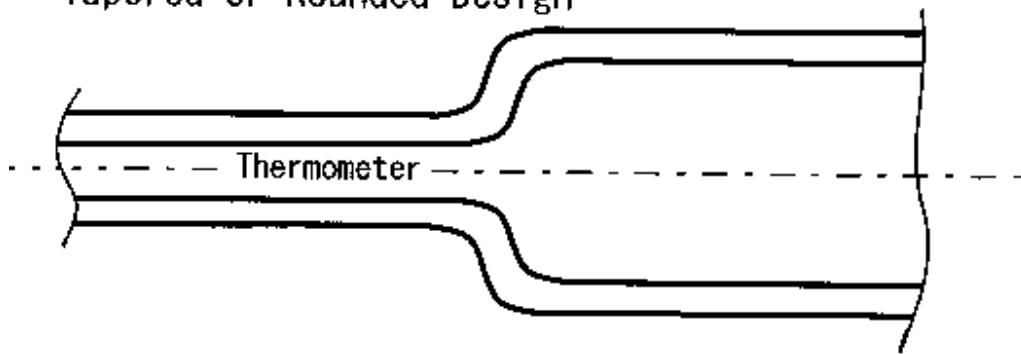
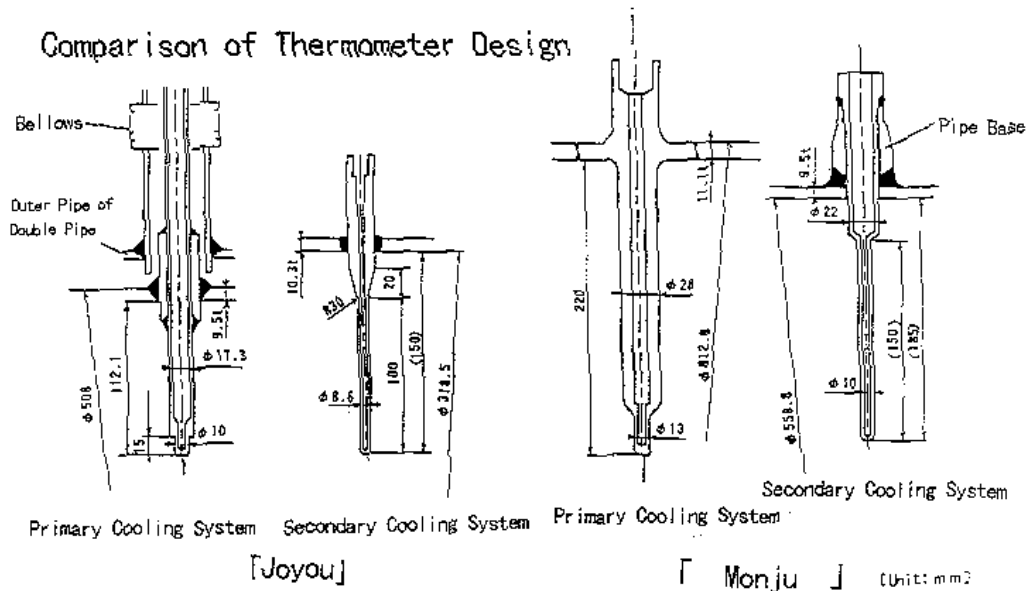


Figure 3:

Comparison of Thermometer Design



The PNC had been always asked by neighbors as well as anti-nuclear organizations whether their nuclear reactors are absolutely safe. They felt constrained to reply "yes" under the circumstances. Under these conditions, the initial cover up of hiding the videotapes taken at the site and of showing them after editing and the PNC's delay (of about one hour) in informing the neighboring community agencies of the accident ignited a fierce protest by the public.

This example teaches the students following lessons:

Influence of quality of engineering works

The small design errors in the cheap component which may come from lack of competence and care of designers in the IH Company and JNC as the user, caused the accident.

The cover up of the video tapes and delay in informing others of the accident

The cover up decision was made by managers including ex-engineers. When I asked our students in the class if they do the same under the situations, one-third of them said they might although they think it is a very stupid act. The delay of informing the accidents is mainly due to lack of the system oversight and to the bureaucracy within the JNC organization. These caused loss of public trust in general and have delayed the several tens of billion dollar project at least 6 years, although the government wants to resume the project as soon as possible.

Importance of professional work in accidents

The manuals to handle this kind of the accident were not made although they had some for other types of sodium coolant leakage. Manuals are necessary and useful especially in simple operation. But in accidents like this, which no one had expected and which are generally much more complex than those anticipated in manuals, professional judgments are much more important and necessary. In this case, the air conditioners, which had not been shut down, continued to supply fresh air to the fire.

Learning from past experience

The earlier experimental fast breeder reactor, Joyo, which was designed based on practical experiences by the engineers of previous generation, had not had any serious sodium leak accident for 18 years since its start of the operation in 1977. Most of these engineers, however, were retired or moved to other job as time passed. New generation of engineers might have thought it easy to handle. This is the problem of transferring and learning engineering experience and skills between generations.

Responsibility of managers (ex-engineers) to the public

Engineers know "nothing is absolutely safe". But sometimes political pressure forces managers to say yes to the public on the absolute safety question. But the more realistic question from the public is that the engineers make a maximum professional effort to eliminate the safety hazard. Engineers should have realized the responsibility of clarifying the situation. After a long discussion on the safety including the following two accidents, the Committee of the Nuclear Safety Commission in Japan formally declared in "The White Paper 2000 on Safety of Nuclear Energy (in Japanese)" approved on March 27, 2001 that "none can say nuclear energy is absolutely safe".

Notes

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