NO SIGNIFICANT FUEL FAILURES (NSFF)

by

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Presented to the Select Committee on Ontario Hydro Affairs

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The term "no significant fuel failures" is now a common expression in the vocabulary of people associated with the nuclear industry in Canada. This is in sharp contrast to the situation only four years ago when most people referred simply to "no fuel failures" in discussing the capabilities of emergency core cooling systems (ECCS). "No fuel failures" was commonly used even though it was recognized that, in the event of some loss-of-coolant accidents (LOCA), fuel would fail despite the actions of the ECCS. In the Douglas Point Safety Report, the authors identified that for a particular size of break in the pump suction header about 14% of the fuel in the core would be expected to fail and release about 30,000 curies of Iodine-131 into the containment. In the Pickering Safety Report it is identified that fuel would fail in the event of a complete failure of an end fitting and similarly fuel failure would be expected in a similar event at any reactor.

Early AECB reports (in the period 1965 to 1972) made it clear that ECCS should be designed with an objective of limiting or preventing fuel failures in the event of a LOCA. These AECB reports are replete with phrases such as

- "it(ECCS) is intended to prevent damage to the nuclear fuel"
- "should be designed to prevent fuel failure"
- "must be capable of limiting the fuel and sheath temperatures so that no more than a very small fraction of the fuel is likely to fail"
When Ontario Hydro applied in 1970 for a license to construct Bruce "A", the Safety Report submitted with the application did not make clear the design intent with respect to the ECCS effectiveness. In response to a requirement of the Construction Licence, the licensee presented in 1971 a report which described the design requirements for ECCS as follows:

"The emergency core cooling system is provided to ensure adequate cooling of the fuel following a major loss-of-coolant accident. As a basic design requirement, the term "adequate cooling" is taken to mean that there should be no fuel sheath failures as a result of inadequate cooling following a major loss-of-coolant accident with proper operation of the reactor shutdown systems".

Early in 1976 AECL/Ontario Hydro indicated to AECB staff that the Bruce "A" ECCS would not be able to prevent fuel failures in all instances. This was confirmed and amplified in a report which was presented in March, 1976. The contention of Ontario Hydro was that it was not possible to build an ECCS which could prevent all fuel failures. After hearing the viewpoints of AECL, Ontario Hydro, AECB staff and the Reactor Safety Advisory Committee the AECB took a position which can be briefly summarized as:

a) The objective for an ECCS should be to prevent fuel failures.

b) If the objective cannot be fully realized it is necessary to show that the consequences are acceptable for "dual failures" comprising any LOCA combined with an assumed impairment of containment.

Such a position is consistent with the requirements which the Board has set out for all other dual failures.

Ontario Hydro and AECL did not dispute the merits of this position but they did dispute the manner in which it should be implemented. Their position was that the only mode of containment impairment that needed to be considered was failure of active components of the containment. In effect, failure of the ventilation isolation dampers to close should be the only mode of containment impairment.
impairment to be considered in the event of a LOCA. Board staff maintained that for the purpose of safety analysis a LOCA should be considered in combination with any one of a wide variety of containment impairments. These included:

- Failure of ventilation dampers
- Deflated seals on an airlock
- Most critical airlock open
- Failure of dousing
- No vacuum in the vacuum building

In particular Ontario Hydro and AECL objected to c) and e) on the grounds that the design of the systems was such as to make the faults extremely unlikely and even if they should occur they would be immediately detected. The Board had some sympathy with this argument of very low probability. Specifically, the Board on the advice of the Reactor Safety Advisory Committee accepted the possibility that for the most critical size of LOCA at Bruce "A" with the most critical airlock open the calculated release of Iodine-131 could be two and one half times (2600 curies) the reference dose limit for dual failures. The designers estimated that the frequency of this dual failure would be $10^{-8}$ per year (once per 100 million years).

Out of the review of the Bruce "A" plant and in particular the deliberations of 1976 comes the definition of "no significant fuel failures". The no significant fuel failure criterion would be met if for any postulated LOCA combined with any one mode of containment impairment the resultant dose to a person or persons at the edge of the exclusion zone would be less than the reference dose limits for dual failures.

Clearly, the preferred condition is to have an ECCS which would be capable of preventing fuel failures in all instances. While this may not be possible the Board considered that there was scope to improve the effectiveness of the ECCS at Bruce G.S. Therefore, the Board requested Ontario Hydro to assign high priority to the design and installation of an improved ECCS at Bruce "A". To comply with this request Ontario Hydro and AECL undertook a large experimental program at the Whiteshell Nuclear Research Establishment. This program was necessary to provide the information required to design...
and assess the effectiveness of a high pressure ECCS. To date this work has proceeded to the point where AECL has been able to identify several possible design concepts for Bruce "A".