TOLEDO EDISON

RICHARD P. CROUSE
Vice President
Nuclear
(419) 259-5221

Docket No. 50-346
License No. NPF-3
Serial No. 766
December 31, 1981

Director of Nuclear Reactor Regulation
Attention: T. H. Novak
Operating Reactors Branch No. 4
Division of Operating Reactors
United States Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Novak:

Our letter of January 23, 1981 (Serial No. 677, copy attached) identified background information relating to the potential of an additional 100% capacity auxiliary feedwater (AFW) pump at the Davis-Besse Nuclear Power Station Unit 1 (DB-1). This additional capability was to consist of a non-steam driven pump to augment the existing two 100% capacity, safety grade, redundant trains of steam turbine driven auxiliary feedwater pumps.

In August, 1980, Toledo Edison completed a feasibility study to evaluate several design options for the above backfit with extremely conservative design criteria. The results of this study were prohibitively expensive and the hardware required excessively long lead times. In a meeting on March 5, 1981, your staff was advised of the above concerns and our intent to undertake a detailed probabilistic risk assessment study on the DB-1 Auxiliary Feedwater System (AFWS). The primary objective of this study was to perform a cost-effective risk reduction comparison to evaluate acceptable design alternatives and positions to address the NRC staff's concerns.

We have since completed the above probabilistic risk assessment study which is provided as Attachment 1 to this letter. This study, performed by EDS Nuclear, Inc., evaluates the following four AFWS configurations for DB-1.

Case 1 - "Pre-TMI" Configuration. This is the AFWS configuration that existed in March, 1979.

Case 2 - "Post-TMI" Configuration. This is the AFWS configuration that contains TMI-related plant changes, including those planned to be implemented in the 1982 refueling outage.

This configuration includes a written procedure for providing core cooling using the main feedwater start-up pump, reactor coolant system make-up pump and the pilot operated relief valve (start-up pump with feed and bleed) in the event of a loss of AFW following a loss of main feedwater.

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Case 3 - "Third Train" Configuration. A potential configuration, which utilizes a larger impeller and higher horsepower motor on the existing main feedwater start-up pump, in an altered discharge mode to provide a back-up third train of auxiliary feedwater. See figure 3-7 of the attached report.

Case 4 - "Analysis Based" Configuration. A potential configuration which incorporates modifications addressing several dominant failure contributors identified by the subject study. This configuration also includes an upgraded written procedure for using start-up pump with feed and bleed in the event of a loss of offsite power. In this configuration the existing start-up pump discharge path remains unaltered.

The attached report provides AFWS unavailability for various initiating events for the above four configurations. The annual frequencies with which the initiating events occur have been estimated using industry average data and DB-1 specific operating experience. The frequency of the initiating event is then multiplied by the AFWS unavailability to yield the annual frequency with which the AFWS will be unavailable when called upon to perform its intended safety function. This overall figure-of-merit is used for comparison to judge the relative cost-effectiveness (on a risk reduction basis) among the four listed AFWS configurations. It is emphasized that this report calculates relative unavailabilities of each of these configurations to logically determine the most cost effective alternative. The end result of the fault tree and the figure-of-merit analyses are therefore used on a relative basis only.

The key conclusions of the probabilistic risk assessment study are summarized below:

- The "Pre-TMI" configuration is dominated by potential human errors, primarily in valve misalignment.

- The "Post-TMI" configuration incorporates many changes to plant procedures and other design changes which diminish the likelihood of human errors. This configuration is dominated by mechanical failures, primarily associated with motor operated valves.

- The "third train" configuration results in a reliability improvement of over an order of magnitude for initiating events other than a seismic event.

- The "analysis based" configuration provides a significant improvement in AFWS availability over the Post-TMI configuration by incorporating procedural and design modifications. These modifications address those specific factors that contribute significantly to the AFWS unavailability, primarily the failure of motor operated valves to open. Additional procedural and design modifications to improve the system reliability during a loss of offsite power event have also been included in this configuration. Several of the modifications in this configuration have been evaluated for safety implications and are already in the design process. Others will be initiated following NRC concurrence of this approach.

The attached study illustrates that significant improvements in the Davis-Besse AFWS reliability have been achieved since the original discussions about a third train. Further improvements and the associated costs of such improvements now need to be compared with the relative benefits gained. As indicated above, both the "third train" and the "analysis based" configurations offer reliability improvements over the Post-TMI configuration. An engineering evaluation of cost-benefit associated with both of these configurations is provided below.

The "Third Train" Configuration:

The "third train" configuration consists of the start-up feed pump with a larger impeller and higher horsepower electric motor in order to provide greater flow to the steam generator. In conjunction with the above, additional piping is provided so the main feedwater start-up pump discharge is fed into the higher-elevation auxiliary feedwater nozzles of the steam generator. This configuration with associated valves is illustrated in figure 3-7 of the attached report. In this configuration, the (upgraded) start-up feedwater pump is manually started at ten minutes after the loss of main and auxiliary feedwater and feeds the auxiliary feedwater nozzles of the steam generator selected by the operator. This configuration results in an overall figure-of-merit of 2.2×10^{-4} i.e. a factor of 15 improvement over the "Post-TMI" configuration. The estimated cost to design and implement the changes associated with this configuration is $1,200,000.00. This cost excludes the replacement power cost incurred because of the required unit downtime to complete this change.

"Analysis Based" Configuration

As indicated above, the "analysis based" configuration incorporates several modifications into the "Post-TMI" configuration. These modifications are primarily aimed at the significant contributors to AFWS unavail-

ability in the "Post-TMI" configuration. It was mentioned above that the "Post-TMI" configuration is dominated by mechanical failures, mainly associated with motor operated valves. The following is an approach to minimize the number of motor operated valves in AFWS which have to operate on demand:

(1) Toledo Edison has investigated the mode in which the auxiliary feed pump turbine (AFPT) speed switch interlock is omitted from the speed controlled valves AF360 and AF388. In this mode, these valves will be left normally open with their handwheels and local pushbutton stations locked in the open position. The deletion of the speed switch interlock requires a license amendment, the application for which has been previously submitted to the NRC (See Serial No. 731 dated July 10, 1981).

(2) To further diminish the contribution of motor operated valve failures, Toledo Edison has investigated the possibilities of keeping the AFW discharge valves (AF3870 and AF3872) normally open with their handwheels and local pushbutton stations locked in the open position. This would totally eliminate the required actuation of any motor operated valve in the AFW discharge piping in the event of a loss of main feedwater.

(3) In addition, Toledo Edison is pursuing a Steam and Feedwater Rupture Control System (auto-initiation system for AFWS) logic modification to accomplish simultaneous opening of all four AFPT steam inlet valves. (See figure 3-4 of the attached report) At the present time, valves and piping exist to provide steam to both AFPTs from each steam generator. On a Steam and Feedwater Rupture Control System (SFRCS) actuation due to steam generator low level, high steam generator-feedwater reverse differential pressure or loss of four reactor coolant pumps (e.g. loss of offsite power) only the steam inlet valves from steam generator 1 to AFPT-1 (MS106) and steam generator 2 to AFPT-2 (MS107) receive an auto-open signal. The crossover valves (MS106A and MS107A) which connect steam generator 1 to AFPT-2 and steam generator 2 to AFPT-1 are normally closed and receive a close signal. This modification will simultaneously open valves MS106, MS106A, MS107 and MS107A on actuation of SFRCS under the above actuation conditions. This will provide a redundant steam inlet path for each AFPT and will decrease the overall reliance of the AFWS on the successful actuation of the individual motor operated steam supply valves.

> It is emphasized that with modifications (1) and (2) above, the AFPT steam inlet valves (one per train) are the only valves that need to be actuated to accomplish auxiliary feedwater delivery to the steam generators under the above actuation conditions. The modification in (3) above, provides a redundant steam inlet path thereby further diminishing the AFWS reliance on successful actuation of motor operated valves. In summary, with all of the above modifications, no single failure (to operate) of a motor operated valve in the AFWS could lead to the unavailability of either AFWS train .

Additionally, Toledo Edison has planned several other modifications to the feed and bleed mode (using start-up pump, make-up pump and the pilot operated relief valve) beyond the current "Post-TMI" configuration. These modifications include locking open of the start-up feedwater pump discharge valve FW106 (see figure 3-9 of the attached report), providing a procedure for the feed and bleed operation in the event of a loss of offsite power and providing a capability of opening the start-up feedwater control valves (ICS-SP7A and ICS-SP7B) and make-up pump discharge valve MU33 from the control room in the event of a loss of offsite power (see figure 3-6 of the attached report). The start-up pump bypass valve FW102 is also locked closed.

The "analysis based" configuration will also include a revised AFW monthly surveillance test scheme which eliminates the current unavailability of a train during the surveillance test and also diminishes the probability of AFW flow diversion.

In conclusion, the "analysis based" configuration pinpointedly addresses the dominant contributors to AFWS unavailability and systematically enhances the overall AFWS reliability. The estimated cost to design and implement all of the above listed modifications is $300,000.00 with a corresponding improvement in the overall AFWS figure-of-merit from 3.3×10^{-3} to 1.4×10^{-4} i.e. a factor of 24 improvement over the "Post-TMI" configuration. The cost mentioned above excludes the replacement power cost incurred because of the required unit downtime to complete these modifications.

Beyond the activities to support the "analysis based" configuration, Toledo Edison is expending efforts in the following two areas. First, the overall reliability of the "analysis based" configuration could further be improved by addressing the failure of motor operated valves in the start-up pump with feed and bleed mode and in the AFWS itself. To support this effort, Toledo Edison has retained Torrey Pines Technology to review and

recommend improvements to the Limitorque valve operations by a reevaluation and determination of the torque switch and limit switch settings. We believe that this will add to further upgrade the reliability of the "analysis based" (particularly the start-up pump with feed and bleed) configuration and the overall AFWS reliability in general.

Secondly, in a parallel effort, Toledo Edison is investigating possible upgrades to the AFPT governor which will culminate in improved AFPT speed control and reduced number of performance failures of the auxiliary feed pump turbine.

The attached report and the foregoing discussion demonstrate that the "third train" and "analysis based" configuration offer significant improvements in AFWS reliability. To logically determine the most cost-effective alternative between these two configurations, a summary cost benefit comparison is juxtaposed in the table below.

Table

Configuration	Overall Figure-of-Merit*	Improvements Over Post-TMI-2 Configuration	Associated Cost (Estimated)
Third Train	2.2×10^{-4}	Factor of 15	$1,200,000
Analysis Based	1.4×10^{-4}	Factor of 24	$ 300,000

* The figure-of-merit is calculated as described on page 2.

From the above table, Toledo Edison proposes the "analysis based" configuration since it results in greater reliability improvement and does so at a lower cost. Pursuant to the above, Toledo Edison is actively pursuing several of the modifications described under the "analysis based" configuration. Others will be initiated following the NRC concurrence of this approach. No activities are planned to incorporate the "third train" configuration.

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We believe that this provides an adequate approach for optimizing the resolution of NRC concern in that the analysis based configuration minimizes monetary and operational perturbations and at the same time provides a superior level of plant protection to the public health and safety.

Yours very truly,

R P Crouse

RPC:SCJ

Attachment (5 copies included)

cc:
NRC DB-1 Resident Inspector

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