Florida Power
CORPORATION

September 27, 1988
3F0988-16

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555

Subject: Crystal River Unit 3
Docket No. 50-302
Operating License No. DPR-72
Resolution of High Energy Line Break Issues

Dear Sir:

Please find attached the results of Florida Power Corporation's (FPC) risk assessment associated with the High Energy Line Break review reported to the staff on September 7, 1988. The LER will be submitted by October 6, 1988 as required.

As part of the long term resolution of this issue FPC will seek NRC approval to utilize advances in the understanding of high energy line break phenomena reflected in more recent staff guidance. This will include relief granted in Generic Letter 87-11 (i.e. elimination of arbitrary intermediate pipe breaks) and elimination of jet impingement consideration from postulated cracks.

FPC will request conceptual concurrence as soon as the request can be effectively described. Formal approval will be sought following development and necessary internal reviews. This is likely to be late this year.

Sincerely,

Rolf C. Widell, Director
Nuclear Operations Site Support

RCW/KRW/wa

Attachments

xc: Regional Administrator, Region II

Senior Resident Inspector

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SUMMARY

Gilbert Associates, Incorporated (GAI) Report #1811, Effects of High Energy Piping Systems Breaks Outside the Reactor Building, contains the criteria for postulating High Energy Line Breaks (HELB's) outside containment at CR-3. This constitutes the original and current design and licensing basis for CR-3. Included in this report are specific protection requirements for safety-related systems that were existing at the time the report was written. Subsequent to the origination of this report, additional safety-related components were installed at CR-3 as part of plant upgrades. In addition, the safety classification of existing raceways was upgraded to safety-related for many originally non-safety-related systems. A number of these modifications/changes have occurred in areas subject to postulated HELB jet impingements without sufficient documentation on the effects of jet impact forces. It is likely that potential pipe whip, EQ and flooding consequences are not made worse by the addition of new potential targets.

This issue was identified as a follow up to a Quality Programs Surveillance Report issued in January 1983 which pertained to the routing of electrical conduit. This Quality Program concern was that "documents establishing acceptance criteria used in engineering design considerations relative to the effects of missiles and high energy line breaks could not be determined".

To better define postulated high energy line break locations, jet pressures, and the effects of HELB's on electrical raceways, Gilbert/Commonwealth (G/C) prepared a report intended to establish electrical raceway design criteria. This report, High Energy Line Break Criteria for Electrical Raceway Protection, (G/C Report #2560) was issued in March 1986. This report showed that numerous HELB's were postulated in areas that contain safety-related systems. FPC believed implementation of the criteria in this report, without further research, would result in numerous jet shields or protection devices being added to mitigate the effects of the postulated breaks. This approach would be potentially unnecessary and counter productive. Jet shields impede maintenance, in-service inspections, etc and thereby increase equipment out-of-service and radiation exposures to plant personnel.

Impell Corporation performed a third-party review of G/C Report #2560 with the purpose of evaluating the criteria and methodologies. This review was completed in November 1986. Impell noted several conservatisms in the HELB criteria for postulating pipe breaks (the GAI #1811 report) in comparison to more recent criteria. The Impell review of the G/C report #2560 lead to a specific study of main steam line associated with penetration #106 to assess alternatives for FPC to address the HELB issue(s). This study was completed in August 1988. FPC determined that the potential exists that safety-related equipment, installed since original construction, did not consider HELB criteria. At that time FPC's recently revised design basis issue resolution process was invoked, and a one-hour notification was made to the NRC in accordance with 10CFR50.72 on September 7, 1988.

FPC evaluated the issues related to the main steam line associated with penetration #106. The evaluation has been completed and concludes that plant safety and operability has not been affected. A

Additional parallel efforts have concentrated on the development of a plan which will (1) resolve this HELB concern for the remainder of the high energy lines in CR-3, (2) perform an evaluation of the safety significance of this issue, and (3) assess what interim corrective actions are required.

A detailed discussion of the plan to resolve this HELB concern for the remainder of CR-3 is included in Attachment B. The Safety Significance Evaluation is contained in Attachment C. Interim corrective actions are being taken to assure that HELB effects are considered in any plant modifications being implemented and/or designed at the present time. A more complete discussion of FPC's interim and long-term corrective actions will be provided as part of the LER submittal.

FPC considers that the results of the Safety Significance Evaluation supports continued operation of CR-3 while the evaluation and resolution of this issue is accomplished. However, if, during the subsequent evaluation, a situation is found which would violate a Technical Specification Limiting Condition for Operation, the appropriate ACTION statement would be entered and the appropriate action taken unless appropriate relief is sought and granted.

ATTACHMENT A

Component Safety Analysis for HELB Effects
The Main Steam Line Associated with Penetration #106

An Impell Corporation study, "Main Steam Line #106 HELB Evaluation (SP83-132)", was performed to assess the practical alternatives which are available to FPC to address the qualification of electrical equipment installed since original construction, for HELB, at CR-3. The Impell study, using Gilbert Commonwealth (G/C) Report #2560, "High Energy Line Break Criteria for Electrical Raceway Protection", dated March, 1986 determined that of the 12 breaks, one circumferential and one longitudinal in each of the 6 locations, 9 needed to be evaluated. (The other 3 breaks were eliminated from further consideration since one was already source shielded and the other two were each enveloped by another of the 9 breaks.) For each of these 9 breaks, plant walkdowns were performed and all targets, which had the potential for being adversely impacted by the discharging fluid, were identified. By applying the more recent NRC criteria (such as that presented in Generic Letter 87-11) the number of breaks which needed further consideration was reduced from 9 to 3. An evaluation of the targets impacted by these remaining 3 breaks was performed to assess safety significance. The evaluation required both trains of the redundant systems to remain operable in order to meet the no loss of redundancy criteria of Gilbert Associates, Inc. (GAI) Report 1811, "Effects of High Energy Piping System Breaks Outside the Reactor Building", dated July 1974. The results of this evaluation are summarized below:

1. Break MS-5 - Terminal end break on 24 inch main steam line at containment penetration #106.

   The targets affected by this break are:

   Component/Conduit # - Associated End Device

   MSE-78 - control station MS-6 (MOV MSV-55)
   MSV-412 - (conduit)
   MSV-412 - (valve)
   MSV-411 - (conduit)
   MSV-411 - (valve)
   MSE-32 - Sol MSV-412 - SV-2
   MSE-25 - terminal block #3 on MSV-411
   MSE-34 - terminal block #3 on MSV-412

   Analysis assuming failure of these components.

   All but one of the above listed targets is associated with one of the two main steam isolation valves, MSV-411 and MSV-412. These valves are energized-to-close solenoid operated valves. Upon loss of the electrical signal to the valves due to either conduit failure, terminal block failure, or solenoid valve failure, these valves would not close in the event of this HELB. However, this HELB occurs in the same steam line as these valves, and their failure to close would not impact the steam line break analysis in Chapter 14 of the FSAR. Since the break is postulated in the

steam line upstream of the isolation valves, the steam generator would boil off and fail to isolate. The other 2 MSIV's, MSV-413 and MSV-414, would isolate the good steam generator and the Emergency Feedwater System would remove decay heat through that steam generator in accordance with the analysis. The motor control station for MSV-55, could also fail. MSV-55 is a stop check valve in the 6 inch steam line going from the main steam line to the emergency feedwater pump turbine. The failure of the control station (MS-6) would prevent the function of this valve. The isolation function of MSV-55 is not required for HELB mitigation.

Conclusion

The failure analysis of these components show that the system relied upon for mitigation, i.e., the Emergency Feedwater System, will continue to operate (i.e. both trains remain operable) and EFIC will provide for isolation of and flow to the good steam generator. Therefore, the ability to remove decay heat via the OTSG's is not impaired.

2. Break AS-5. Circumferential break. Six inch steam line to the emergency feedwater pump turbine.

Targets affected by the break are:

Component/Conduit # - Associated End Device

MSE-11 - motor starter for MSV-55
MSE-12 - MOV MSV-55
MSE-74 - control station MS-6 (MOV MSV-55)
MSV-55 - stop check valve
MSE-78 - control station MS-6 (MSV-55)
MSS-45 - MS-107-PT
MSS-49 - MS-109-PT
MS-108-PT
MS-106-PT

Analysis

The first 5 items above are all associated with MSV-55. See analysis for break MS-5.

The other 4 items are associated with or are transmitters providing main steam pressure signals to the Emergency Feedwater Initiation and Control (EFIC) System. These signals are used to initiate the EFW System on a steam line break. There are 8 transmitters total, two per steam line.

The postulated failures of these 4 transmitters are as follows:

. Loss of power and signal - transmitter fails Low - EFIC actuates.
. Loss of sensor - transmitter fails Low - EFIC actuates.
. Hot short - transmitter fails High - EFIC will not actuate for these four transmitters. However, it will actuate due to transmitters MS-110, 111, 112, 113-PT (the other 4 transmitters).

Conclusion

The postulated failure of MSV-55 and the 4 transmitters will not prevent both trains of the Emergency Feedwater System from actuating and mitigating the HELB.

3. Break AS-5. Longitudinal breaks six inch steam line to Emergency Feeder to pump turbine.

Targets affected by the break are:

Component/Conduit # - Associated End Device

MSS-45 - MS-107-PT
MSS-49 - MS-109-PT
CDR-41 - CD-98-LT (spare)
MSS-46 - MS-112-PT
MSS-43 - MS-106-PT
MSS-41 - MS-110-PT
FWE-13 - control station FW6 (FWV-34)
MSS-47 - MS-108-PT

Analysis

CDR-41 has been made a spare. FWE-13, the control station FW6 for valve FWV-34 is of no consequence as FWV-34 is locked closed and the power is removed from the breaker. 6 EFIC transmitters are affected by this break (MS-106, 107, 108, 109, 110, 112-PT). Two failure modes are possible for these transmitters: hot short or fail open. A hot short on all 6 transmitters would prevent the 4 MSIV's from closing. (Should the transmitters fail open, the 4 MSIV's would close and EFIC's function would be accomplished.)

FPC examined the hot short failure, more closely, to determine the failure effects. The following logic is used in the EFIC cabinets.

Cabinet A Logic
(A + B) (C + D) = Start EFP-1, Closes MSIV 411, 412, 413, 414

Cabinet B Logic
(A + C) (B + D) = Start EFP-2, Closes MSIV 411, 412, 413, 414

Transmitters are associated with the EFIC cabinets as follows:

*MS-106-PT	A	
*MS-107-PT	B	
*MS-108-PT	C	Steam Gen. A Logic
*MS-109-PT	D	
*MS-110-PT	A	
*MS-112-PT	C	
MS-111-PT	B	Steam Gen. B Logic
MS-113-PT	D	

(*AS-5 Longitudinal HELB affected)

If the six transmitters failed in a hot short condition, then the following occurs:

1. Steam Gen. A logic does not actuate.
2. Steam Gen. B logic - cabinet A logic can actuate, cabinet B logic will not actuate.
3. Therefore, train A EFW will actuate but train B EFW will not actuate.

Therefore, these postulated failures could impact EFW System operability. FPC initiated action to evaluate the jet impingement forces on the conduits going to the six pressure transmitters referenced in this analysis. A field walkdown showed that two of the conduit targets (MSS-45 and MSS-49) going to the transmitters were protected from the jet stream by the rupture restraints on the six inch steam line going to the Emergency Feedwater Pump Turbine. The other four conduits (MSS-41, MSS-43, MSS-46, and MSS-47) that were originally identified as targets (going to the other four transmitters) were located on a conduit support that was partially in the jet stream, but the actual conduits themselves were not in the jet stream. The conduit support was analyzed, and it was determined that the jet impingement forces were not sufficient to compromise the conduit support integrity.

Conclusion

The six transmitter associated failures have been shown to be not credible and the other two postulated failures do not impact EFW system operability. (i.e. both trains would remain operable).

Summary

The jet impingement effects of these three breaks on targets installed since the original review was completed does not pose any undue safety risk. Sufficient equipment will remain functional to mitigate the HELB.

ATTACHMENT B

Action Plan

In order to resolve the HELB concern at CR-3, it is necessary to develop a systematic approach to review the high energy lines at CR-3. The Gilbert Associates Inc. (GAI) Report #1811, "Effects of High Energy Piping Breaks Outside the Reactor Building", dated July 1974, contains the HELB methodology and criteria that was used to evaluate safety-related equipment installed during original construction. The focus of this action plan is to identify all safety-related equipment that must function to mitigate the effects of HELB events and ensure that loss of redundancy does not occur during postulated HELB events.

This action plan has been divided into six phases of evaluation. A discussion of the objective and scope of each of these six phases is presented below.

Phase 1: HELB Jet Impingement Zone Maps

Objective: Develop revised HELB jet impingement zone maps using the criteria from Gilbert Commomwealth (G/C) Report #2560, "High Energy Line Break Criteria for Electrical Raceway Protection", dated March 1986, and elimination of Intermediate Arbitrary Breaks.

Scope: The G/C Report #2560 identified 59 break locations that must be evaluated using the existing HELB criteria for CR-3. This phase of the review will apply the new criteria contained in the NRC Generic Letter 87-11, "Relaxation In Arbitrary Intermediate Pipe Rupture Requirements", dated June 19, 1987, to determine the number of break locations that must be evaluated at CR-3. The jet impingement zone maps contained in G/C Report #2560 will be revised to reflect the break locations for terminal ends and stress related breaks.

This effort began on Friday, September 9, 1988, and a preliminary list of break locations were identified by G/C to FPC on Sunday, September 11, 1988. This preliminary review has reduced the number of breaks from 59 to 15 locations in the Intermediate Building that must be evaluated during our review. Jet impingement zone maps will be revised prior to conducting the field walkdowns discussed in Phase 4 of this plan. G/C documented the basis of their review and provided a report to FPC on September 16, 1988.

Phase 2: Systems Identification

Objective: Identify the primary and support systems that must function at CR-3 to mitigate the consequences of HELB events.

Scope: A review of previous safety analysis reports and documents will be made to identify and document those primary systems that must function to mitigate HELB events defined in GAI Report #1811. Included in this review will be a review of support systems that must also function in order for the primary safety systems to function.

Phase 2 was completed on Friday, September 23, 1988.

Phase 3: Identification of Potential HELB Targets

Objective: Review all Safety Related systems identified in Phase 2 to determine the list of potential targets (equipment) that must be reviewed for HELB effects.

Scope: To accomplish this review, each discipline section has been assigned to develop a plan and criteria for determining which components/equipment/structures would be potential targets for an HELB. The data gathered will be entered into an electronic data base to facilitate control of the work and sorting needs. This data base is compatible with configuration management requirements.

This review effort commenced on Monday, September 12, 1988 and is currently scheduled to be complete by September 30, 1988.

In parallel with this activity, FPC is also evaluating other alternatives available to resolve the HELB issue. Included in this effort is shielding of sources and adopting the current SRP 3.6.1 and 3.6.2. This parallel activity, which is scheduled to be completed by October 14, 1988, will provide additional detail regarding cost, schedule and resources needed to implement the alternatives considered. Based upon this information a decision will be made regarding which approach will be implemented to resolve the HELB issue at CR-3.

Phase 4: Field Walkdown of High Energy Lines at CR-3

Objective: Identify the targets (components, cable, piping, etc.) that are within the HELB jet map zones for postulated breaks in the high energy lines within the Intermediate and Auxiliary Buildings consistant with the adopted criteria and approach from Phase 3.

Scope: This phase of the review will utilize the break location information developed in Phase 1 and the list of potential targets (equipment) developed in Phase 3 to determine which specific equipment (i.e., cable,

components, piping) are affected by jet impingements in the high energy lines in the Intermediate and Auxiliary Building consistant with the adopted criteria and approach from Phase 3.

Field walkdowns will be accomplished using teams comprised of engineering personnel. The exact number of teams to be used and the schedule for starting and completing this phase cannot be determined until Phases 1, 2, and 3 are completed. In preparation for performing these walkdowns, an Engineering consultant team performed field surveys of the break locations on September 14-16, 1988. The intent of this effort was to assess equipment needs, personnel requirements, and to develop a preliminary plan to accomplish the final walkdowns described above. The results of the field survey was presented to FPC on September 20, 1988. A schedule and plan for completing the walkdowns will be developed by October 28, 1988.

Phase 5: Failure Analysis

Objective: Evaluate operability of systems needed to mitigate the effects of HELB events at CR-3.

Scope: Perform a failure analysis on the equipment identified in Phase 4 that is affected by jet impingement forces to determine if their failure would cause any of the systems needed to mitigate the HELB event to become inoperable. The schedule and resources needed to accomplish this task cannot be determined until Phase 4 is completed.

Phase 6: Target Survivability Analysis for HELB Events

Objective: Determine if identified targets actually fail due to jet impingement forces from HELB events.

Scope: Conduct an engineering evaluation to determine if the jet impingement forces are of sufficient magnitude to cause equipment and/or system failure. The schedule and resources to complete this effort will be dependant upon the number of targets identified in Phase 5.

ATTACHMENT C

Full Scope Evaluation of Safety Significance

FPC's evaluation, to-date, of the safety significance of the potential HELB problems at CR-3 concludes that a threat to the health and safety of the general public does not exist and continued operation of CR-3 is justified. The bases for this conclusion include the following:

1. System Redundancy

   CR-3 is analyzed and licensed to have the capability to be shut down using either the HPI System or the EFW System. No HPI System components are located in the Intermediate Building. Therefore, a HELB event in the Intermediate Building could not effect the HPI System, leaving it to safely shutdown the unit.

2. Conservative Design Criteria

   The HELB criteria described in the GAI Report #1811 is conservative relative to the current SRP requirements. The report contains lower break stress allowables than the SRPs and thus more stress-related breaks are postulated than necessary. The report considered the break postulation stresses to include more conservative seismic loads than does the SRP. Also, the report considers crack induced jet impingement effects which are not required by current standards. These factors show that CR-3 high energy line break effects are conservatively postulated.

3. Operator Training and Procedures

   Licensed operators are trained to mitigate accidents initiated by HELBs. Scenarios are routinely run during simulator training providing opportunities for operators to diagnose conditions caused by HELB and mitigate resulting transients. Emergency/Abnormal operating procedures address compensatory measures which can be taken in the event that certain equipment fails to actuate or does not perform its intended function. These procedures and training provide added assurance that the plant can be safely shutdown in the event of HELB.

4. Low Probability of a Seismic Event

CR-3 is located in an area which is considered to be seismically inactive. Studies performed before CR-3 began construction showed that the site has never exceeded a maximum ground motion of 0.025g even during the 1885 Charleston, SC earthquake. For design purposes, the maximum ground acceleration and response spectra were developed using 0.05g. Piping analysis considered these factors and established the Design Basis Earthquake (DBE) as 0.05g acting horizontally and 0.033g acting vertically and occurring simultaneously. The Maximum Hypothetical Earthquake (MHE) is 2 x DBE. The facts that the piping is designed for 4 times the expected ground motion (0.025g) combined with the historical perspective of earthquake activity discussed in FSAR Section 2.5.4, Seismology, leads FPC to conclude that the seismic load contribution to the potential for HELB's is overstated.

5. Integrity of Piping Systems

Increased attention given to the integrity of feedwater piping systems brought about by the Surry event and the actions required by Bulletin 87-01, Thinning of Pipe Walls in Nuclear Power Plants, reduces the probability of a HELB. FPC's program which is described in our letter dated September 3, 1987 began with the last refueling outage and is ongoing. As stated in our bulletin response, FPC's program provides additional assurance that adequate structural integrity remains in our high energy feedwater piping systems and CR-3 can continue to operate safely.

6. MS-106 Evaluation

FPC's detailed evaluation of one particular postulated break in the main steam line associated with penetration 106 has provided some assurance that other systems required to mitigate the effects of a HELB event will remain operable.