ATTACHMENT 1
SE No. 120012-008
Rev. 1

GPU NUCLEAR CORPORATION

SAFETY EVALUATION FOR THE USE OF WESTINGHOUSE ROLLED PLUGS IN THE TMI-1 ONCE THROUGH STEAM GENERATORS

1.0 PURPOSE, SCOPE AND BACKGROUND INFORMATION

1.1 Purpose

The purpose of this tube plugging is to remove from service certain TMI-1 Once Through Steam Generator (OTSG) tubes using rolled plugs developed by the Westinghouse Electric Corp. (W). The plugs are utilized in defective tubes to establish an adequately leak tight pressure boundary between the OTSG primary and secondary sides. In accordance with the TMI-1 tube plugging criteria (Ref. 5.1 and 5.6) Westinghouse plugs will be used in tubes identified to be plugged only, (i. e. not requiring plugs with stabilizers).

1.2 Scope

The scope of this safety evaluation includes evaluation of the design basis of the W rolled plug, evaluation of the rolled plug qualification program and evaluation of the qualification program results to insure that the plug has adequate integrity under transient and accident conditions that have been postulated to occur during plant operation. The adequacy of plug design and qualification tests has been assessed based on the plant design conditions and the OTSG functional requirements.

This safety evaluation also addresses the adequacy of the test, repair, and replacement program that was initiated following the identification in July, 1984 of seven plugs which had been installed in the TMI-1 OTSG tubes and had dislodged.

1.3 Background Information

Intergranular stress assisted cracking caused primary side damage to the TMI-1 steam generator tubes in 1981. Eddy current tests (ECT) indicated that most of the defects were located within the upper tubesheet and could be isolated and satisfactorily repaired by the kinetic expansion process. Other tubes with defects which would not be satisfactorily repaired by kinetic expansion and did not require stabilization were plugged with a rolled plug developed in 1982 by the Westinghouse Electric Corp. for use in the TMI-1 OTSG's. Approximately 1013 rolled plugs were installed as of May, 1984.

In July, 1984, following plant hot functional testing, seven rolled plugs were identified as missing from their installed positions. Four of the plugs were from the bottom tubesheet of OTSG "A", two were from the bottom tubesheet of OTSG "B", and one was from the upper tubesheet of OTSG "A". Only the plug from the upper tubesheet of OTSG "A" was recovered. The remaining six plugs are believed to be in the bottom of the reactor vessel.

A comprehensive field and laboratory test program was conducted to test the integrity of the installed plugs, to determine the cause of the dislodged plugs, and to develop a repair program to re-establish the design integrity of the installed plugs.

2.0 SYSTEMS AFFECTED

The boundary between the primary and secondary systems, within the OTSG, is affected by this repair. The boundary starts at the upper tube to tube sheet joint, continues down the tube itself, and ends at the lower tube to tubesheet joint as shown on Babcock and Wilcox drawing 131102 (Ref. 5.2).

3.0 EFFECTS ON SAFETY

3.1 Documents Defining Safety Functions

3.1.1 TMI-1, Final Safety Analysis Report, Section 4.3. (Ref. 5.8)

3.1.2 TMI-1 Technical Specifications 2.2, 3.1.6.3, 4.19, (Ref. 5.8)

3.1.3 NRC Regulatory Guide 1.121, "Bases for Plugging Degraded PWR Steam Generator Tubes".

3.2 Description of Safety Function

The safety function of the system affected, the primary to secondary pressure boundary within the OTSG, is to provide a barrier to the transport of fission products and activated corrosion products to the steam system and limit allowable primary to secondary leakage through the OTSG tubes to 1 gpm total for both steam generators. (Ref. 5.8)

3.3 Effect of Proposed Modification on the System Safety Function

3.3.1 Westinghouse Plug Qualification Program

3.3.1.1 Plug Performance Criteria

The Westinghouse rolled plug was designed and qualified to establish an adequately leak tight and pressure retaining boundary between the OTSG primary and secondary sides under plant operating and accident conditions.

The plug qualification program employed laboratory testing to determine key plug design and installation parameters and to demonstrate plug performance in accordance with the established performance criteria. These performance criteria and their bases are summarized as follows:

a) Demonstrated primary to secondary leak tightness under plant operating conditions shall be less than 1.6 drops per minute per installed plug.

This value was derived by setting the combined allowable leakage from all installed rolled plugs at 0.1 gallons per minute and is based upon an empirically derived equivalence between drops per minute and gallons per minute. It was assumed that up to 4,400 rolled plugs could be installed. Approximately 1015 rolled plugs were actually installed.

b) The hydraulic pressure necessary to cause ejection of the installed plug from its tube shall be 3 times the maximum secondary to primary pressure and 1.5 times the maximum primary to secondary pressure.

c) The plug shall be designed to sustain a maximum secondary to primary pressure of 1050 psi at 650°F and a maximum primary to secondary pressure of 2500 psi at 650°F, based on plant design and postulated LOCA loads.

d) The plug shall be designed so that the force required to extract an installed plug from its tube using mechanical removal tooling is greater than 3000 lb.

This mechanical pull test provides an additional method of demonstrating plug retention capability. A mechanical pull force of 3000 lb. was established as conservatively enveloping the plug ejection pressure criteria.

e) The plug shall be removable to allow the return of the tube to service after some future unspecified repair. The plug and associated removal tooling shall be designed so that the tube to tubesheet weld is not excessively loaded during plug removal to preserve leak tightness.

f) The plug shall be designed so that it takes advantage of the plug design and qualification program work done for earlier successful plant applications of rolled plugs by Westinghouse.

3.3.1.2 Qualification Program Test Objectives

A detailed description of the qualification test program can be found in the Ref. 5.3. The following test objectives were established to determine conformance to the stated design criteria:

a. Determine the optimum torque for roll expanding the plugs into the TMI-1 steam generator tubes.

b. Determine the hydraulic pressure needed to move or eject the rolled plugs.

c. Determine the mechanical pull force needed to extract an installed rolled plug from the tube and determine if plug removal adversely affects the tube to tube sheet seal weld and tube surface condition.

d. Determine whether the installation of the rolled plugs will produce significant strain in the tube sheet ligaments and whether adverse interactions occur with adjacent tubes, both plugged and not plugged.

e. Determine whether the rolled plug will continue to seal adequately for the design life of the plug when subjected to the design thermal and pressure cycling for the plant.

f. Determine the sealing effectiveness of a rolled plug installed in a tube with a circumferential defect when subjected to thermal cycling under normal operating pressure.

g. Determine if the integrity of the plugs can be maintained under Loss of Coolant Accident (LOCA) conditions.

3.3.1.3 <u>Qualification Program Results</u>

The following results were obtained from the qualification program (Ref. 5.3):

a. A plug installation roll torque of 90 $\pm$ 5 in-lb produces plug wall thinning in the range of 4 to 12 percent. This applied torque and range of wall thinning was shown by the testing to result in the plug meeting the design criteria.

b. Plugs installed with nominal roll torques of 90 in-lb meet the allowable leakage requirements when installed in previously unplugged tubes and when installed in tubes from which a rolled plug had been previously extracted. Comparing the specified leak rate at operating conditions of 1.6 drops/minute/plug (equivalent to 0.1 GPM gross leak rate assuming a total of 4400 plugs were installed) with those given in Ref. 5.3, it was concluded that the rolled plug meets the leakage limit criterion.

Hydrostatic testing of plugs at 3750 psi following thermal cycling showed no plug leakage. Likewise, testing of plugs by subjecting them to a 150 psi nitrogen pressure inside the tube indicated no plug leakage.

c. Laboratory tests demonstrated that the average hydraulic pressure needed to eject an installed rolled-plug from its tube is greater than three times the greatest secondary to primary pressure (1050 psi) and 1.5 times the greatest primary to secondary (2500 psi) pressure that was postulated to occur in the steam generator. This result satisfies the design criteria.

d. The average force to extract a plug rolled with an average torque of 90 in-lb. was greater than the 3000 lb. minimum design criterion.

e. The average force to extract a rolled plug was sufficiently low such that extraction will not excessively load the tube to tube-sheet weld when the plug is extracted using tooling developed for that purpose.

f. The rolled plug was shown to remain in place and maintain its seal capability under a simulated LOCA event.

g. Measurements taken before and after tube installation in the test blocks and before and after plug rolling in the test blocks indicate no significant effect from the plug rolling on tubes adjacent to those being plugged.

3.3.2 Kinetic Tube Expansion Impact on Installed Rolled Plugs

3.3.2.1 Kinetic Expansion Impact Test Objective

Testing was done to determine the impact of the kinetic (explosive) tube expansion process on the installed plugs. This testing was performed by the Westinghouse Electric Corp. in conjunction with Foster-Wheeler, Inc. and the Babcock & Wilcox Co. The results of the testing can be found in Ref. 5.4.

The objectives of the test were to determine whether the plug leak tightness and pull-out load established previously would be preserved after exposure to the effects of the kinetic expansion process in adjacent tubes and to determine the effect of kinetic expansion on the diameter of the tube being expanded. Additionally, the ability to install a replacement plug after removal of the initial plug was to be demonstrated.

3.3.2.2 Test Description

Two 12 hole test blocks which simulate the TMI-1 tube to tube sheet configuration were used for the testing. Typical TMI-1 OTSG tubes were rolled and welded to the test block as in the original OTSG design. Four (4) tubes in each block were then plugged following previously developed procedures for use of the final plug design. Plugged tubes were chosen so that at least one plug was totally surrounded by the tubes to be kinetically expanded. These plugs were hydrostatically tested to a pressure of 3750 PSIG.

The eight (8) remaining tubes were then kinetically expanded in the same manner as the tubes in the OTSG's.

3.3.2.3 Test Results

After the expansion, the specimens were tested and the following observations were recorded:

a. Hydrostatic Leak Test

A very minute change in the average leak rate was observed during the tube pressurization to a pressure of 3750 PSIG:

Pre-kinetic expansion Leak Rate (Drop/min)	Post-kinetic expansion Leak Rate (Drop/min)
0	Less than .1

b. Plug Mechanical Pull Out Test

No significant change in mechanical pulling load was seen when results of this test were compared to the results reported in Ref. 5.3.

	Results From Ref. 5.3	Results From This Test (8 Plugs)
Removal Load (range)	4470 to 5160 lb.	3750 to 5220 lb.
Removal Load (avg.)	4645 lb.	4842 lb.

c. Plug O.D. and Tube I.D. Surface Conditions After Plug Removal

It was observed that the galling that occurred on the plug outer surface and tube inner surface after plug removal during this program was similar to the type of galling seen during the original plug qualification work done in April, 1982. This degree of galling was demonstrated to be acceptable for replugging (Ref. 5.3).

d. Tube I.D. Measurement

The average difference between pre-and-post kinetic expansion measurement of all unplugged tubes was 0.00034". This small increase was well within the variation used in the plug qualification program and thus demonstrated that rolled plugs could be later installed in such tubes if required.

3.3.3 Rolled Plug Retention Capability For Postulated Water Filled Tubes

An evaluation was performed (Ref. 5.5) to assess the effects of pressure buildup inside a plugged OTSG tube postulated to be completely filled with water and subjected to a temperature increase similar to that occurring during plant heatup to full power operating conditions. This condition was hypothesized to be caused by water which leaks into and fills the tube and is subsequently unable to leak from the tube. The analysis conservatively assumed no leakage path out of the tube as temperature was increased to normal operating temperature. The resulting specific volume increase of the water was then postulated to be accommodated by thermal expansion and mechanical strain of the tube.

It was determined that the pressure within a plugged tube could reach 9600 psi under the assumptions of the analysis. Accounting for a nominal primary side pressure of 2100 psi working opposite to this expansion pressure during plant normal operation, the resulting net effective ejection pressure of 7500 psi is below the average ejection pressure of 9200 psi determined during the hydrostatic plug ejection tests as reported in reference 5.3. That testing also demonstrated that the plug typically leaks prior to ejection. This leakage would tend to relieve the internal pressure increase and result in lower peak pressure than determined in the analysis.

3.3.4 Material Compatibility

The Westinghouse roll plugs are machined from Inconel 600 bar stock that had received a thermal heat treatment. This heat treatment has been demonstrated by laboratory testing to have improved resistance to intergranular attack in caustic and polytheoric acid environments. The plug material is similar to the tube material and contains no unacceptable contaminants. Thus, the plug material is considered compatible with other materials in the OTSG and suitable for use in the TMI-1 OTSG environments.

3.3.5 Dislodged Plug Investigation and Repair Program

3.3.5.1 In Generator Plug Testing

Following identification of the dislodged plugs in July, 1984, a field test program was initiated to assess the condition of the installed plugs. This program included a laboratory qualification of the test parameters and development of required test tooling.

3.3.5.2 Qualification Program for Plug Testing

The following criteria were established for the test qualification program:

a) Testing shall assess the installed condition of the plugs with respect to their integrity under postulated LOCA conditions. Loading on the plug under these conditions is equivalent to a secondary to primary pressure difference of 1050 psi.

b) Testing shall not adversely affect the condition of existing, properly installed plugs.

Axial mechanical pulling was tentatively selected as the test method. To qualify the test method, tube and tubesheet test blocks were prepared with plugs installed with varying roll torque values to simulate installed plugs with varying degrees of leak tightness. The test blocks were alternately mechanically pull tested and hydrostatically leak tested. From the test data a relationship between mechanical pull force and hydrostatic pressure at the point of plug large leakage increase or plug movement was established. The testing also addressed the effect of the selected pull force on the integrity of a properly installed, non-leaking plug, by performing hydrostatic leak testing before and after plug pull testing.

The following results were obtained from the testing:

a) A test load of 800 lb. was selected, being determined to be equivalent to 1050 psi pressure differential acting on the plug.

b) The selected test load of 800 lb. did not adversely affect the integrity of a properly installed, non-leaking plug.

3.3.5.3 Pull Test Tooling

Test tooling developed by Westinghouse consisted essentially of a plug gun (hydraulic cylinder) with integral force and displacement sensors. The hydraulic cylinder is attached to the plug via a threaded mandrel. Pull force and displacement are indicated on a control console outside the steam generator head. The plug gun reacts off the steam generator tube sheet.

It was observed during tool development testing that plug movement up to six mils could be indicated by the instrumentation when the plug displacement was actually zero based on direct measurement. This was found to be due to the high sensitivity of the displacement measuring instrumentation and variations in the positioning of the tool and contact between tool and tubesheet. An allowance of six mils was, therefore, made for tool movement during pressurization of the hydraulic cylinder. This effect was further investigated and confirmed in the field by additional testing.

3.3.5.4 Field Pull Testing

Based on the qualification program results the following field test acceptance criteria were established:

a) A pull load of 800 to 875 lbs. is maintained for 5 to 10 seconds with no indicated plug displacement during the hold period.

b) The total indicated displacement during plug loading is less than or equal to 0.006 inches.

All plugs remaining in the generator were pull tested. Test data yielded the following results:

a) 25 plugs were pulled completely out of the tube by the test load.

b) The vast majority of plugs were judged acceptable by the above defined criteria. A number of plugs were, however, judged unacceptable.

3.3.5.5 Investigation of Failures

Following completion of the field pull testing Westinghouse performed an investigation to determine the cause of the plug failures. This investigation included visual and metallographic inspection of the plugs removed during the pull test and the plug recovered from OTSG "A". Also, a series of tests were done to determine the effects of potential variations in installation parameters and procedures. These tests included:

a) Determination of the plug wall thinning achieved as a function of rolling torque and initial clearance between the plug O.D. and the tube I.D.

The objective of this test was to demonstrate whether or not the design rolling torque of 90 in-lb could be achieved without contact of the plug with the tube I.D. and the consequent development of interface pressure as required for proper plug installation. This was of interest since dimensional measurements of the dislodged plugs, measurement of the inside diameters of the parent tube ends, and visual examination of the dislodged plugs suggested that the plugs had not been properly rolled against the tubes.

b) Determination of the effect of using a roller for more than the specified limit for consecutive rolls without cooling the roller.

The objective of this test was to demonstrate whether or not using a roller more than five consecutive times without cooling the roller would adversely affect the rolling torque applied to the plug. Installation procedures called for roller cooling after five rolls.

c) Determination of the effect of low air supply pressure to the pneumatic motor in the roll gun on roll torque applied to the plug.

The objective of this test was to determine whether or not reduced air pressure might result in inadequate plug roll torque.

d) Determination of the effect on plug rolling torque of the universal joint employed between the roll gun and the plug roller.

The objective of this test was to determine whether or not the use of the universal joint would have a significant negative effect on the torque applied to the plug.

e) Determination of the effect of side loads on the roll gun during plug installation.

The objective of this test was to determine whether or not the application of any sidewise forces on the plug installation tooling by the operator might adversely affect the torque applied to the plug.

f) Determination of the effect of local reduced I.D. in the tube due to foreign material between the tube and tubesheet.

The objective of this test was to determine whether or not such localized diameter reduction might adversely affect plug performance characteristics.

The results of the tests were as follows:

a) A diametral plug expansion through an initial plug to tube clearance of 10 mils will produce a plug wall thinning of approximately 2% before significant contact is made between the plug O.D. and the tube I.D. 10 mils is a typical clearance for the actual steam generator conditions. A 90 in-lb torque is sufficient to expand a plug in excess of 50 mils with no radial external restraint on the plug.

The measured wall thinning values of the dislodged plugs were 1.1%, 1.4%, 1.8%, and 3.5%. These measurements along with the above test results strongly suggested that the dislodged plugs were not properly rolled to 90 in-lb roll torque.

b) It was found that increasing the number of consecutive uses of the roller did not affect torque applied to rolling a plug.

c) Use of varied supplied air pressure below the design value of 90 psig within the limits of operational and gauge variations resulted in no loss of applied torque or plug holding capability.

d) It was determined that universal joint angle can result in reduced net torque delivered to the plug.

e) It was determined that sidewise load can result in reduced net torque delivered to the plug.

f) Simulation of a local reduced I.D. in the tube did not affect plug holding capability.

The investigation concluded that the plugs that either became dislodged or pulled completely out during the pull test had not received wall thinning within the original design objective of 4%-12% and had not been adequately rolled during the original installation. From this, it was inferred that the other plugs which failed the pull test were also not adequately rolled during initial installation. This in turn was attributed to having not assessed, in the initial qualification program, the potential adverse effects of use of the universal joint and sidewise loading on the tooling. It was demonstrated in the laboratory that the conditions observed in the field could be caused by reduced rolling torque. These effects have been eliminated by improved tooling and augmented training as described in Para. 3.3.5.6.

3.3.5.6 Plug Repair Program

Re-rolling was tentatively selected as the repair method for plugs identified as unacceptable by the initial pull test. To provide additional assurance, it was also tentatively decided to re-roll those plugs that had passed the pull test. A process qualification program was then formulated and qualification testing performed. The objective of the qualification program was to establish that re-rolling of the installed plugs would:

a) Not adversely affect the integrity of existing satisfactory plugs.

b) Re-establish to the original qualification requirements the integrity of the plug/tube joints for those plugs which exhibited limited axial movements during the initial field pull test.

Testing was performed in mockups simulating steam generator conditions. Varying degrees of plug leak tightness were simulated. Some plugs were rolled so that they would move when subjected to an axial pull force to simulate those that failed the initial pull test. Other plugs were installed with the nominal roll torque to simulate proper installation. The effects of boric acid deposits between plug and tube were also included. All the plugs were subjected to leak testing and axial pulling prior to re-rolling. Following re-rolling the installed plugs were leak tested, mechanically pull tested, and some were hydrostatically tested for plug ejection. Some test specimens were thermal cycle and LOCA tested after re-roll and prior to final performance testing. Metallurgical examinations were performed on plugs rolled up to a total of six times.

The test program was successfully completed. Re-rolled plugs held hydrostatic pressure in excess of 7500 psig. No loss of metallurgical integrity was observed as a result of re-rolling.

Improved tooling was developed and tested during the qualification program. The improved tooling incorporates a fixed angle drive and eliminates the previously used universal joint to ensure a constant torque output. The tool is designed to be calibrated with the angle drive included. All process qualification testing was performed with the fixed angle drive tooling.

The field procedures for plug re-rolling include increased quality assurance surveillance of critical process parameters such as roll gun calibration and roller material condition inspections. To avoid the pressure drop in the plant air system, a dedicated air supply was used to provide more constant supply pressure to the roll gun. The training program for channel head workers was augmented to increase awareness of important process parameters.

A special drilling tool was developed by Westinghouse to remove plugs whose condition was unsuitable for repair by re-rolling; e.g., plugs exhibiting excessive protrusion from the tube end after the pull test. This tool includes provisions to collect machining chips and is designed to not cut the tube end I.D. surface during plug drilling. Successful tool operation was demonstrated by laboratory testing by Westinghouse. The tool was selected in lieu of the originally designed hydraulic puller to eliminate axial mechanical load on the tube end and tube seal weld and to reduce worker radiation exposure.

The rolled plug is employed for tube locations requiring installation of plugs to replace those that were dislodged or removed as a result of pull testing. The field installation procedure was revised to provide a re-roll using the tooling qualified for the re-roll repair, after an initial roll using the originally qualified roll gun. Requirements for obtaining tube and plug dimensions before and after plug installation were added to allow confirmation of adequate plug wall thinning and a repeat pull test was added to provide additional assurance of proper installation.

In addition to the plugs identified as unacceptable by the initial pull test, it was decided based on the test results to also re-roll the balance of the installed plugs to increase assurance of their installed integrity.

To supplement the assurance provided by the re-roll process qualification testing, it was decided to repeat the pull test, after re-rolling of plugs judged unacceptable by the initial pull test. The balance of plugs, which were acceptable by the initial pull test, would not be pull tested after re-rolling.

3.3.6 Effects of Dislodged Plugs Within the Reactor Coolant System

Although the balance of this safety evaluation supports the conclusion that it is unlikely that additional plugs will be ejected after return to service, consideration has been given to the effects of a single isolated plug failure by ejection.

A dislodged plug presents two concerns:

a) Potential breach of primary to secondary pressure boundary.

b) Potential loose parts effects in the Reactor Coolant System.

3.3.6.1 The unlikely event of an ejection of a single plug and the maximum potential resulting flow path to the OTSG secondary side has been considered. The radiological consequences of this event are bounded by the analysis performed in FSAR Para. 14.1.2.10. This analysis evaluated the consequences of a double ended rupture of one OTSG tube which is in service (not plugged) during plant operation.

This analysis indicated the following total dose at the Exclusion Distance:

Thyroid:	2.13×10^{-3} Rem as compared to a maximum limit of 300 Rem/2 hrs. per 10CFR100 (Ref. 5.9).
Whole Body:	0.155 Rem as compared to a maximum limit of 25 Rem/2 hrs. per 10CFR100.

Thus, no unanalyzed event has been introduced by considering a single failure.

3.3.6.2 The potential effects and consequences of loose plugs within the reactor coolant system has been evaluated in reference 5.7. That evaluation concluded that the six loose plugs remaining in the reactor coolant system pose a very small operational risk and raise no new safety concerns. That evaluation also indicates that these conclusions would not change for loose plug populations an order of magnitude larger than six. Thus, an additional loose plug is likewise considered to raise no new safety concerns.

4.0 CONCLUSIONS

The purpose of the activity is to plug defective OTSG tubes as required by the established plugging criteria (Ref. 5.1 and 5.6). As a result of this safety evaluation it is concluded that the adequacy of the original plug qualification program as well as the more recent investigation and repair programs required by the identification of seven dislodged plugs has been demonstrated. It is further concluded that those plugs remaining in the generators following completion of the repair program and those plugs installed to replace dislodged and pulled out plugs will meet their design objectives and primary pressure boundry integrity will be maintained. The following specific conclusions have been drawn:

a) The proposed activity will not increase the probability of occurrence or the consequences of an accident.

The original Westinghouse plug qualification program demonstrated acceptable primary to secondary leak rates and plug retention capability under normal as well as postulated accident conditions. Loss of coolant accident conditions were simulated by the hydrostatic plug ejection tests and demonstrated that a plug is unlikely to be ejected under LOCA conditions.

The more recent re-rolling of all installed plugs, using a procedure proven by a specific qualification program to restore any improperly installed plugs to the original acceptable installed condition, ensures that the installed plugs will meet the original design criteria. Successful performance of a repeat pull test, after re-rolling, on those plugs that definitely exhibited movement in the initial pull test, provides additional assurance that these plugs are now properly installed to meet original design criteria. Repeat pull testing on plugs that passed the initial pull test is not required because the re-roll qualification testing demonstrates that re-rolling does not degrade properly installed plugs.

The potential for plug ejection from a tube which has become filled with water due to plug in-leakage and then heated during normal plant startup has been evaluated by analysis. The resulting hydrostatic ejection pressure on the plug was found to be less than the average ejection pressure demonstrated in the original qualification program and less than the minimum ejection pressure demonstrated in the re-roll qualification program. The testing also demonstrated that the plug typically leaks prior to ejection. This leakage would tend to relieve the internal pressure increase and result in a lower peak pressure than calculated in the analysis.

b) The activity will not increase the probability of occurrence or consequences of a malfunction of equipment "Important to Safety".

By virtue of the analysis, testing and qualification programs it has been demonstrated <as noted in item a) above> that the plugs are able to meet their specified design requirements and thereby maintain primary pressure boundry integrity.

c) The activity does not create the possibility for an accident or malfunction not previously identified in the SAR.

Primary pressure boundary integrity will be maintained by the plugs. The affects of loose plugs within the reactor coolant system has been found to not pose any significant risk and to not create any accident or malfunction not previously analyzed (see Ref. 5.7).

d) The activity does not decrease the margin of safety as defined in the basis of any technical specification.

The design maximum allowable primary to secondary leakage, if assumed to occur for all the installed plugs, is a small fraction of the Technical Specification limit on total leakage through the OTSG tubes during plant operation.

e) The activity will not violate any plant Technical Specification.

Rolled plugs are installed in tubes with defects, as determined by eddy current testing, of through-wall extent requiring plugging in accordance with the plant Technical Specifications. Maximum expected plug leakage is a fraction of the limit specified in the Technical Specification.

f) The activity will not violate any license requirements or regulations.

Plugging of tubes is an acknowledged and accepted means for maintaining OTSG integrity. Use of the plugs maintains the primary pressure boundary and limits leakage to below established limits.

g) The activity does not involve a radiological safety concern or a change to plant environmental interfaces.

The potential concern relates to primary to secondary leakage which has been demonstrated to be a fraction of the total leakage assumed in the basis for the plant Technical Specification. Consequently, the release of radioactivity will remain far below established regulatory limits.

5.0 REFERENCES

5.1 GPUN Technical Data Report TDR-421 "TMI-1 Steam Generator Adequacy of Tube Plugging and Stabilizing Repair Criteria."

5.2 Babcock and Wilcox Dwg. 131102, Rev. 12, "Longitudinal Section Through Steam Generator".

5.3 Westinghouse Document No. WCAP-10084 "Three Mile Island - Unit #1, Steam Generator Tube Rolled Plug Qualification Test Report", April, 1982.

5.4 Westinghouse Report dated November, 1982 by S. Sinha/H. T. Keller entitled "Three Mile Island - Unit #1, Explosive Tube Expansion Impact on Installed Rolled Plugs"

5.5 MPR Associates, Inc., Calculation dated December 7, 1982, "TMI-1 Rolled Plug Pressure Load Retention Capability."

5.6 GPUN Safety Evaluation SE-120012-009, Rev. 1, "Safety Evaluation for Tube Plugging and Stabilization".

5.7 GPUN Safety Evaluation SE-123094-002, Rev. 0 "Loose OTSG Westinghouse Rolled Plugs"

5.8 TMI-1 Final Safety Analysis Report (Updated Version)

5.9 Code of Federal Regulations, Title 10 Part 100 (10CFR100)

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