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4410-84-L-0009

January 30, 1984

TMI Program Office
Attn: Dr. B. J. Snyder
Program Director
US Nuclear Regulatory Commission
Washington, DC 20555

Dear Dr. Snyder:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Response to Comments on First Pass Stud Detensioning
Safety Evaluation Report

Attached for your review and approval is GPUNC's response to NRC comments on the First Pass Stud Detensioning Safety Evaluation Report (SER). The SER was previously submitted via GPUNC Letter 4410-83-L-0222 dated September 29, 1983. NRC comments were forwarded via a NRC Letter from Dr. B. J. Snyder to Mr. B. K. Kanga dated December 6, 1983. Both NRC comments and GPUNC responses are included in the attachment.

If you have any further questions or require additional information, please contact Mr. J. J. Byrne of my staff.

Sincerely,

B. K. Kanga

B. K. Kanga
Director, TMI-2

BKK/JJB/RBS/jep

Attachment

CC: Deputy Program Director - TMI Program Office, Mr. L. H. Barrett

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RESPONSES TO REQUESTS FOR ADDITIONAL INFORMATION

FIRST PASS STUD DETENSIONING

SAFETY EVALUATION REPORT

Comment 1

Please provide the details of the analysis which shows that the reactor vessel head seal will be capable of maintaining up to 1000 psig following the first pass detensioning of all of the studs and the removal of up to five studs.

Response 1

A. INTRODUCTION

An analysis was performed to determine the pressure retaining capability of the TMI-2 reactor vessel head seal with one pass detensioning of all studs and the removal of up to five studs, two guide stud locations (#15 and #45) and three other stud locations (#10, #30, and #50). This report describes the method of analysis and the assumptions upon which it is based. It also presents the results and the conclusion as to the pressure retaining capability of the head seal.

B. BACKGROUND

The reactor vessel closure head is held in place by sixty studs tensioned to predetermined loads. Two stud tensioners are used to tension/detension the studs. The tensioning process requires four (4) passes--two to seat the gaskets and two to fully tension the studs. Each tensioning pass consists of 30 sequences with two diametrically opposite studs tensioned per sequence.

Two detensioning passes are required to fully unload the studs with each pass consisting of 30 sequences. The studs must be detensioned in a specific sequence and by a specific amount of detensioning to prevent the energy stored in the flexed flanges from creating excessive loads in the remaining studs as the flanges spring back toward their unstressed positions. At the end of the first detensioning pass, all studs will be approximately equally loaded since they are re-seated at set elongations. The average stud elongation after the first pass detensioning is about 0.030" compared to a target elongation of 0.047" when fully tensioned for the 2500 psi design pressure. During the second detensioning pass, two studs are fully unloaded in each of the 30 detensioning sequences.

The tensioning/detensioning analyses and procedures associated with the closure studs are developed with the aid of two B&W computer programs. Computer Program P91035 is used in the ASME Code analysis of the closure assembly for all B&W fabricated reactor vessels for commercial power reactors. The program uses a conventional interaction analysis described in ASME Section III for a closure consisting of a spherical head, head flange, vessel flange, vessel shell, and studs. Outputs from this program include the vertical deflection of the two flanges at the bolt circle and the stud elongation. This data is utilized by the computer program STUDTEN to account for the interaction between the studs and flanges during stud tensioning and detensioning.

The STUDTEN computer program determines the sequence of stud tensioner pump pressures to be used for tensioning and detensioning the closure studs. The program will determine the minimum number of detensioning cycles and print-out the tensioning/detensioning data, i.e., stud tensioner pump pressures and stud elongations as the cycle progresses. Additional input parameters required to execute the program are the tensioner characteristic curves for the tensioners to be used at the plant site. These curves are provided by the tensioner manufacturer and are plots of the stud elongation and load in terms of the tensioner pump pressure.

The above methodology has successfully been used in establishing the stud tensioning/detensioning procedure for all operating plants with B&W-fabricated reactor vessels. It has also been verified by comparing computer program outputs to measured data obtained during reactor vessel shop hydrotests.

C. METHOD OF ANALYSIS

The methodology used to determine the permissible internal pressure after the first detensioning pass and after removal of up to five studs is given in the following steps.

1. Execute the P91035 and STUDTEN computer programs.

2. Determine the total stud load (P) based on the stud elongations calculated by STUDTEN for the conditions following the detensioning of the third pair of studs (the third sequence) in the second detensioning pass. (At this stage of the detensioning, six studs are fully unloaded and could be removed.)

$$P = \frac{NAE\Delta}{L}$$

where: P = total stud load - lbs.
N = number of studs
A = effective stud area - in^2
E = modulus of elasticity - lbs/in^2
Δ = stud elongation - in.
L = effective stud length - in.

3. Determine the spring-back load(s) for the gaskets using deflection versus gasket loading data from the manufacturer.

   The gaskets are initially positioned in grooves in the flanges. The groove depth provides a set gasket deformation recommended by the manufacturer to provide for sealing when the flanges are brought in contact during the initial seating of the gaskets. Since the flanges remain in contact after the first pass detensioning, removal of five studs, and internal pressure loading up to some pressure p, the spring-back load providing the sealing force remains essentially constant; thus, the initial gasket sealing capability is maintained.

4. Calculate the allowable internal pressure (p)

$$p = \frac{P-S}{\pi R^2}$$

where R = radius of outermost gasket
S = spring-back load

The assumptions used in the analysis are listed below:

1. The stud tensioner characteristic curves supplied by the manufacturer are still valid.

2. The studs and flanges have not yielded or deformed; i.e., the existing stud elongations are the same or less than those taken during the last tensioning operation.

3. Variations of stud elongations within the bolt pattern are minor.

4. Gaskets have maintained their structural and metallurgical properties.

5. Weight of closure head is conservatively neglected.

D. SUMMARY OF RESULTS

Using the recommended B&W detensioning procedure, the allowable reactor vessel internal pressure after the first detensioning pass and the subsequent unloading of six studs is approximately 1600 psi. To account for the assumptions itemized above and to provide for a safety margin, 1000 psi was selected as the maximum internal pressure to which the reactor vessel could be subjected after the first detensioning pass and subsequent removal of up to five studs.

Comment 2

Please provide the profiles of the maximum temperatures estimated during the accident for the metal in the reactor vessel flange and head mating surface. Provide the basis for your assumption that the silver cladding on the surface of the "O" rings is unperturbed and intact.

Response 2

Two "O" ring gaskets of austenitic stainless steel with silver plating are compressed between the reactor vessel head flange and the reactor vessel flange to act as pressure seals. The inner and outer rings are 169 3/4" and 173" in diameter, respectively. A temperature analysis has been performed (Reference) for the sixty minute boildown transient which occurred 113 minutes after the turbine trip. At the flange region, the maximum inside surface temperature of approximately 900°F was reached at the end of the sixty minute time interval (173 minutes). Considering the heat sink effect afforded by the thickness of the flanges, the actual temperature in the area of the "O" rings would be less than 900°F. The inner "O" ring is located approximately 1 1/8" and 4 3/8" from the inside surfaces of the reactor vessel flange and the reactor vessel head flange, respectively. The melting point temperature of silver is at least 1615°F with a maximum (depending on purity) of 1760°F. Silver also has low friction (high antiseizure) properties. Therefore, it can be concluded that no damage to the silver plating is expected and that the surface of the "O" rings is unperturbed and intact.

Reference: "Scoping Thermal Analysis of the Three Mile Island Unit 2 Pressure Boundary," EPRI NP-3211, July, 1983

Comment 3

Provide estimates of the occupational exposure that would result from first pass stud detensioning and removal of up to five studs.

Response 3

An occupational exposure of 15 man-rem has been calculated to result from first pass detensioning and removal of up to five studs. This estimate is approximate and is based on an estimated 151 man-hours expended during six entries. No additional exposure has been included for removing stuck studs should they be encountered.