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PIPING CONFIGURATION VERIFICATION	PROJECT MANAGER [signature] DATE 7-24-87 Q.A. ADMINISTRATOR [signature] DATE 7/24/87

FOR INFORMATION ONLY

INSTRUCTION

PIPING CONFIGURATION VERIFICATION

OPERABILITY AND FSAR
COMPLIANCE CRITERIA

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TABLE OF CONTENTS

1.0 PURPOSE AND SCOPE

Under the direction of Commonwealth Edison Company, NUTECH is conducting a program to verify some aspects of the as-built configuration of certain piping systems at Dresden Units 2 and 3 and at Quad Cities Units 1 and 2. The scope of this program consists of safety related piping, greater than 4" in diameter, which was analyzed by NUTECH as part of the Torus Attached Piping (TAP) Project in the Mark I Program during the early 1980's.

This current verification effort focuses on the existence and location of pipe supports as well as the details utilized for the construction of branch connections. However, if the field engineers observe other discrepancies between the as-built configurations and the piping isometrics, which provided the bases of the earlier analysis models, those discrepancies are also noted and reported in the field walkdown data packages. Also, a parallel effort has compared the pipe sizes and pipe schedules indicated on the plants' process and instrumentation drawings (P&IDs) with those used as input for the pipe model analyses.

This Instruction is one of several written to guide the effort of the current TAP piping configuration verification project. It provides the criteria to be satisfied in order to complete a Formal Operability Assessment of the piping and piping support systems with due considerations for the discrepancies between the as-built configurations and the configurations utilized in the current FSAR documentation. It also gives the criteria to be satisfied in order to provide the required updated Documentation that the as-built configurations are in compliance with the current FSAR design criteria for the piping and piping support systems.

2.0 APPLICABILITY

Because of the number of TAP systems for each plant and because this program is being implemented for a total of four units, it is a large program. Thus, multiple discrepancies have been noted and each must be processed. The overall procedure for processing the discrepancies is described in a NUTECH Project Plan (Reference 6.1). The user of this Instruction should have an overall understanding of the content of Reference 6.1 and the discrepancy disposition process as described in that Project Plan.

The majority of the effort required to either demonstrate operability or demonstrate FSAR compliance is similar. The fundamental difference is that FSAR compliance requires that stresses and/or pipe support reactions satisfy established Code allowables, whereas a somewhat less conservative acceptance criteria is permitted for the purpose of an operability assessment. Thus, this Instruction has been written to apply to both operability assessments and the efforts required to document FSAR compliance. The differences between the two types of evaluations are reflected in different allowable stresses and/or pipe support reactions.

3.0 DEMONSTRATION OF COMPLIANCE

Before discrepancies are evaluated using the methods described in this Instruction, they will have been subjected to the evaluation specified in the Second Level Screening Criteria Instruction (CEC-99-014). The result of that screening will have been noted on each Discrepancy Disposition Report (DDR). Instruction CEC-99-014 requires that the user properly consider whether or not multiple discrepancies may have a compounding effect on a given element of the screening evaluation. However, other than that requirement, the screening criteria permits the processing of individual DDRs. Such is not the case for the work described in this Instruction.

The work described in this Instruction is intended to be organized such that all DDRs identified for a given piping system mathematical model (in the current FSAR documentation) are processed together. Thus, the first step is to assemble all DDRs which are applicable to the piping system mathematical model under consideration. That means both those DDRs which did not pass the second level screening and those which did pass the screening. Those which did not pass the second level screening (if there are any) must first be evaluated in accordance with the operability criteria provided herein but then all of the DDRs for the model must also be evaluated in accordance with the FSAR criteria using one or more of the approaches described herein.

The second step is for the user to assure that the most current FSAR analysis results are being utilized for the application of this Instruction. It is possible that the piping system (or a portion of the system) represented by the mathematical model has been previously observed to have differences between its as-built configuration and that which was analyzed with the mathematical model. Another possibility is that a modification has been made to the system in the plant without a complete update and rerun of the mathematical model. In either of these cases, documentation should exist which provides an assessment of the effect such differences have of the results of the most current analysis of the complete mathematical model. The most current analysis results, modified by the effects of previously documented deviations (e.g., Analysis Deviation Reports) and/or hardware modifications, are to be used as the starting bases for the evaluations described in this Instruction.

In some cases, one or more DDRs for a given mathematical model can be dispositioned by referring to acceptable installation tolerances. If the noted discrepancies do not exceed those tolerances, it is not required that calculations be performed to evaluate what are judged to be insignificant changes in stresses or support reactions. This method of DDR resolution is the subject of Section 3.1. However, if all of the DDRs for a given mathematical model do not satisfy the tolerances provided in Section 3.1, then some calculations must be made to evaluate the possible effects the apparent discrepancies may have on the piping stresses and/or support reactions.

The procedures used to analyze and qualify modifications to the TAP systems in the Mark I Program are very sophisticated. As can be seen from Tables 3.0-1, 3.0-2 and 3.0-3, several loading combinations are considered in a full, formal FSAR analysis of the piping, piping supports and torus penetrations. These requirements are established in References 6.3, 6.4, and 6.5. For the purpose of this reconciliation project, it is not necessary to compute revised stresses, support reactions and penetration loads corresponding to each loading combination. It is however required to do so for the controlling loading combination(s), if all of the DDRs for a given mathmatical model do not meet the tolerances given in Section 3.1. More guidance on this subject is provided in Sections 3.2 and 3.3 of this Instruction. However, the user of this Instruction must have an understanding of the applicable Mark I Program requirements contained in References 6.3, 6.4, and 6.5.

Thus, after:

(a) assembling all the DDRs and walkdown data that apply to the model under consideration,

(b) assuring that the most current, previous analysis results (possibility updated by previous reconciliations) are available to serve as the base-line for this reconciliation, and

(c) selecting the controlling loading combination(s);

one must compute revised stresses, support reactions and/or torus penetration loads (if applicable) which reflect the effects of the observed discrepancies. Acceptable procedures for carrying out this step are the subject of Section 4.0. One acceptable method is to simply update and re-run the entire mathematical model. That approach is addressed in Section 4.1. Depending on the number and the extent of the discrepancies which apply to the model under consideration, this approach may, however, be unnecessarily time consuming and expensive. Thus, Section 4.2 provides guidelines for using acceptable approximate methods which will bound the effects of various kinds of discrepancies.

If revised calculations are required, then the new (or bounding) values of stresses and/or pipe support loads must be compared to appropriate allowables as specified below in Sections 3.2 and 3.3. Then, the final step in the implementation of this Instruction is to complete the required documentation. Those requirements are given in Section 5.0 of this Instruction.

TABLE 3.0-1
LOAD COMBINATIONS AND STRESS LIMITS - TOROUS ATTACHED PIPING

L.C. NUMBER	LOAD COMBINATIONS	ASME CODE EQUATION	STRESS LIMIT	CONDITION
A-1	P + DW + OL	8	$1.0S_h$	Design
A-2	TE + THAM + TD + OBE_D	$10^{(3)}$	S_a	Design
A-3	TE + THAM + TD + QAB_D	$10^{(3)}$	S_a	SRV
A-4	TE_1 + $THAM_1$ + TD_1 or TD_2 + SSE_D + QAB_D	$10^{(3)}$	S_a	SRV + SSE
A-5	TE_1 + $THAM_1$ + TD_1 or TD_2 + $PCHUG_D$ + QAB_D + SSE_D	$10^{(3)}$	S_a	SBA/IBA + SRV + SSE
A-6	TE_1 + $THAM_1$ + TD_1 or TD_2 + $CHUG_D$ + QAB_D + SSE_D	$10^{(3)}$	S_a	SBA/IBA + SRV + SSE
A-7	TE_1 + $THAM_1$ + TD_2 + $PCHUG_D$ + QAB_D + SSE_D	$10^{(3)}$	S_a	DBA + SRV + SSE
A-8	TE_1 + $THAM_1$ + TD_2 + $CHUG_D$ + QAB_D + SSE_D	$10^{(3)}$	S_a	DBA + SRV + SSE
A-9	TE_1 + $THAM_1$ + TD_3 + PS_D + QAB_D + SSE_D	$10^{(3)}$	S_a	DBA + SRV + SSE
A-10	TE_1 + $THAM_1$ + TD_3 + CO_D + QAB_D + OBE_D	$10^{(3)}$	S_a	DBA + SRV + SSE
A-11	TE_1 + $THAM_1$ + TD_3 + $PCHUG_D$ + QAB_D + SSE_D	$10^{(3)}$	S_a	
A-12	TE_1 + $THAM_1$ + TD_3 + $CHUG_D$ + QAB_D + SSE_D	$10^{(3)}$	S_a	
B-1	P_o + DW + OBE_I + OL	9	$1.2S_h$	Design
B-2	P_o + DW + QAB + QAB_I + OL	9	$1.2S_h$	SRV
C-1	P_o + DW + QAB + QAB_I + SSE_I + IL	9	$1.8S_h$	SRV + SSE
C-2	P_o + DW + PCHUG + $PCHUG_I$ + QAB + QAB_I + OL	9	$1.8S_h$	SBA + SRV
C-3	P_o + DW + CHUG + $CHUG_I$ + QAB + QAB_I + OL	9	$1.8S_h$	SBA + SRV
D-1	P_o + DW + PCHUG + $PCHUG_I$ + QAB + QAB_I + SSE_I + OL	9	$2.4S_h$	DBA + SRV + SSE
D-2	P_o + DW + CHUG + $CHUG_I$ + QAB + QAB_I + SSE_I + OL	9	$1.8S_h$	DBA + SRV + SSE
D-3	P_o + DW + PSO + PSO_I + VCLO	9	$2.4S_h$	DBA
D-4	P_o + DW + PS + PS_I + VCL + QAB + QAB_I + SSE_I + OL	9	$2.4S_h$	DBA + SRV + SSE
D-5	P_o + DW + CO + CO_I + OBE_I + OL	9	$2.4.S_h$	DBA + OBE
T-1	1.25P + DW	8	$1.0S_h$	Test

TABLE 3.0-2

LOAD COMBINATIONS - PIPE SUPPORTS

L.C. Number	Load Combinations
S-1	$DW + OL \pm OBE_I$
S-2	$DW + OL \pm [QAB + QAB_I]$
S-3	DW
S-4	$DW + OL \pm [(QAB + QAB_I)^2 + SSE_I{}^2]^{1/2}$
S-5	$DW + OL \pm [(QAB + QAB_I)^2 + (PCHUG + PCHUG_I)^2]^{1/2}$
S-6	$DW + OL \pm [(QAB + QAB_I)^2 + (CHUG + CHUG_I)^2]^{1/2}$
S-7	$DW + OL \pm [(QAB + QAB_I)^2 + SSE_I{}^2 + (PCHUG + PCHUG_I)^2]^{1/2}$
S-8	$DW + OL \pm [(QAB + QAB_I)^2 + SSE_I{}^2 + (CHUG + CHUG_I)^2]^{1/2}$
S-9	$DW + OL \pm [OBE_I{}^2 + (CO + CO_I)^2]^{1/2}$
S-10	$DW + OL \pm [(QAB + QAB_I)^2 + SSE_I{}^2 + (PS + PS_I + VCL)^2]^{1/2}$
S-11	$DW + OL \pm [PSO + PSO_I + VCLO]$
S-12	$[DW + OL + TE + THAM + TD] \pm [OBE_I + OBE_D]$
S-13	$[DW + OL + TE + THAM + TD] \pm [QAB + QAB_I + QAB_D]$
S-14	$[DW + OL + TE_1 + THAM_1 + TD_3] \pm [(QAB + QAB_I + QAB_D)^2 + (PCHUG + PCHUG_I + PCHUG_D)^2]^{1/2}$
S-15	$[DW + OL + TE_1 + THAM_1 + TD_3] \pm [(QAB + QAB_I + QAB_D)^2 + (CHUG + CHUG_I + CHUG_D)^2]^{1/2}$
S-16	$[DW + OL + TE_1 + THAM_1 + TD_3] \pm [(QAB + QAB_I + QAB_D)^2 + (SSE_I + SSE_D)^2 + (PCHUG + PCHUG_I + PCHUG_D)^2]^{1/2}$
S-17	$[DW + OL + TE_1 + THAM_1 + TD_3] \pm [(QAB + QAB_I + QAB_D)^2 + (SSE_I + SSE_D)^2 + (CHUG + CHUG_I + CHUG_D)^2]^{1/2}$
S-18	$[DW + OL + TE_1 + THAM_1 + TD_3] \pm [(OBE_I + OBE_D)^2 + (CO + CO_I + CO_D)^2]^{1/2}$
S-19	$[DW + OL + TE_1 + THAM_1 + TD_3] \pm [(QAB + QAB_I + QAB_D)^2 + (SSE_I + SSE_D)^2 + (PS + PS_I + PS_D + VCL)^2]^{1/2}$
S-20	$[DW + OL + TE_1 + THAM_1 + TD_3] \pm (PSO + PSO_I + PSO_D + VCLO)$
S-21	$[DW + OL + TE + THAM + TD] \pm [(QAB + QAB_I + QAB_D)^2 + (SSE_I + SSE_D)^2]^{1/2}$

Table 3.0-3

GOVERNING PENETRATION LOAD COMBINATIONS - CONTAINMENT PENETRATIONS

LOAD COMBINATION NUMBER	LOAD COMBINATIONS	SERVICE LEVEL
CHUG-14E	$\lvert DW + TE_1 + THAM_1 + TD^{(1)} + OL \rvert +$ $(\lvert QAB \rvert + \lvert CHUG \rvert + \lvert QAB_I \rvert + \lvert OBE \rvert^{(2)}$ $+ \lvert CHUG_I \rvert)$ OR $2 (\lvert QAB \rvert + \lvert CHUG \rvert +$ $\lvert QAB_I \rvert + \lvert OBE \rvert^{(2)} + CHUG_I \rvert)$, WHICHEVER IS HIGHER	B
CHUG-14M	$\lvert DW + TE_1 + THAM_1 + TD^{(1)} + OL \rvert$ $+ \lvert QAB \rvert + QAB_I \rvert + \lvert OBE \rvert^{(2)} + \lvert CHUG \rvert$ $+ \lvert CHUG_I \rvert$	B
CHUG-27M	$\lvert DW + TE_1 + THAM_1 + TD^{(1)} + OL \rvert$ $+ \lvert QAB \rvert + \lvert SSE \rvert^{(3)} + \lvert QAB_I \rvert +$ $\lvert CHUG \rvert + \lvert CHUG_I \rvert$	C
PS-15M	$\lvert DW + TE_1 + THAM_1 + TD^{(1)} + OL \rvert$ $+ \lvert QAB \rvert + \lvert SSE \rvert^{(3)} + \lvert QAB_I \rvert + \lvert PS \rvert$ $+ \lvert PS_I \rvert$	C
PS-18M(4)	$\lvert DW + TE_1 + THAM_1 + TD^{(1)} + OL \rvert$ $+ \lvert OBE \rvert^{(2)} + \lvert PS \rvert + PS_I \rvert$	B
CO-27M	$\lvert DW + TE_1 + THAM_1 + TD^{(1)} + OL \rvert$ $+ \lvert SSE \rvert^{(3)} + \lvert CO \rvert + \lvert CO_I \rvert$	C

(1) TD IS THE MAXIMUM OF TD_1, TD_2, AND TD_3.

(2) OBE IS DEFINED AS $OBE_I + OBE_D$.

(3) SSE IS DEFINED AS $SSE_I + SSE_D$.

(4) PRIMARY PLUS SECONDARY STRESS INTENSITY RANGE AND FATIGUE EVALUATION ARE NOT REQUIRED, SINCE CHUG-14E GOVERNS.

3.1 Acceptable Tolerances

One acceptable method of resolving apparent discrepancies is to demonstrate that the deviations are within tolerance limits. A set of such limits is provided in Table 3.1. These limits have been established by referring to both documents used in previous projects as well as industry publications. Note that the values of the tolerances specified in Table 3.1 for pipe supports are identical to those originally used for installation during the Mark I Program (Reference 6.7). If one or more of the apparent discrepancies reported on the DDR(s) are within the tolerances given in Table 3.1, then no further effort is required to resolve the corresponding DDR(s). All that is required is that the documentation requirements of Section 5.0 of this Instruction be satisfied.

It would be consistent with industry practice to allow any single DDR to be dispositioned by noting that the apparent discrepancy is less than that permitted by the tolerances provided in Table 3.1, without any further consideration of that DDR as it relates to the processing of other DDRs on the same mathematical model. However, this Instruction requires that a level of judgement be applied to such a circumstance and documented in the calculation. For example, if other DDRs for the mathematical model being considered require that an entire piping system model be subjected to re-analysis (see Section 4.1), then the model shall be revised to consider <u>all</u> discrepancies reported for the piping system modeled, including those which satisfy the tolerances given in Table 3.1. The same is true if some of the approximate approaches outlined in Section 4.2 are being utilized. Basically, any calculations which are to be performed, be they a complete re-analysis of the model or be they smaller mathematical models used to bound the effects of discrepancies, should be performed using the most accurate information available to develop (or modify) the models. It should be noted that the initial walkdown effort associated with the project allowed visual (not measured) verification of dimensions previously specified on piping isometrics. If existing dimensions were visually verified, then they will be considered as verified design input. However, if an existing dimension on a drawing was questioned based on a visual estimate, then a field measurement shall be taken to accurately record the actual dimension which should be used as design input.

Table 3.1

TOLERANCES FOR PIPING AND PIPE SUPPORTS

ITEM	LOCATION	ACCEPTABLE TOLERANCE
Deviations in the locating dimension along the pipe center-line of pipe supports, branch connections, fittings, flanges, valves, etc.	From Torus Penetration up to 2nd Restraint. (Note 1)	±6"
Deviations in the locating dimension along the pipe center-line of pipe supports, branch connections, fittings, flanges, valves, etc.	Beyond 2nd Restraint. (Note 1)	±12"
Deviations in the angular orientation of pipe supports, valve stems or operators, and pipe runs	All Applications	±5°
Uniformly Distributed Weight	All Applications	±10%
Concentrated Weight	All Applications	±10%

Note 1: For purposes of defining the location where this tolerance applies, a restraint is defined as a strut, rod hanger, structural frame, or snubber (spring supports are not considered restraints).

3.2 Operability Compliance

If one or more of the DDRs do not satisfy the tolerance limits specified in Section 3.1 and if previous steps in the overall reconciliation process (e.g., the Second Level Screening Criteria) have concluded that a formal operability assessment is required, then revised bounding values of pipe stresses and/or pipe support reactions are to be calculated using one of the methods permitted in Section 4.0 of this Instruction. However, note that for an operability evaluation, only the loading combination(s) which clearly results in the maximum pipe stresses and/or support reactions, which are likely to be influenced by the discrepancies, need be considered. The analyst shall consider the possibility that one load combination may govern at a particular DDR location, while a different load combination may govern at a "nearby" DDR location. In this case, the cummulative effects of each DDR on the other shall be considered, with its respective controlling load combination(s).

After computing bounding values for the pipe stresses and/or support reactions, these are to be compared to the operability acceptance criteria provided in Appendix A of this Instruction. If that criteria is satisfied with the revised (or bounding) pipe stresses and/or support reactions which consider all the DDRs for the subject piping model, that conclusion is to be documented in accordance with the requirements given in Section 5.1 of this Instruction. In such a case, the user should proceed to Section 3.3 of this Instruction and follow the procedure necessary to carry out the FSAR Compliance demonstration. In the event that operability cannot be demonstrated, then the reporting and corrective actions described in Reference 6.1 must be undertaken.

3.3 FSAR Compliance

At some point in the discrepancy resolution process described in the Project Plan (Ref. 6.1), FSAR compliance will have to be demonstrated for all DDR's on each model.

Any one of the following methods are to be used to demonstrate FSAR compliance.

1) Show that all DDRs on the model are within the tolerances specified in Section 3.1.

2) Show that all DDRs on the model meet the acceptance criteria of Section 4.2.

3) Perform a formal FSAR analysis as outlined in Section 4.1. For each Service Level only the controlling load combinations for each stress or reaction effected by each DDR need be evaluated. Show that the acceptance criteria of the applicable TAP Design Specification (Ref. 6.4 and 6.5) are met.

FSAR compliance is then to be documented according to Section 5.2. Should it not be possible to demonstrate FSAR compliance, CECo shall be notified and action undertaken per the Project Plan (Ref. 6.1).

4.0 REVISED PIPE STRESSES AND SUPPORT REACTIONS

This section outlines the procedures to be used to calculate revised pipe stresses and support loads when required for formal assessment (per Section 3.2) for either operability or FSAR compliance (per Section 3.3). There are two ways of doing this; 1) performing a complete reanalysis of the piping model, or 2) calculating bounding values of pipe stresses and support loads. The first approach is discussed in Section 4.1 below. Depending on the number and the extent of the discrepancies which apply to the model under consideration, this approach may, however, be unnecessarily time consuming and expensive. Thus, Section 4.2 provides guidelines for using acceptable approximate methods which will bound the effects of various kinds of discrepancies.

4.1 Revised Results for Entire Piping System Model

If the selected approach is a reanalysis of the entire piping system model, then assemble all the DDRs which apply to the piping system model under consideration, resurrect the latest mathmatical model (PISTAR model) for the piping system under consideration, and assemble the most current previous analysis results for all load conditions. Considering all DDRs pertaining to the model, and using the most current verified design input, update the resurrected piping system geometry (PISTAR model) and perform a geometry check run. Note that field measurements visually estimated during previous field walkdown activities on this project which contradict previously specified dimensional data is not valid design input unless it has been subsequently checked with measurement instruments. After verifying the geometry of the piping system model (see References

6.9, 6.10 and 6.11), analyze the models for the controlling loadings and loading combinations. The series of computer codes listed in the Summary Report (Reference 6.11) or other acceptable methods should be used to perform Mark I TAP analyses. The results of this analysis will provide a revised set of piping stresses and pipe support reactions. The resulting values for pipe stresses and support reactions then are to be compared with the appropriate allowables and the results are to be documented in accordance with the requirements of Section 5.0 of this Instruction.

4.2 Bounding the Effects of Discrepancies

Provided below are some guidelines and/or acceptable methods for establishing the bounding effects of various kinds of discrepancies. Such methods or guidelines are not provided for every kind of discrepancy which may have been noted. However, in those cases where guidelines are provided, it is acceptable to use the alternate methods described, rather than requiring a complete reanalysis of an updated PISTAR piping model.

4.2.1 Branch Connection Details Discrepancies

To determine the effects of a revised SIF for a branch connection, the stresses from the PISTAR output at the node for the branch connection for each Service Level must be modified as shown in Table 4.2-1. The ratio of the revised SIF to the previous SIF is applied to those stress terms affected by an SIF and is not applied to the pressure stress term in the code equations. For reduced output branch connections, the section modulus used in the stress equations may be dependent on the SIF in accordance with NC-3652.4 of the ASME Code (Reference 6.13):

$$Z = \pi (r_m')^2 t_s$$

where r_m' is the mean radius of the branch pipe and t_s is the lesser of run pipe thickness or the product of the SIF times the branch pipe thickness. As a result, the ratio of the revised section modulus should be applied to those stress terms containing the section modulus as shown in Table 4.2-1. NC-3642.4 may contain further refinement of the pipe stresses that can be included where applicable.

After the modified stresses have been determined for the branch connection, compare the results against the allowables in Appendix A for operability and the TAP Design Specifications for FSAR compliance.

4.2.2 Elbow Radii Discrepancies

To determine the effects of a revised SIF for an elbow because of the difference between long radius and short radius elbows, the stresses from the PISTAR output at the nodes for the elbow for each Service Level must be modified as shown in Table 4.2-1. The difference in flexibility between long and short radius elbows has been reviewed and has been found to have an insignificant effect. The ratio of the revised SIF to the previous SIF is applied to those stress terms affected by an SIF and is not applied to the pressure stress term of the Code equations. After the modified stresses have been determined for the elbow, compare the results against the allowables in Appendix A for operability and in the TAP Design Specifications for FSAR compliance.

4.2.3 Apparent Discrepancies at Model Boundaries

In situations where the PISTAR model included a support which was not found to exist during the walkdowns, the apparent discrepancy may be the result of modelling techniques.

In some situations, restraints are modelled to terminate an analytical piping model at a point where the response to the Mark I loads have sufficiently attenuated or where the piping is beyond the safety related boundary such that effects in this portion of piping are judged not to have a significant impact on the safety related portion of piping, even though these restraints do not physically exist on the piping. This condition is acceptable and does not constitute a discrepancy that requires demonstration of operability or FSAR compliance.

Table 4.2-1

MODIFIED STRESS EQUATIONS DUE TO REVISED SIFs

Service Level	ASME[4] Code Equation	Allowable Stresses [1][2][3]
A	8	$\sigma_{PD} + \sigma_A \dfrac{(I_R)}{(Z_R)} \leq 1.0S_h$
B	9	$\sigma_P + [\sigma_A + \sigma_B] \dfrac{(I_R)}{(Z_R)} \leq 1.2S_h$
C	9	$\sigma_P + [\sigma_A + \sigma_B] \dfrac{(I_R)}{(Z_R)} \leq 1.8S_h$
D	9	$\sigma_P + [\sigma_A + \sigma_B] \dfrac{(I_R)}{(Z_R)} \leq 2.4S_h$
Secondary	10	$\sigma_C \dfrac{(I_R)}{(Z_R)} \leq S_A = (1.25S_c + 0.25S_h)$
Secondary	11	$\sigma_{PD} + [\sigma_A + \sigma_C] \dfrac{(I_R)}{(Z_R)} \leq (S_h + S_A)$

(1) Allowable stresses and load combinations are defined in References 6.4 and 6.5.

(2) I_R (= i_{new}/i_{old}) is the ratio of the revised SIF to the previous SIF. For Equation 8, 9, or 11, if 0.75i is less than 1.0, then I_R should be computed using i = 1.0. Z_R (= Z_{new}/Z_{old}) is the ratio of the revised section modulus to the previous section modulus which is dependent on the value of i per NC-3652.4 for reduced outlet branch connections (i.e., not applicable for full outlet branch connections).

(3) The following stress terms are found in the PISTAR Element Stress Evaluation Table: σ_{PD} = Design Pressure Term, σ_P = Peak Pressure Term, σ_A = Sustained Loads Term σ_B = Occasional Loads Term, and σ_C = Thermal Loads Term.

(4) ASME Code, 1977 Edition, up to Summer 1977 Addenda.

5.0 DOCUMENTATION REQUIREMENTS

An important objective of this project is to produce clear documentation of the reconciliations which have been completed. The operability assessment documentation requirements are the subject of Section 5.1 and the FSAR compliance documentation requirements are given in Section 5.2.

5.1 Operability Criteria Compliance

The work done to demonstrate compliance with the operability acceptance criteria is to be contained in NUTECH Calculation Packages. They are to be prepared in accordance with the requirements established in NUTECH Quality Engineering Procedure Number 3-2 (QEP 3-2), "Preparation and Checking of Calculation Packages." Further, they are to be controlled, indexed, and dispositioned in accordance with NUTECH Quality Engineering Procedure Number 17-1 (QEP 17-1), "Identification, Transmittal, Storage, and Maintenance of Quality Records," and the Project Plan (Ref. 6.1).

5.2 FSAR Criteria Compliance

The work done to demonstrate compliance with the FSAR acceptance criteria is to be contained in the original Mark I Program NUTECH Calculation Packages on file. They are to be prepared in accordance with the requirements established in NUTECH Quality Engineering Procedure Number 3-2 (QEP 3-2), "Preparation and Checking of Calculation Packages." Further, they are to be controlled, indexed, and dispositioned in accordance with NUTECH Quality Engineering Procedure Number 17-1 (QEP 17-1), "Identification, Transmittal, Storage, and Maintenance of Quality Records," and the Project Plan (Ref. 6.1).

6.0 REFERENCES

6.1 Project Plan for Piping Configuration Verification Program, Dresden Units 2 & 3 and Quad Cities Units 1 & 2, Document PAF-CEC99, File Number CEC099.0008.

6.2 Deleted

6.3 "Mark I Containment Long-Term Program," Safety Evaluation Report, USNRC, NUREG-0661, July 1980, Supplement 1, August 1982.

6.4 "Torus Attached Piping Analysis and Modification," Design Specification. - Dresden 2 and 3. NUTECH Document Number COM-01-011, Revision 2.

6.5 "Torus Attached Piping Analysis and Modifications Design Specification. - Quad Cities 1 and 2." NUTECH Document Number COM-09-003, Revision 1.

6.6 DELETED

6.7 "Criteria for Pipe Support Installation Tolerances, Quad Cities Nuclear Power Station Units 1 & 2 and Dresden Nuclear Power Station Units 2 & 3," NUTECH Document COM-24-097, Revision 1, October, 1982.

6.8 DELETED

6.9 "Dresden Nuclear Power Station Units 2 and 3," Plant Unique Analysis Report. NUTECH Engineers Volumes 1, 2, 3, 4, 6, and 7; Numbers COM-02-041-1, COM-02-041-2, COM-02-041-3, COM-02-041-4, COM-02-041-6, and COM-02-041-7; all Revision 0.

6.10 "Quad Cities Nuclear Power Station, Units 1 and 2," Plant Unique Analysis Report. NUTECH Engineers, Volumes 1, 2, 3, 4, 6, and 7; Numbers COM-02-039-1, COM-02-039-2, COM-02-039-3, COM-02-039-4, COM-02-039-6, COM-02-039-7; all Revision 0.

6.11 "Summary Report - Torus Attached Piping and Suppression Chamber Penetration Analysis of Mark I Program for Dresden Units 2 and 3 and Quad Cities Units 1 and 2," NUTECH Number XCE-09-100, Revision 0.

6.12 DELETED

6.13 ASME Boiler and Pressure Vessel Code, Section III, 1977 Edition with Addenda through Summer 1977.

Appendix A

OPERABILITY ACCEPTANCE CRITERIA
FOR
ALLOWABLE STRESSES AND SUPPORT LOADS

A.1 Use of this Appendix

Section 4.0 of this Instruction describes the method to be used to establish bounding values for the stresses in the pipe and reactions in the pipe supports, given the apparent discrepancies identified in the as-built survey data versus the input that was used in the current PISTAR, FSAR analysis models. This Appendix provides allowable values of stresses and/or pipe support loads which, if satisfied, constitute conformance with the Operability Acceptance Criteria for this project.

Specifically, paragraph A.2 provides allowable operability stress for pipe elements. Allowable stresses are specified for some of the elements which make up pipe supports and allowable loads for other elements of pipe supports are provided in paragraph A.3. Allowable stresses for the welds in pipe supports is the subject of paragraph A.4. Finally, for those instances where a pipe support is in fact a penetration in the containment vessel, paragraph A.5 provides allowable penetration operability stress intensities and stresses in equipment nozzles are the subject of paragraph A.6. Paragraph A.7 contains a list of the references noted in paragraphs A.2 thru A.6.

A.2 Allowable Stresses for Piping

The bounding value of pipe stresses, computed by the methods described in Section 4.0, for the critical loading combination shall satisfy the following:

$$\text{SRSS}\,(S_{SSE} + S_{Mark\ I}) + S_{DW} + S_{press} < 2.0\ S_y,$$ (Reference A.7.1)

Where Sy is the material yield stress at the maximum specified operating temperature.

A.3 Allowable Stress and Loads for Pipe Supports

The bounding values of stresses or loads in pipe supports, from reactions computed by the methods described in Section 4.0, for the critical loading combination shall satisfy the following:

A.3.1 Structural Steel

A.3.1.1	Tension (Axial and/or Bending)	1.12 Sy	(Reference A.7.2)
A.3.1.2	Shear	0.75 SY	(Reference A.7.2)
A.3.1.3	Compression (Axial and/or Bending)	MIN [$.67S_{cr}$, 1.12 Sy]	(Reference A.7.2)
A.3.1.4	Web Crippling	1.00 Sy	(Reference A.7.2)

A.3.2 Anchor Bolts

A.3.2.1 Manufacturer's Ultimate Capacity with FS = 2 (Reference A.7.3)

A.3.3 Standard Components

A.3.3.1 Manufacturer's Catalog Service Level D Allowables.

A.3.3.2 Where Level D allowables are not given, and the factor of safety is specified in the catalog, use design allowables but with FS = 2 (Manufacturers generally supply only Level B allowable using FS = 5).

A.3.4 Where neither a Level D allowable nor the factor of safety on Level B allowable is given, justification for use of higher allowables shall be provided.

NOTES:

1. For U-bolts, Manufacturer's Catalog allowables for side loads may be ratioed by the diameters in cases where the catalog gives only one allowable for a range of pipe sizes. For example, if the catalog gives the same allowable for a 1/2" rod size for 8" and 10" pipe sizes, the allowable for the 8" size may be increased by the factor (10/8).

2. Vendor allowables which are based on conservatively high material temperatures may be adjusted to correspond to the appropriate specified design temperature.

3. In lieu of using Manufacturer's Catalog allowables, U-bolts may be qualified by analysis in accordance with ASME III, Appendix F, para. 1370.

A.4 <u>Allowable Weld Stresses in Pipe Supports</u>

The bounding values of pipe support weld stresses, from reactions computed by the methods described in Section 4.0 for the critical loading combination, shall be less than or equal to the following:

0.42 x (Su of weld material) (Reference A.7.2)

A.5 <u>Allowable Stress Intensities in Containment Vessel Penetrations</u>

The bounding values of stress intensities in piping penetrations into the containment vessel from reactions, computed by the methods described in Section 4.0, for the critical loading combination shall satisfy the following:

ASME, Section III, Subsection NE, (Reference A.7.5)
Service Level D Allowables

A.6 Allowable Equipment Nozzle Loads

Piping analysis models often treat equipment (e.g., pumps or turbines) nozzles as piping support points. In such cases, the allowable support reactions which act on the nozzles shall be such that the stresses in the equipment nozzles do not exceed the minimum specified yield stress for the nozzle material.

A.7 References

A.7.1 "CECo Operability Criteria for 79-14 Program," Project Instruction COM-PI-008, Revision 1.

A.7.2 ASME Boiler & Pressure Vessel Code, Section III, Subsection NF, 1977 Edition with Summer 1977 Addenda.

A.7.3 USNRC IE Bulletin No. 79-02, Revision No. 1, Supplement No. 1, Pipe Support Baseplate designs using concrete expansion anchor bolts.

A.7.4 Deleted

A.7.5 ASME Boiler & Pressure Vessel Code, Section III, Subsection NE, 1977 Edition with Summer 1977 Addenda.