CEC-99-037

COMMENTARY ON
PIPING CONFIGURATION VERIFICATION
INSTRUCTION CEC-99-014,
SECOND LEVEL SCREENING CRITERIA

JUNE 1987

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1.0 INTRODUCTION

The purpose of the Second Level Screening Criteria (Instruction CEC-99-014, Reference 6.1) is to provide a means to quickly screen potential discrepancies (DDRs) to determine the likelihood of their meeting a more formal operability criteria. This screening step is essential in order to separate the DDRs which may require immediate attention from those which can be reviewed for FSAR compliance with less of a sense of urgency. Thus, this screening step is used to quickly establish priorities. Ultimately, FSAR compliance for all DDRs is to be addressed, regardless of whether or not they "pass" or "fail" the Second Level Screening Criteria.

The screening methods and acceptance criteria was developed by drawing on the judgement of experienced engineers and the operability criteria for piping and pipe supports which was used by Commonwealth Edison, and accepted by the NRC, during the I.E. 79-14 Bulletin (Reference 6.2) programs for Dresden and Quad Cities. The purpose of this commentary document is to provide some insight as to the reasoning behind some of the judgement which was applied to arrive at the methods. Although it is not the purpose of this commentary to provide theoretical derivations which "prove" the adequacy of the approaches, it is felt that the insights provided herein should provide some assurance in the mind of a reviewer and that approach has adequate merit, given its intended purpose.

In some instances, dimensional or weight tolerances are provided as the basis for concluding that, given apparent discrepancies, do not constitute a basis for concern. These are discussed below in Section 2.0. The majority of the Instruction deals with approaches to be used to bound the effects that apparent discrepancies may have on the stresses in the pipe and the loads (and, hence, stresses) in the pipe supports. Some background on the reasoning behind these approaches is provided below in Section 3.0. As mentioned above, the allowable operability stresses and pipe support loads criteria have been used in past, similar evaluations and these are addressed briefly in Section 4.0. A summary of the philosophy behind Instruction CEC-99-014 is the subject of Section 5.0 and documents referenced in this commentary are listed in Section 6.0.

2.0 TOLERANCES

One acceptable approach, commonly used in the industry, to resolve questions about the differences between as-built conditions and the precise conditions that are specified in design and analysis documents is to refer to a set of permitted tolerances. This approach is used, for example, to monitor original construction activities. This approach was also used in the I.E. 79-14 Bulletin programs at not only Dresden and Quad Cities but also at several other plants in the U.S. However, until recently, there has not been a uniform set of set tolerances available for use by the industry. In July of 1986, the Welding Research Council published their Bulletin Number 316 which is titled, "Technical Position on Piping Installation Tolerances" (Reference 6.3). This document was prepared by a panel of experts from the industry. As the title indicates, this document establishes installation tolerances for piping system construction. If systems are constructed within the published tolerances, it is suggested that reconciliation with the original design documentation is not required even from the standpoint of compliance with the FSAR criteria.

Since Instruction CEC-99-014 establishes an approach for screening DDRs from the standpoint of operability concerns, it specifies tolerances which are generally twice those suggested by WRC Bulletin Number 316. This is true, except for the first span of piping adjacent to the torus where the basic WRC tolerances are specified. Specifically, tolerances are established for each of the following types of apparent discrepancies:

- Support Locations
- Pipe Routings
- Component Weights
- Pipe Segment Lengths
- Support Orientations
- Valve Orientations

If apparent discrepancies in these categories are less than the specified tolerances, then the DDRs are characterized as having "passed" the Second Level Screening Criteria and no further screening evaluation is required. As mentioned above, however, each of the DDRs will ultimately be subjected to an FSAR compliance evaluation.

3.0 BOUNDING STRESSES AND PIPE SUPPORT REACTIONS

The majority of the material in Instruction CEC-99-014 deals with approaches to be used to bound the effects that apparent discrepancies may have on the stresses in the pipe and the reactions in the pipe supports. These bounding estimates for increases in pipe stress and support reactions are then to be added to the values documented in the current analyses and the results are to be compared with a set of operability allowables. In general, the approaches specified are based upon simple statics and a consideration of the effects of such parameters as increased pipe segment span lengths and changes in stiffness. The key characteristic of each method is that the postulated effect is reasoned to be a bounding effect. In some cases, additional factors of 10% or 20% is applied to provide further assurance that the results are conservative. The rationale behind each of the specified approaches is described briefly in the following sections of this commentary.

3.1 Support Location Discrepancies

In addition to tolerances as discussed above in Section 2.0, it is permitted to evaluate the effects of mislocated supports by considering the effect which would apply if the support were completely missing. Certainly, the effect of mislocating a support would not generally be any worse than a situation where the support was completely missing.

3.2 Missing Support Discrepancies

Three separate bounding effects are evaluated for the condition of a missing support. First, the documented reaction in the missing support is distributed to the two adjacent supports on either side of the missing support. The distribution is based upon simple statics except that the value of the missing reaction is increased by 20% to provide some additional conservatism. Next, the stresses in the pipe at the location of the missing support are bounded by statically evaluating the affected span of piping as if it were a simply supported beam and also adding 20% for additional conservatism. Since, in reality, the continuous piping system offers moment resistance at the locations of the adjacent supports, the simple beam approach should provide an upper bound for the stresses in the pipe away from the adjacent supports. Finally, the stresses in the pipe at the locations of the adjacent supports is bounded by computing the effect of the missing reaction acting on a straight beam which is assumed to be fixed at both ends. Here again, the results of this calculation are increased by 20%.

3.3 Non-Demolished Support Discrepancies

As explained in the Instruction itself, the reason a support was specified to be demolished is generally because a new, stronger support was installed near the original support and thus it was no longer required. As such, the only reason to question the continued existence of the non-demolished support is to assure that its existence (or its failure) would not result in local pipe stresses which exceed the operability acceptance criteria. Instruction CEC-99-014 requires that such an evaluation be performed.

3.4 Pipe Size or Schedule Discrepancies

If a pipe is determined to have a larger cross sectional area and hence a larger moment of inertia and section modulus, there are two counteracting effects on the existing analysis results. First, it is possible that the internal bending moments in the pipe section will increase due to the increased stiffness of the pipe segment. This possible increase in internal bending moment is bounded by increasing the reported bending moments in proportion to the two moments of inertia; and, for the sake of additional conservatism, an additional 20% increase is imposed. On the other hand, consistant with the recognition of a change in the internal bending moment, the observed section modulus is used to compute the pipe stresses which are then to be compared to the operability allowables.

In keeping with the commitment to compute bounding effects, if the observed pipe has a smaller stiffness than the stiffness used in the existing analysis, the internal bending moments from the analysis are <u>not</u> decreased. However, the stresses are increased by using the smaller (observed) section modulus.

Another possible effect that an increased stiffness may have is to increase the reactions in the pipe supports adjacent to each end of the affected pipe segment. That possibility is accounted for by requiring that the appropriate pipe support reactions from the existing analysis be increased by the ratio of the larger stiffness to the smaller stiffness. An additional 10% conservatism is also specified. Note that the reported support reactions are <u>not</u> decreased if the observed stiffness is actually less than that modeled in the analysis.

3.5 Branch Connection Details Discrepancies

In the case of branch connection details, the issue centers on the use of the proper value for the Stress Intensification Factor (SIF). The approach required by the Instruction is thus rather straight forward. Namely, the effect of the discrepancy is simply accounted for by multiplying the reported pipe stress by the ratio of the correct SIF to the incorrect SIF.

3.6 Elbow Radii Discrepancies

As with the case of branch connection details, the case of elbow radii discrepancies centers on the use of a proper Stress Intensification Factor (SIF). The effect of the discrepancy is simply accounted for by multiplying the reported pipe stress by the ratio of the correct SIF to the incorrect SIF.

3.7 Restraint Modeling Discrepancies

If a restraint was included in a mathematical model but was found not to exist, the Instruction allows the apparent discrepancy to be treated in the same manner as used to evaluate a missing support discrepancy. This approach is logical since the effect of the two types of discrepancies is essentially the same, as it relates to the validity of the analysis results. On the other hand, if the mathematical model did not include a restraint which was determined to exist, that type of apparent discrepancy is to be evaluated using the same approach as specified for the case of a non-demolished support because, again, the only valid concerns are similar. Note that restraint modeling discrepancies are also permitted to be evaluated by other means as long as those means are based upon sound engineering judgement and the bases are explained and documented.

3.8 Pipe Routing Discrepancies

The only bases for accepting pipe routing discrepancies which are provided by Instruction CEC-99-014 are specified tolerances which have been described in Section 2 of this commentary.

3.9 Component Weight Discrepancies

Tolerances, as discussed in Section 2 of this commentary, are provided as a bases for evaluating component weight discrepancies. Also, it is acceptable to use simplified mathematical models to bound the effects of such discrepancies so long as it can be clearly argued and documented that the models produce bounding results.

3.10 Pipe Segment Length Discrepancies

Tolerances, as discussed in Section 2 of this commentary, are provided as a bases for evaluating pipe segment length discrepancies. Also, it is permissible to evaluate such discrepancies by computing the bounding effects on pipe stresses and support reactions. In the case of pipe stresses, the static effects are clearly a function of the square of the length of pipe between adjacent supports and thus the method specified requires that the reported pipe stresses be increased by the square of the ratio of the observed, longer segment length to the length used in the analysis. This result is further increased by 20% to provide additional conservatism. Note that if the pipe segment length is observed to be shorter than modeled, it is not permitted to reduce the reported values of the pipe stresses.

For the effects on the reactions in the supports at either end of the pipe segment under consideration, the approach is based upon rational provided in Reference 6.3. Namely, the reported reactions are increased by the square of the appropriate ratio of pipe length segments. In one sense, the increase in the pipe support reactions will be influenced by the direct ratio of the two lengths (as it relates to the weight and mass of pipe between the two supports). However, since the change in stiffness of the system will be in proportion to the square of the ratio of the two lengths and since this will result in a more conservative prediction of the bounding effect, that approach is specified. Also, an additional 10% margin is specified.

3.11 Support Orientation Discrepancies

The only approach permitted for the evaluation of support orientation discrepancies is by the comparison with tolerances as discussed in Section 2 of this commentary.

3.12 Valve Operator Orientation Discrepancies

The only approach permitted for the evaluation of valve operator orientation discrepancies is by the comparison with tolerances as discussed in Section 2 of this commentary.

3.13 Other Discrepancies

No specific rules are given for discrepancies of types other than those described above. However, special case evaluations are permitted as long as the methods used are clearly demonstrated to produce conservative values for the bounding effects. This is consistent with the presidence established for such evaluations as long as the bases are adequately documented and the arguments as to the validity of the approach used are technically sound arguments.

4.0 PREVIOUSLY USED OPERABILITY CRITERIA

The operability criteria (stress and pipe support load allowables) specified in Instruction CEC-99-014 were initially developed during the I.E. 79-14 Bulletin program for Dresden and Quad Cities. This criteria, which initially addressed only pipe stresses, was eventually expanded to cover pipe supports as well. NUTECH's 79-14 criteria was contained in Project Instruction COM-PI-008 (Reference 6.4), which was reviewed and accepted by the NRC.

In August, 1986, an operability procedure, including acceptance criteria, was written for evaluating small bore piping at Dresden and Quad Cities. The criteria in this procedure, XNC-03-001 (Reference 6.5), was identical to the 79-14 operability acceptance criteria used by NUTECH during the 79-14 program.

The current criteria used for the second level screening, in Instruction CEC-99-014, is the same as that used in the XNC-03-001 document and the original NUTECH 79-14 document COM-PI-008.

5.0 SUMMARY

The purpose of the Second Level Screening criteria is to quickly screen potential discrepancies (DDRs) to determine the likelihood of their meeting operability criteria. The screening step is an essential prioritization of DDRs for evaluation against FSAR criteria. All DDRs are ultimately reviewed for FSAR compliance, regardless of whether they "pass" or "fail" the Second Level Screening.

This commentary provides insight into the reasoning used by the author in developing the Second Level Screening criteria. The objective of this commentary is not to "prove" the adequacy of the approaches used, but to provide some assurance that the criteria is based on sound, reasonable approaches and is sufficient for its intended purpose.

6.0 REFERENCES

6.1 NUTECH Instruction CEC-99-014, "Piping Configuration Verification, Second Level Screening Criteria"

6.2 CECo Operability Criteria for I.E. 79-14 Bulletin Program at Dresden and Quad Cities

6.3 Welding Research Council Bulletin 316, Technical Position on Piping Installation Tolerances, July, 1986

6.4 NUTECH Project Instruction COM-PI-008, "Piping Operability assessment"

6.5 NUTECH Instruction XNC-03-001, "Mark I Operability Assessment Procedure for Small Bore Pipe Supports"