UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST TO USE CODE CASE N-480 FOR

DUKE POWER COMPANY

CATAWBA NUCLEAR STATION, UNIT 1

DOCKET NO. 50-413

1.0 INTRODUCTION

By letters dated August 5 and August 8, 1996, Duke Power Company (DPC or the licensee) proposed an alternative to the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Section III, Subarticle NC-3600, for Catawba Nuclear Station, Unit No. 1. The licensee requested approval to use the evaluation and analysis provisions in Section 3600 of ASME Code Case N-480, "Examination Requirments for Pipe Wall Thinning Due to Single Phase Erosion and Corrosion, Section XI, Division 1." The licensee intends to apply the allowances of N-480 to two 18-inch sections of pipe in two portions of feedwater piping. Both sections are just down stream of check valves.

2.0 ASME CODE REQUIREMENTS

The requirements for the determination of the minimum wall thickness for piping products for the Catawba Nuclear Station, Unit 1, are found in the 1974 Edition of the ASME Code, Section III, Paragraph NC-3640.

NC-3640 PRESSURE DESIGN OF PIPING

NC-3641.1 Straight Pipe Under Internal Pressure

The minimum thickness of pipe wall required for design pressures and for temperatures not exceeding those for the various materials listed in Tables 1-7.0 including allowances for mechanical strength, shall not be less than that determined by Formula (3) as follows:

$$t_m = \frac{PD_o}{2(S+Py)} + A$$

$$P = \frac{2S(t_m - A)}{D_o - 2y(t_m - A)}$$

$$t_m = \frac{Pd + 2SA + 2yPA}{2(S + Py - P)}$$

t_m = minimum required wall thickness, inches

Note: If pipe is ordered by its nominal wall thickness, the manufacturing tolerance wall thickness must be taken into account. After the minimum pipe wall thickness, t, determined by Formula (3), this minimum thickness shall be increased by an amount sufficient to provide the manufacturing tolerance allowed in the applicable pipe specification or required by the process. The next heavier commercial wall thickness shall then be selected from standard thickness schedules such as contained in ANSI B36.10 or from manufacturers' schedules for other than standard thickness. The wall thickness of tubing shall not be less than that shown by Fig. NC-3676.6(a)(1)-1.

P = internal design pressure, psi

Note: When computing the design pressure for a pipe of a definite minimum wall thickness by Formula (4), the value of P obtained by this Formula may be round out to the next higher unit of 10.

D_o = outside diameter of pipe, in. For design calculations, the outside diameter of pipe given in tables of standards and as given in tables of standards and specifications shall be used in obtaining the value of t_m. When calculating the allowable working pressure of pipe on hand or in stock, the actual measured outside diameter and actual measured minimum wall thickness at the thinner end of the pipe may be used to calculate this pressure.

d = inside diameter of pipe, in. In using Formula (5), the value of d is for the maximum possible inside diameter allowable under the purchase specifications.

S = maximum allowable stress in material at the design temperature, psi.

A = an additional thickness. in inches, which may be used as stipulated in (a), (b), and (c) below

(a) To compensate for material removed or wall thinning due to threading, or grooving, required to make a mechanical joint. The values *of A* listed in Table NC-3641.1(a)-i are minimum values for material removed in threading.

TABLE NC-3641.1(a)
VALUES OF A

Type of Pipe	A (Inches)
Threaded steel & nonferrous pipe	
3/4 in. nominal & smaller	0.065
1 in. nominal & larger	Depth of Thread
Grooved steel & non-ferrous pipe	Depth of Groove plus 1/64 in.

(b) To provide for mechanical strength of the pipe. Small diameter, thin wall pipe or tubing is susceptible to mechanical damage due to erection, operation and maintenance procedures. Accordingly, appropriate means must be employed to protect such piping against these types of loads if they are not consider as design loads. Increased wall thickness is one way contributing to resistance against mechanical damage.

(c) To provide for corrosion or erosion. Since corrosion and erosion vary widely from installation to installation, it is the responsibility of designers to determine the proper amounts which must be add for either or both of these conditions.

y = a coefficient having a value of 0.4 except that, for pipe with a D_o/t, ratio less than 6, the value of y shall be taken as:

$$y = \frac{d}{d + D_o}$$

3.0 LICENSEE'S BASIS FOR REQUEST

Duke Power Company has requested approval to use the evaluation and analysis provisions in ASME Code Case N-480 as an alternative to the requirements found in the 1974 Edition of ASME Section III for the determination of minimum wall thickness. The acceptance standards and analytical evaluation sections of Code Case N-480 state:

-3400 ACCEPTANCE STANDARDS

To accept an eroded or corroded piping item for continued service without further evaluation, the minimum predicted wall thickness(t_p), projected to the next inservice examination, shall not be less than 0.875 times the nominal thickness of the piping item, t_{nom} as given in the design documentation.

When t_p *is less* than 0. 875 t_{nom}, the acceptability of the piping item for continued service shall be evaluated using the criteria defined in -3410 and -3420.

Evaluation for Repair or Replacement

When t_p is not greater than 0.3 t_{nom}, further evaluation is not permitted and the piping item shall be repaired of replaced.

-3420 Evaluation for Continued Service

When t_p is less than 0.875t_{nom} but greater than 0.3t_{nom}, the piping item shall be repaired, replaced, or evaluated for acceptability for continued service. An acceptable evaluation method and criteria are given in -3600. Alternative evaluation methods and Criteria may be used. When alternative methods or criteria are used, the evaluation methods, the criteria, and the evaluation shall be the responsibility of the Owner and shall be subject to review by the regulator and enforcement authorities having jurisdiction at the plant site.

-3600 ANALYTICAL EVALUATION

(a) Piping items with predicted erosion-corrosion wall thinning exceeding the standards of -3400 may be evaluated to determine their acceptability for continued service in accordance with the evaluation procedures and acceptance criteria of -3610 and -3620. The evaluation is a two part procedure. Compliance with the criteria of the first part demonstrates adequacy for continued service without further evaluation. The second part evaluates piping with deeper wall degradation.

(b) The analytical evaluation shall be the responsibility of the Owner and shall be subject to review by the regulatory and enforcement authorities having jurisdiction at the plant site.

(c) For piping items with predicted erosion-corrosion wall thinning that exceeds the acceptance standards of-3400, and satisfies the acceptance criteria of -3600, the areas containing the degradation shall be examined during three successive inservice examinations. The examination frequency shall be determined by the predicted erosion-corrosion rate in accordance with -2420. The frequency of further examinations shall be determined by the erosion-corrosion rate calculated from inservice inspection data.

-3610 Evaluation Procedure and Acceptance Criteria- Step I

(a) For acceptance of an affected piping item for continued service without further evaluation, t_p shall not be

less than t_{min}, where t_{min} is the calculated minimum wall thickness for the piping item determined from the primary stress equations of the Construction Code. Both hoop and axial stress directions shall be considered and bending load shall be included. Design pressure and design mechanical loads shall be used at design temperature. When bending loads are not available, bounding values shall be used. Alternatively, assume t_{min} equals $0.876t_{nom}$ and proceed with Step 2, below.

(b) When t_p is less than t_{min}, an evaluation shall be performed in accordance with Step 2 below.

-3620 Evaluation Procedure and Acceptance Criteria- Step 2

-3621 Acceptance Criteria

For acceptance of an eroded or corroded piping item with degradation deeper than that permitted by-3610 for continued service, or for which it has been assumed that t_{min} equals 0.876 t_{nom}, t_p predicted to the end of the evaluation period shall not be less than t_{aloc}, the allowable local wall thickness. The extent of degradation as measured by, L_m, $L_m(_t)$ and $L_m(_a)$, defined in Fig. 3621-1, shall not exceed the requirements of -3622.

-3622 Evaluation Procedure

The evaluation procedure is a function of the depth and the extent of the affected area. An erosion-corrosion area and the parameters which define the depth and extent of thinning are illustrated in Fig. -3621-1. The allowable local was thickness, t_{aloc}, is determined from -3622.1, -3622.2, and -3622.3, based on the extent and shape of the thinned area.

-3622.1 Local Thinning(Case 1).

When the transverse extent of wall thinning that exceeds t_{min}, $L_m(_t)$, is not greater than $\sqrt{Rt_{min}}$, t_{aloc} is determined from Curve 1 of Fig. -3622-1, where R is the pipe outside radius and $L_m(_t)$ is defined in Fig. -3621-1. When the above requirement is not satisfied, -3622,2 shall be met.

-3622.2 Local Thinning(Case 2).

When the maximum extent of wall thinning that exceeds t_{min}, $L_m(_t)$, is not greater than 2.65 $\sqrt{Rt_{min}}$ and t_{nom} is greater than $1.13t_{min}$, t_{aloc}, is determined by satisfying both of the following equations:

$$\frac{t_{aloc}}{t_m} \geq 1.5 \frac{\sqrt{Rt_{min}}}{L}\left[1 - \frac{t_{nom}}{t_{min}}\right] + 1$$

$$\frac{t_{aloc}}{t_{min}} \geq 0.353 \frac{L_m}{\sqrt{R t_{min}}}$$

When the above requirements are not satisfied, -3622.3 shall be met.

-3622.3 Local Thinning(Case 3)

When the requirements of both-3622.1 and -3622.2 are not satisfied, t_{aloc} is determined from curve 2 of Fig. -3622-1. In addition, t_{aloc} shall satisfy the applicable Construction Code equation.

The licensee determined that the minimum allowable wall thickness for loop "A" calculated using Code Case N-480 is 0.689 inch. The projected minimum wall thickness at the start of the next refueling outage will be 0.755 inches. The projected minimum wall thickness was determined using CHECKWORKS, the latest version of software developed by the Electric Power Research Institute (EPRI) to estimate wall thinning by erosion-corrosion.

The minimum allowable wall thickness for loop "B" calculated using Code Case N-480 is 0.689 inch. The projected minimum wall thickness at the start of the next refueling outage will be 0.762 inch.

The licensee believes the projected thickness provides an adequate margin (loop "A," 0.066 inch and loop "B," 0.073 inch) to the acceptable limits of Code Case N-480.

4.0 EVALUATION

The equations in Section III of the Code were developed without consideration for erosion-corrosion. As erosion-corrosion events occurred in the nuclear industry, methods were developed to analyze situations where either erosion or erosion-corrosion were encountered. The methods developed were incorporated into Code Case N-480. Although the staff has not formally approved Code Case N-480 in RG 1.147 at this time, the analytical methods incorporated in Code Case N-480 are referenced in Generic Letter 90-05, "Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2, and 3 Piping," as methods considered acceptable as alternatives to the Section III requirements for determining if adequate wall thickness remains.

The staff has reviewed the licensee's submittal and concludes that the licensee has demonstrated that sufficient margin exists in the affected feedwater lines to safely operate the plant until the next refueling outage.

5.0 CONCLUSIONS

The staff has reviewed Duke Power Company's submittal and finds that the use of Code Case N-480 is an acceptable alternative to the Code requirements pursuant to 10 CFR 50.55a(a)(3)(i) as long as Duke Power Company satisfies all of the requirements in the Code Case as discussed above. The use of the alternative to the Code requirements is authorized and will provide an acceptable level of quality and safety.

This authorization is valid until the Code Case is included in a future revision of Regulatory Guide 1.147. At that time, Duke Power Company is to follow all the provisions in Code Case N-480, with the limitations issued in Regulatory Guide 1.147, if any, if it continues to implement this alternative.

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Dated: September 9, 1996