CENTRAL FILES

NIAGARA MOHAWK

NMP-1135

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July 6, 1979

Mr. Boyce H. Grier
Director
United States Nuclear Regulatory Commission
Region I
631 Park Avenue
King of Prussia, PA. 19406

RE: Docket No. 50-220
I.E. Bulletin 79-02

Dear Mr. Grier:

Your March 8, 1979 I.E. Bulletin 79-02 addressed concerns with pipe support base plate designs using concrete expansion anchor bolts.

The attachments address those concerns.

Very truly yours,

Thomas E. Lempges

Thomas E. Lempges
General Superintendent
Nuclear Generation
for R.R. Schneider
Vice President -
Electric Production

mtm

Attachments

xc: United States Nuclear Regulatory Commission
Office of Inspection and Enforcement
Division of Reactor Operations Inspection
Washington, D.C. 20555

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ITEM 1

Verify that pipe support base plate flexibility was accounted for in the calculation of anchor bolt loads. In lieu of supporting analysis justifying the assumption of rigidity, the base plates should be considered flexible if the unstiffened distance between the member welded to the plate and the edge of the base plate is greater than twice the thickness of the plate. It is recognized that this criterion is conservative. Less conservative acceptance criteria must be justified and the justification submitted as part of the response to the Bulletin. If the base plate is determined to be flexible, then recalculate the bolt loads using an appropriate analysis. If possible, this is to be done prior to testing of anchor bolts. These calculated bolt loads are referred to hereafter as the bolt design loads. A description of the analytical model used to verify the pipe support base plate flexibility is accounted for in the calculation of anchor bolt loads is to be submitted with your response to the Bulletin.

It has been noted that the schedule for analytical work on base plate flexibility for some facilities extends beyond the Bulletin reporting time frame of July 6, 1979. For those facilities for which an anchor bolt testing program is required (i.e., sufficient QC documentation does not exist), the anchor bolt testing program should not be delayed.

In re-analyzing pipe support base plates using concrete expansion anchors on seismic Category I Systems, flexible plate effects are considered for all plates.

For flexibility effects due to the moment, the resultant of the concrete compressive stress was assumed to be acting directly beneath the edge of the attachment which is furthest from the center of the anchors under tension (See Figure 1). This assumption is considered conservative because:

1) *The deflection and resulting load is greatest beneath the point of application of the load.*
2) *The attachment to the base plate serves as a stiffener on the base plate. This enables the assumption of rigid plate behavior over that area of the base plate where the attachment is connected.*

For flexibility effects due to direct tension, the tensive load per concrete expansion anchor was increased by a factor of 1.5. This assumption conservatively bounds uncertainties related to stiffnesses of concrete and anchor bolts used in various finite element analysis completed to date by the anchor bolt owner's group.

Shear-Tension interaction has been assumed to combine linearly:

$$\frac{f_t}{F_t} + \frac{f_v}{F_v} \leq 1.0 \text{ (Unity Formula)}$$

f_t = *Actual anchor tensile load*
F_t = *Allowable anchor tensile load*
f_v = *Actual anchor shear load*
F_v = *Allowable anchor shear load*

ITEM 1 (continued)

Values for minimum edge distance and minimum bolt spacing were adopted from those recommended by the Expansion Anchor Manufacturer's Institute. (i.e., if 10 diameters were not met, the allowable anchor loads for shear (F_v) and tension (F_t) were reduced by a factor of the actual spacing divided by the minimum spacing).

ITEM 2

Verify that the concrete expansion anchor bolts have the following minimum factor of safety between the bolt design load and the bolt ultimate capacity determined from static load tests (e.g. anchor bolt manufacturer's) which simulate the actual conditions of installation (i.e., type of concrete and its strength properties):

a. Four - For wedge and sleeve type anchor bolts,

b. Five - For shell type anchor bolts.

The bolt ultimate capacity should account for the effects of shear-tension interaction, minimum edge distance and proper bolt spacing.

If the minimum factor of safety of four for wedge type anchor bolts and five for shell type anchors can not be shown then justification must be provided.

The minimum factors of safety recommended by I.E. Bulletin 79-02 were used. The allowable anchor loads for shear (F_v) and tension (F_t) were calculated as follows based on the anchor manufacturer's literature:

	Sleeve & Wedge	*Shell*
Allow. Anchor Load Shear (F_v)	$Pu_s/4$	$Pu_s/5$
Allow. Anchor Load Shear (F_t)	$Pu_t/4$	$Pu_t/5$

Pu_s = Ultimate Load Capability of the Anchor in Shear
Pu_t = Ultimate Load Capability of the Anchor in Tension

$$F_v = (Pu_s / 4 \text{ or } 5) \left(\frac{\text{Actual Spacing or Edge Distance}}{\text{Minimum Spacing or Edge Distance}} \right)$$

$$F_t = (Pu_t / 4 \text{ or } 5) \left(\frac{\text{Actual Spacing or Edge Distance}}{\text{Minimum Spacing or Edge Distance}} \right)$$

ITEM 3

Describe the design requirements if applicable for anchor bolts to withstand cyclic loads (e.g. seismic loads and high cycle operating loads).

Cycle load testing information is currently being developed generically by the Owners Group. This information is expected to be available by August 15, 1979 and will be submitted by that date.

ITEM 4

Verify from existing QC documentation that design requirements have been met for each anchor bolt in the following areas:

(a) Cyclic loads have been considered (e.g. anchor bolt preload is equal to or greater than bolt design load). In the case of the shell type, assure that it is not in contact with the back of the support plate prior to preload testing.

(b) Specified design size and type is currectly installed (e.g. proper embedment depth).

An inspection, testing and repair program is currently in progress at Nine Mile Point Unit #1. The attached table provides the status of this program.

The inspection program consists of 100% base plate dimensional checks, approximately 100% examination of all anchor bolts including removal to check for dimensions and proper installation.

After repairs are made, one (1) bolt per base plate will be pull-tested if practical. The anchor bolts are tested to the bolt design load considering shear and flexible plate effects. Anchors between 1/4" and 3/4" in diameter are acceptable if anchor slippage under tested load is less than 0.065". Anchors larger than 3/4" in diameter are acceptable if anchor slippage is less than one thread pitch displacement. Industry standards and practices indicate that bolts are capable of withstanding four times the test load, if anchor slippage is less than the amount indicated above. Therefore, this acceptance criteria meets the required minimum factor of safety between bolt design load and bolt ultimate capacity indicated in the Bulletin. The design load will be appropriately increased for those bolts required to have a minimum factor of safety of five.

Prior to startup, all pipe restraints which would become inaccessible during power operation were inspected, tested on a sample basis, analyzed and repaired, if necessary.

As of July 4, 1979, 30% of the base plates inspected have been pull-tested with only one (1) bolt failure. This confirms that our inspection and repair program is sufficient to assure that bolts will perform adequately.

All inspection, repair and testing is scheduled for completion by December 31, 1979. A final report will be submitted within sixty (60) days of completion of this program. Justification to support continued operation is contained in Licensee Event Report LER 79-12, submitted on June 6, 1979 by letter from R.R. Schneider to B.H. Grier.

SUMMARY TABLE OF INSPECTION PROGRAM FOR BASE PLATES ANCHORED IN CONCRETE[1]

	# of Plates	# of Plates Inspected[2]	# of Plates With Deficiencies[3]
High Energy Systems Including Main Steam[4], Feedwater[4], Emergency Condenser and Control Rod Drive Systems	357	327	135
Other Safety Related Systems Which Have Been Inspected Including Core Spray, Reactor Instrumentation, Shutdown Cooling, Liquid Poison, Condensate Transfer, Reactor Building Closed Loop Cooling, and Containment Spray Systems	776	729	193
Other Safety Related Systems[5] Which Have Not Been Inspected Including Cleanup, Vacuum Relief, Diesel Generator Cooling, Instrument Air, Diesel Generator Starting Air, N_2, Vent and Purge and Drywell Instrumentation Systems	208	30	---
TOTAL	1341	1086	328

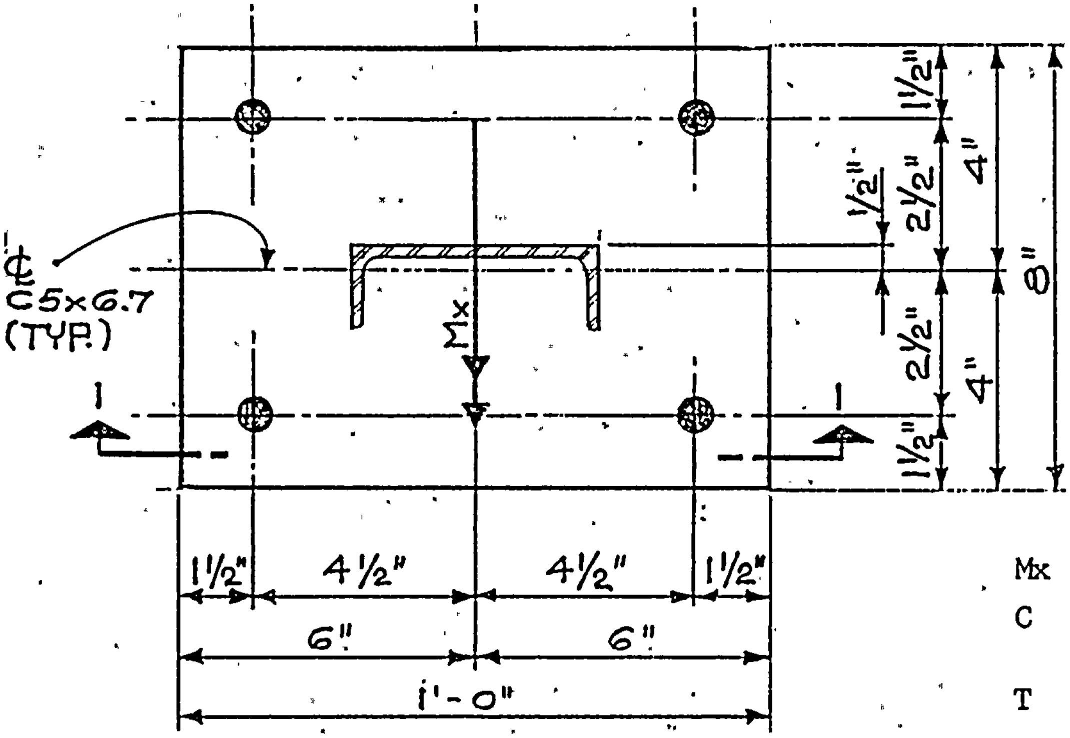
1 Average of 4 bolts per base plate

2 30% of those base plates inspected have been pull-tested with only one failed bolt as of July 4, 1979.

3 90% of all identified repairs have been made as of July 4, 1979. Although the repairs may require a complete new base plate, the deficiency may only be with one bolt.

4 All base plates anchored in concrete in the Main Steam and Feedwater Systems are non-safety related.

5 The Containment Atmosphere Dilution System is not included since this was installed and inspected within the last two years.



PLAN

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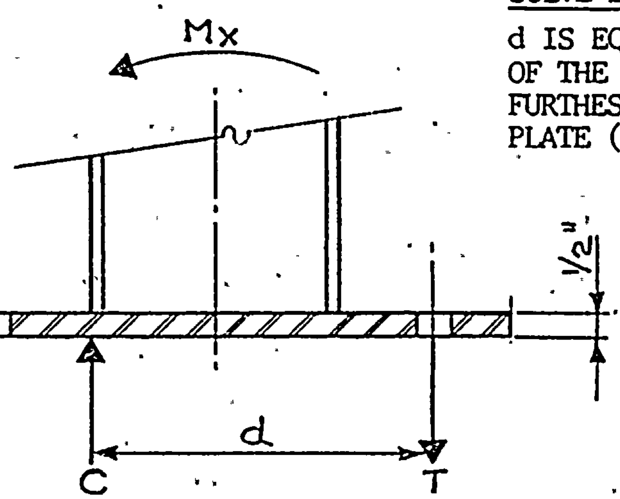

SECTION 1-1

Mx – MOMENT ABOUT X-AXIS

C – RESULTANT OF CONCRETE COMPRESSIVE STRENGTH

T – TENSILE FORCE IN CONCRETE EXPANSION ANCHOR

d – MOMENT ARM FOR RESISTING OVERTURNING POINT

SOLVE BY STATICS:

d IS EQUAL TO THE DISTANCE FROM THE CENTERLINE OF THE TENSION CONCRETE EXPANSION ANCHORS TO THE FURTHEST EDGE OF THE ATTACHMENT TO THE BASE PLATE (IN THIS EXAMPLE, d = 5.5").

$\Sigma m = 0$ IMPLYING $T = Mx/d$

$\Sigma F_y = 0$ IMPLYING $T = C$

NIAGARA MOHAWK POWER CORP.

SYRACUSE, N.Y.

NINE MILE POINT-UNIT #1

NRC BULLETIN 79-02

NOTE: MODEL USED TO CALCULATE LOADS ON CONCRETE EXPANSION ANCHORS DUE TO MOMENT.

FIGURE 1