PSE&G

Public Service Electric and Gas Company 80 Park Place Newark, N.J. 07101 Phone 201/430-7000

January 18, 1979

Director of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. Olan D. Parr, Chief
Light Water Reactors Branch 3
Division of Project Management

Gentlemen:

RESPONSE TO REQUESTS FOR
ADDITIONAL INFORMATION
NO. 2 UNIT
SALEM NUCLEAR GENERATING STATION
DOCKET NO. 50-311

Public Service Electric and Gas Company hereby transmits sixty (60) copies of its responses to certain of your requests for additional information to NRC Questions 4.38, 5.96, 5.110, 13.9 (preoperational testing), Quality Assurance and Subcompartment Analysis. The information contained herein will be incorporated into the Salem FSAR in an amendment to our application.

Should you have any questions, please do not hesitate to contact us.

Very truly yours,

R. L. Mittl
General Manager -
Licensing and Environment
Engineering and Construction



Enclosure

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The Energy People



AP

QUESTION 4.38

Appendix XVII-2461 of the ASME Code Section III requires that bolt loads in bolted connections for linear component supports include prying effects due to the flexibility of the connection.

(1) Provide confirmation that the loads in bolted connections for linear component supports were determined by considering the deformation of the connection and tension-shear interaction for the bolts. For connections of supports which are anchored to a concrete structures provide in addition:

a. The type of anchor bolt

b. The factors of safety (and their bases) against pullout under static, repeated and transient loading.

This information should include representatives diagrams of the connections, material properties and interaction diagrams, the analythical techniques and models used, and the maximum stresses in the bolts and the connections under both static, repeated, and transient type loading.

(2) If any connection was assumed to be rigid, provide complete analytical or experimental justification for this assumption.

ANSWER

(1) In developing designs for bolted component supports for piping, tension and shear interactions were considered. The design conservatism on structural members is considered sufficient such that deformation of the connection does not adversely affect the capacity of connections to withstand design loadings.

a. Types of anchor bolts used for the various bolted connections in the plant are as follows:

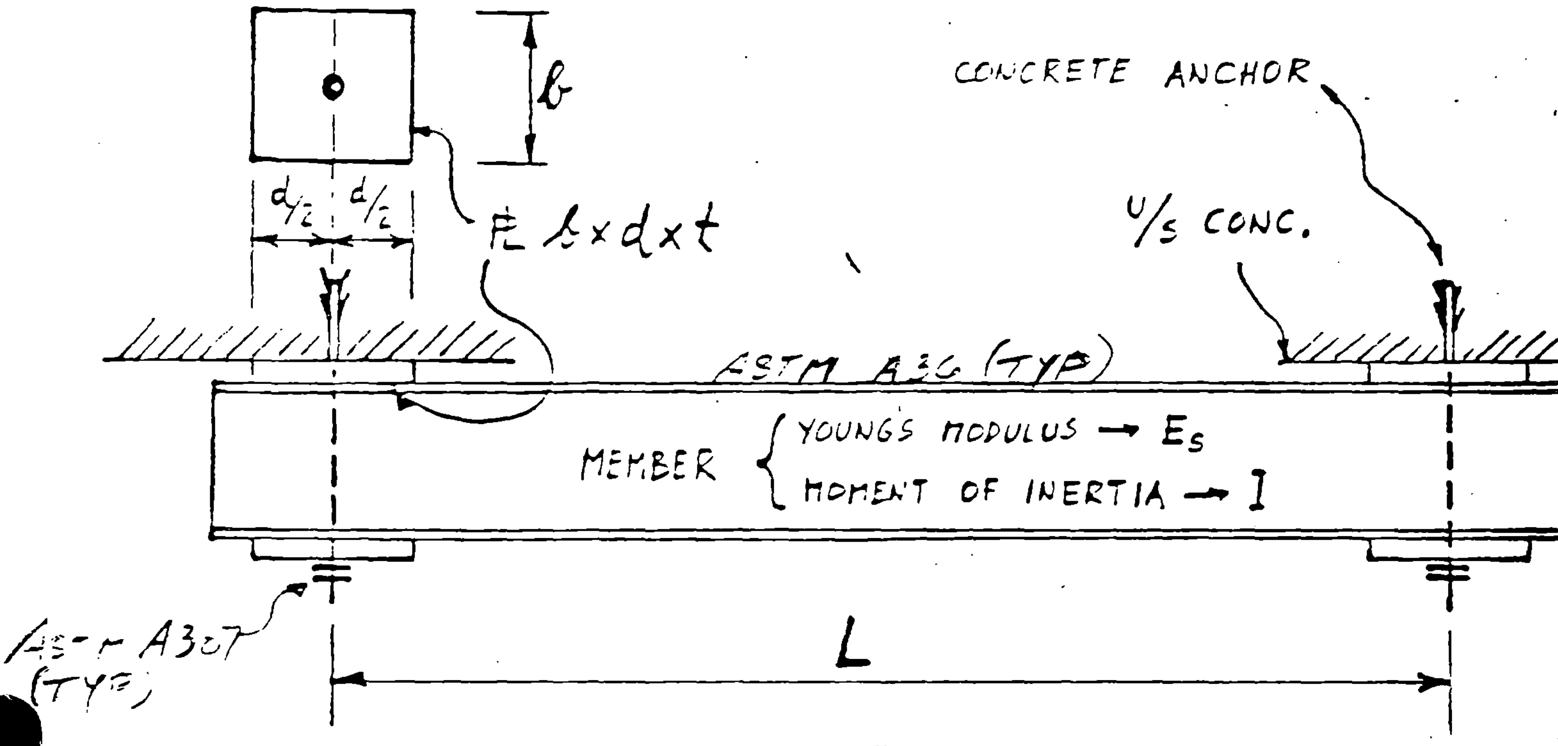
(1) The majority of safety related supports employ connections bolted to concrete inserts which derive their strength from an integral steel

coil embedded in the concrete at the time of structure forming.

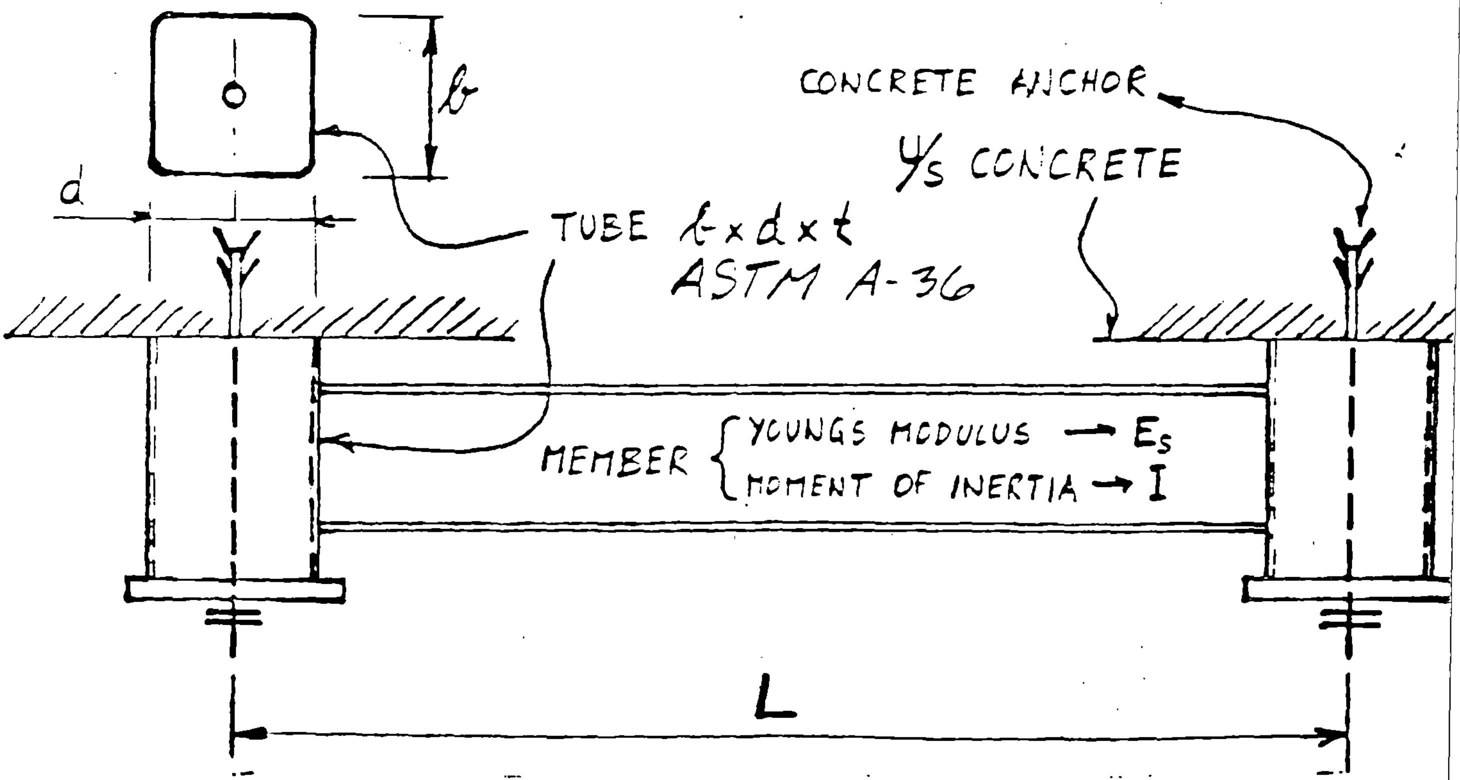
(2) The other type of anchor bolt used employs an expandable wedge piece inserted in a pre-bored hole in the concrete.

b. Loads applied to these anchor bolts are within manufacturer's specified limits. Attached you will find representative analysis of typical standard supports.

(2) The assumption of rigidity for bolted linear support connections, where applicable, is made on the basis that the applied loads to the supports have been determined by analytical methods to be adequate. Refer to attached typical support evaluation.




TYPE "G" FRAMING




TYPE "E" OR "F" FRAMING

## INPUT PARAMETERS :

$B = \frac{b}{2}$ (in case of circ. ℞'s or round tubes → B = RADIUS)

$D = \frac{d}{2}$ (in case of circular ℞'s or round tubes → D = RADIUS)

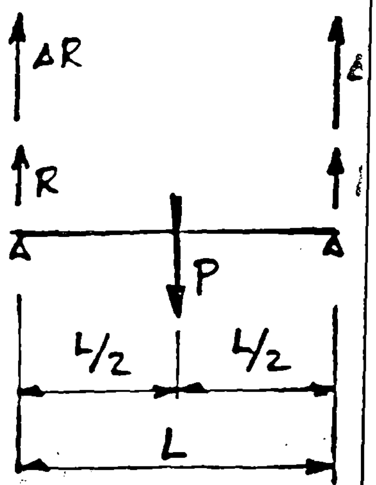
$A_s$ = TENSILE CROSS-SECTIONAL AREA OF A. BOLT

$L$ = SPAN LENGTH $h$ = DEPTH OF MAIN MEMBER

$I$ = MOMENT OF INERTIA OF MAIN MEMBER (s)

$$n = \frac{E_s}{E_c} \approx 8$$

ADDITIONAL REACTION IN CONCRETE ANCHOR DUE TO PRYING ACTION ($\Delta R$) :




$$\Delta R = \frac{PL^2}{8\left(D - \frac{kd}{3}\right)\left(L + \frac{2nI}{Z_c} + \frac{2I}{Z_s}\right)}$$

$$Z_c = \frac{1}{2} B D jd \qquad Z_s = \frac{2 A_s D jd}{h}$$

$$kd = -\frac{n A_s}{B} + \sqrt{\left(\frac{n A_s}{B}\right)^2 + 2D \frac{n A_s}{B}}$$

$jd$ … $kd$

## 1- EXAMPLE

$n = 8$, $B = \frac{4}{2} = 2\ in$, $D = \frac{4}{2} = 2\ in$, $A_s = 0.61\ in^2$ (1"φ BOLT)
$L = 45\ in$, $I = 17.8\ in^4 \Rightarrow 2\ C5\times9$, $h = 5$

$$kd = -\frac{8(0.61)}{2} + \left[\left(\frac{8(0.61)}{2}\right)^2 + \frac{2(2)(8)(0.61)}{2}\right]^{\frac{1}{2}} = 1.52\ in$$

$$jd = 2 - \frac{1.52}{3} = 1.49\ in$$

$$Z_c = \frac{1}{2}(2)(2)(1.49) = 2.98\ in^3$$

$$Z_s = \frac{2(0.61)(2)(1.49)}{5} = 0.73\ in^3$$

$$\Delta R = \frac{45^2 P}{8(1.49)\left(45 + \frac{2(8)(17.8)}{2.98} + \frac{2(17.8)}{0.73}\right)} = 0.9P$$

TOTAL REACTION FOR ONE END $= R + \Delta R = 0.5P + 0.9P$
$= 1.4P$

CAPACITY OF RICHMOND TYPE EC INSERT:

$T = 10000$ lbs (SAFE WORKING LOAD)

MAXIMUM HANGER CAPACITY $= 1.4P = 10000$

$P = 7143$ lbs

HANGER A2-SWH-49
(DWG 236838D4253)
COMBINED LOAD = 4745 lbs

## 2- EXAMPLE (LOAD ACTING AT MIDSPAN):

$n = 8;\ B = \frac{5.25}{2} = 2.62\ in;\ D = \frac{3.0}{2} = 1.5\ in;\ A_s = 0.61\ in^2$ (1"φ BOLT)

$L = 43\ in;\ h = 4.0\ in;\ I = 9.18\ in^4 \longrightarrow$ 2 - C4×7.25

$$kd = -\frac{8*0.61}{2.62} + \sqrt{\left(\frac{8*0.61}{2.62}\right)^2 + 2*1.5\ \frac{8*0.61}{2.62}}$$

$$kd = -1.86 + \sqrt{3.47 + 5.59} = -1.86 + 3.01 = 1.15\ in$$

$$jd = 1.5 - \frac{1.15}{3} = 1.12\ in$$

$$Z_c = \frac{1}{2} * 2.62 * 1.5 * 1.12 = 2.20\ in^3$$

$$Z_s = \frac{2*0.61*1.5*1.12}{4.0} = 0.51\ in^3$$

$$\Delta R = \frac{43^2 P}{8\left(1.5 - \frac{1.15}{3}\right)\left(43 + \frac{2*8*9.18}{2.20} + \frac{2*9.18}{0.51}\right)} = \frac{1849\ P}{8.96\ (43 + 67 + 36)} = 1.41\ P$$

TOTAL REACTION FOR ONE END → $R + \Delta R = 0.50P + 1.41P = 1.91\ P$

CAPACITY OF "RICHMOND" TYPE EC-2W 1" CONC. INSERT:

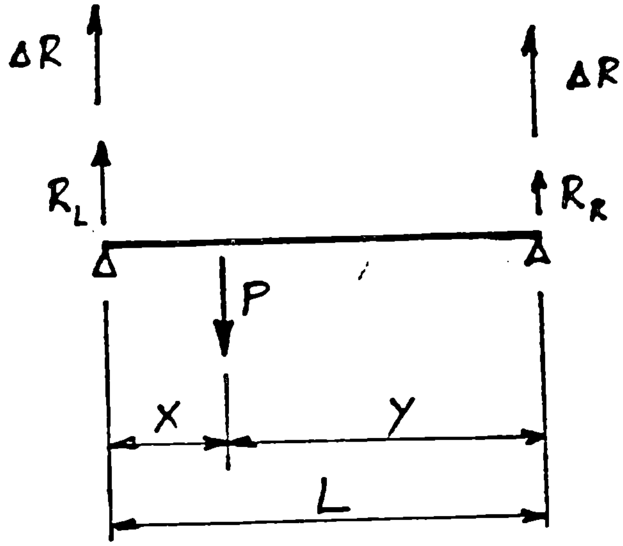
$T = 10\,000$ lbs (SAFE WORKING LOAD)

MAXIMUM HANGER LOAD:

$$1.91\ P = 10\,000 \rightarrow P_{max} = 5235\ lbs$$

HANGER A2-SWH-50
(DWG. 236838 D 4253)
COMBINED LOAD: 5195 LBS

## GENERAL EXAMPLE




(1) COMPUTE "ΔR" AS THOUGH THE LOAD "P" WAS ACTING AT MIDSPAN.

(2) COMPUTE $R_L$ & $R_R$, DISREGARD THE SMALLER ONE OF THESE VALUES:

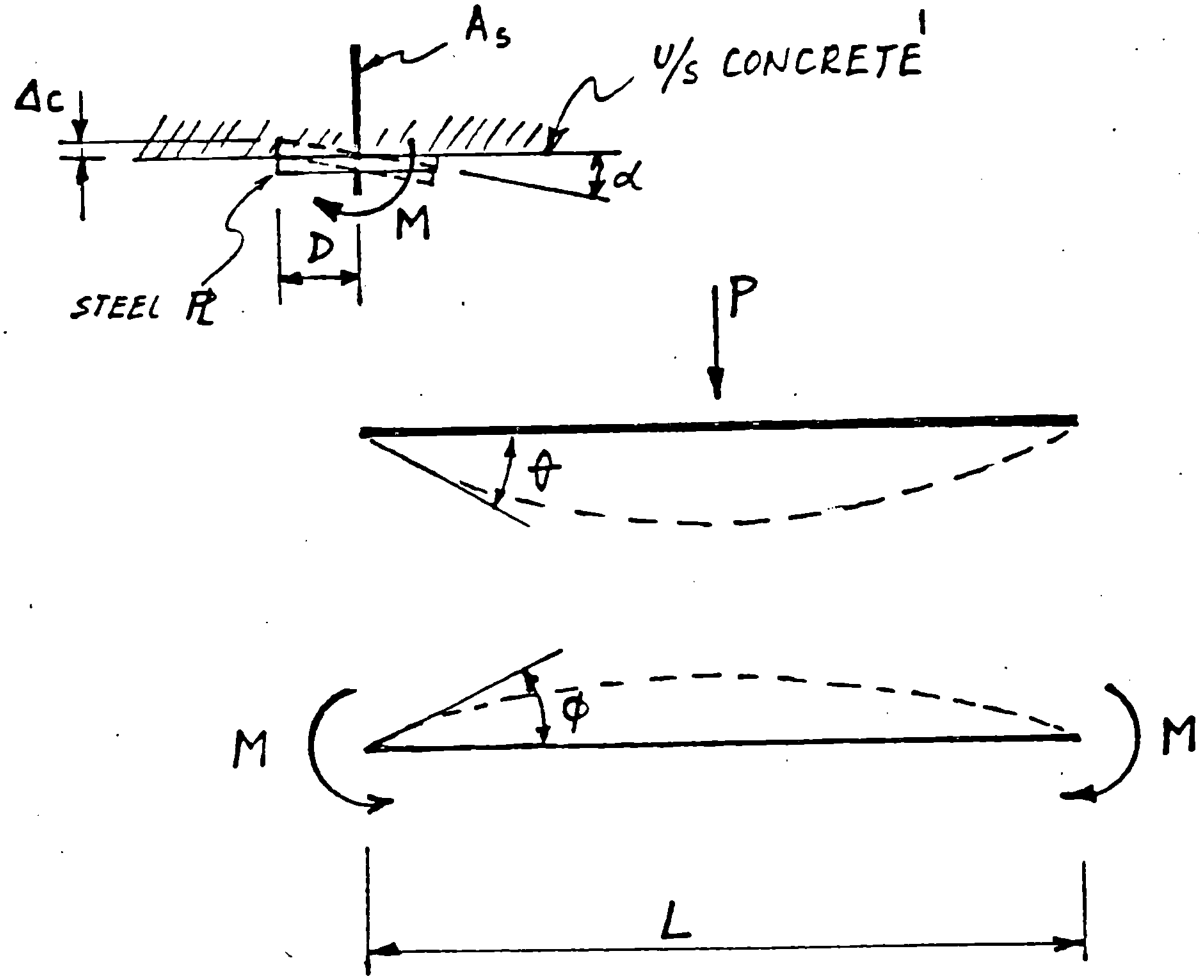
$$R_L = P\frac{Y}{L} \quad \text{(GOVERNS)}$$

$$R_R = P\frac{X}{L}$$

(3) COMPUTE MAX. REACTION FOR ONE SIDE:

$R_{max} = \Delta R + R_L < T$ (safe working load of CONC. AN

## DERIVATION




THE FOLLOWING EQUATION WILL YIELD "M":

$$\alpha = \theta - \phi$$

ADDITIONAL FORCE IN BOLT DUE TO PRYING ACTION:

$$\Delta R = \frac{M}{jd}$$

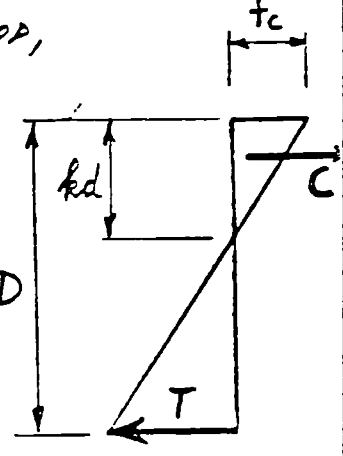
INTERNAL LEVER ARM → $jd = D - \frac{kd}{3}$

FOR "kd" SEE NEXT PAGE

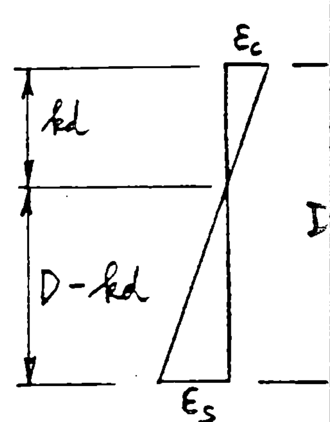
ASSUMPTIONS FOR CONCRETE ANCHORAGE :

(1) BEHAVIOUR SAME AS FOR WORKING STRESS METHOD,

(2) STEEL PLATE IS RIGID. THIS ASSUMPTION IS CONSERVATIVE FOR THE CALCULATION OF THE ROTATIONAL ANGLE "$\alpha$".




STRESSES




STRAINS

$$C = \frac{1}{2} f_c B\, kd$$

$$T = A_s f_s = A_s E_s \varepsilon_s = A_s E_s \frac{D - kd}{kd} * \frac{f_c}{E_c}$$

$$T = A_s n \frac{D - kd}{kd} f_c \quad \text{where} \quad n = \frac{E_s}{E_c}$$

$$\Sigma F = 0 \rightarrow C = T \rightarrow \frac{1}{2} B\, kd = A_s n \frac{D - kd}{kd}$$

$$\frac{B}{2}(kd)^2 = n D A_s - n\, kd\, A_s$$

$$(kd)^2 + \frac{2n}{B} A_s (kd) = \frac{2nD}{B} A_s$$

$$kd = -\frac{n A_s}{B} + \sqrt{\left(\frac{n A_s}{B}\right)^2 + 2D \frac{n A_s}{B}}$$

$$\Sigma M = 0 \rightarrow M = C\, jd = \frac{1}{2} f_c B\, kd\, jd$$

$$f_c = \frac{M}{\frac{1}{2} B\, kd\, jd}$$

$$\Delta = \frac{PL}{AE} = \sigma \frac{L}{E} \rightarrow \Delta_c = f_c \frac{kd}{E_c}$$

where $kd \approx$ AFFECTED CON[CRETE] DEPTH SUBJECT[ED] TO AXIAL COMP[RESSION]

$$\Delta_c = \frac{M}{\frac{1}{2} B\, jd\, E_c}$$

$$\Sigma M = 0 \rightarrow M = T\, jd = A_s f_s\, jd \rightarrow f_s = \frac{M}{A_s\, jd}$$

$$\Delta_s = f_s \frac{h/2}{E_s}$$

where $h$ = DEPTH OF MAIN MEMBER.

$$\Delta_s = \frac{M}{2 A_s\, jd\, E_c}$$

$\frac{h}{2}$ = BOLT LENGTH CONSIDERED FOR

$$\alpha = \frac{\Delta_c + \Delta_s}{D} = \frac{M}{\frac{1}{2} B D jd \, E_c} + \frac{M}{2 \frac{A_s D jd}{h} E_s}$$

let $Z_c = \frac{1}{2} B D jd$ and $Z_s = \frac{2 A_s D jd}{h}$

$$\alpha = \frac{M}{Z_c E_c} + \frac{M}{Z_s E_s}$$

$$\left.\begin{aligned} \theta &= \frac{PL^2}{16 E_s I} \\ \phi &= \frac{ML}{2 E_s I} \end{aligned}\right\} \text{GENERALLY KNOWN EQUATIONS}$$

$$\theta - \phi = \alpha \longrightarrow \frac{PL^2}{16 E_s I} - \frac{ML}{2 E_s I} = \frac{M}{Z_c E_c} + \frac{M}{Z_s E_s}$$

$$\frac{PL^2}{16 E_s I} = \frac{L Z_c E_c Z_s + 2 E_s I Z_s + 2 Z_c E_c I}{2 E_s I Z_c E_c Z_s} M$$

$$M = \frac{PL^2}{8} * \frac{Z_c E_c Z_s}{L Z_c E_c Z_s + 2 I E_s Z_s + 2 Z_c E_c I}$$

$$M = \frac{PL^2}{8L + \frac{16 n I}{Z_c} + \frac{16 I}{Z_s}}$$

$$\Delta R = \frac{M}{jd} = \frac{PL^2}{8\left(D - \frac{kd}{3}\right)\left(L + \frac{2nI}{Z_c} + \frac{2I}{Z_s}\right)}$$

# PROOF TEST REPORT

Product: 1" diameter Richmond E.C. Type Insert with machine thread coil pulled from 18" x 18" x 6" concrete slab by means of 1" x 36" Anchor Stud Bolt with nuts. The insert was made of .442E wire, and its setback in the concrete was 1/8". The concrete slab was reinforced with a .442 wire mat, 6" x 6" center opening, located at mid-depth of the slab. The strength of the concrete was 2850 p.s.i., and the slip dial indicator was zeroed in at a load of 2000 lbs.

Failure occurred in both specimens by the insert pulling out of the concrete slab. Six cracks emanated from the insert on the top of tho slab and extended down on four side surfaces to the reinforcement. The first crack appeared with a load of about 14000 lbs. on both specimens.

Detail:

Anchor Stud

Insert

Specimen No. 1

| Load, kips | Slip, in. |
|---|---|
| 2 | 0 |
| 4 | 0.021 |
| 6 | 0.035 |
| 8 | 0.048 |
| 10 | 0.066 |
| 12 | 0.080 |
| 14 | 0.092 |
| 16 | 0.141 |
| 18 | 0.162 |
| 20 | 0.182 |
| 22 | 0.205 |
| 24 | 0.245 |

Ultimate Load = 25500 lbs.

Specimen No. 2

| Load, kips | Slip, in. |
|---|---|
| 2 | 0 |
| 4 | 0.008 |
| 6 | 0.015 |
| 8 | 0.023 |
| 10 | 0.044 |
| 12 | 0.058 |
| 14 | 0.072 |
| 16 | 0.089 |
| 18 | 0.107 |
| 20 | 0.127 |
| 22 | 0.149 |
| 24 | 0.180 |

Ultimate Load = 24600 lbs.

QUESTION 5.96

Provide the criteria used for the selection of the number of lumped masses.

ANSWER

Refer to the response to Question 5.25. The containment structures at the Salem station used a finite element model for the seismic analysis. A total of 190 elements were used in discretizing the structure.

The Auxiliary Building and Fuel Handling Building used the lumped mass models for the seismic analysis. The points of mass concentration of these buildings are most apparently at the roof, floor and foundations. Heavy equipment and subsystems in the buildings are rigidly attached to the floors. Therefore, the masses of the analytical models were logically lumped at these levels.

We have reviewed our analytical models and have concluded that the degrees of freedom used are adequate. Additional number of degree of freedom in these models will not result in more than 10% increase in structural responses.

Based on the above, the Salem design is in compliance with the modeling criteria defined in Section 3.7.2 of the SRP.

QUESTION 5.110

In request for additional information 5.100 we asked that you state if the fundamental frequencies of the key subsystems are controlled to be either greater than twice or less than one-half the dominant frequencies of their supporting system. Your response stated that the fundamental frequencies of the key subsystems were considered in relation to the dominant frequencies of their supporting systems. However, you did not state if the above criteria were used to accomplish the adequate design of the key subsystems or some other criteria that may be proven to be just as adequate. Provide a more detailed response to this concern.

ANSWER

The fundamental frequencies of key subsystems were considered in relation to the dominant frequencies of their supporting systems. Elimination of resonance was one of the principles of design. Various methods for seismic qualification were employed for key subsystems. In most cases, the key subsystems were considered to be very flexible and were analyzed/tested as a decoupled system from the supporting system. Refer also to the response to Question 5.38 which addresses the approach to avoid the predominant input frequencies of components to earthquake inputs. Refer also to the responses to Questions 4.12, 5.35, 5.37, 7.18 and 7.29.

These subsystems were analyzed/tested as a decoupled system from from the supporting system, because the mass ratio of the subsystem to that of the supporting system is less than 1%.

QUESTION 13.9(a) (Initial Testing)

The test methods and plant's electrical systems status need to be defined for tests that will be conducted to satisfy regulatory positions in Regulatory Guide 1.41, "Preoperational Testing of Redundant Onsite Electrical Power Systems to Verify Proper Load Group Assignments." If exceptions to this guide are taken, they should be explained in sufficient detail to show that the plant status and test methods will provide equivalent assurance of proper load group assignments and independence between redundant AC and DC sources of onsite power and independence from offsite power sources. Otherwise, the test methods described in Regulatory Guide 1.41 will be required by the staff.

ANSWER

The No. 2 Unit initial preoperational test program is in full conformance with the Regulatory guide which functionally demonstrates the independence among redundant onsite power sources and their load groups. This is accomplished by the performance of the Integrated Safeguards Test. As stipulated in part c.1 of the guide, isolation from the offsite transmission network will be accomplished by the direct actuation of the undervoltage sensing relays (opening the 4 kv AC undervoltage relay knife switches). All loads off the No. 2 Unit group buses not required to maintain necessary and independent construction and testing activities, as well as backup power to No. 1 Unit, will be de-energized to the maximum extent practical.

The functional testing requirements covered under c.2 and c.3 of this guide are performed as part of the Integrated Safeguards Test.

QUESTION 13.9(b)

Our position relative to your proposal to eliminate the turbine trip test from 100 percent power is that it is not acceptable. PSE&G should be modified to include this test or the following additional information should be provided:

1. Provide a listing of all initiating events or conditions that result in opening of main generator output breaker.

2. Describe which trips listed in item 1 will result in a direct turbine trip event and which trips will result in a turbine trip event via sensed T-G overspeed conditions.

3. Describe the automatic transfer functions for the plants electrical distribution system along with associated time delays for each initiating event or condition.

4. Describe the means by which you plan to initiate the generator load rejection test from 100 percent power.

ANSWER

1. Table Q13.9-1 indicates the initiating events which cause opening of the main generator output breakers and those which result in a turbine trip. The initiating events are grouped to indicate whether they act to cause a direct turbine trip or a turbine trip via a common tripping device. Refer to Figure Q13.9-1 for information regarding the breaker setup.

2. As indicated in Table Q13.9-1, all automatic generator breaker trips (both breakers) will cause a direct turbine trip. Only a manual trip of both breakers will not cause a direct turbine trip. This will not cause a turbine overspeed trip but result in a reactor trip through primary system parameters and a subsequent turbine trip. An individual output breaker trip will not cause a turbine trip or overspeed

since the generator still has output to the electrical system via the remaining output breaker.

Operation of the unit with only one generator breaker in service is considered to be an abnormal operating condition used only during periods of maintenance which require the condition. Any trip signal which normally opens both generator breakers and causes a direct turbine trip is unaffected by having one breaker open prior to the trip signal. The trip signals listed in Table Q 13.9(b) which normally open only one generator breaker and do not produce a direct turbine trip would perform in the same manner if a generator breaker were open prior to the trip signal. In this case, the unit would respond as if a manual trip of both generator breakers had occurred.

3. The automatic transfer function associated with these events is the transfer of the 4 kV group busses from the auxiliary power transformers to the station power transformers. This transfer is accomplished in less than one second.

Automatic transfer of the kV group busses is accomplished when all of the following conditions exist:

a. Both 500 kV generator breakers are open.
b. Potential exists on the Station Power Transformer.
c. None of the protective trips have occurred (i.e., bus differential, bus overload, and failure of auxiliary power transformer side infeed breaker).

4. The Generator Trip Test will be performed at 100% of rated thermal power. It is expected that a reactor trip and a turbine trip, as well as any turbine overspeed, will be noted and recorded. The test is performed by manually opening both output breakers.

Salem intends to conduct a generator trip test since it will cause a more severe transient on the plant than a turbine trip. This was done on Unit 1 and is our intent on Unit 2.

A turbine trip will cause an immediate reactor trip when above the P7 setpoint power level and vice versa, a reactor trip will always cause a turbine trip. Since these two events occur in conjunction with each other, the differences in effects on the plant whether a turbine trips first or the reactor is negligible. Since the data that would be generated from an additional turbine trip would be insignificantly different than that generated during a reactor trip and that the generator trip as described above is the more severe transient, the costs associated with a turbine trip test do not appear to justify the benefits to be derived from the test. If during the course of power operation prior to the first refueling an event such as this does not occur, then a reactor trip (with subsequent turbine trip) test will be performed.

QUESTION 13.9(c)

The staff concluded that Regulatory Guide 1.108, "Periodic Testing of Diesel Generator Units as Onsite Electric Power Systems at Nuclear Power Plants" is applicable for the Salem 2 facility. Since this guide addresses both pre-operational and periodic testing, PSE&G needs to be modified to describe how your planned preoperational tests will conform with this guide of how they will provide for equivalent pre-operational testing.

ANSWER

The No. 2 Unit initial preoperational test program is in conformance with the Regulatory Guide 1.108 with the following exceptions:

Paragraph c2.a(4) - We comply with the section by tripping the diesel output breaker at 2750 KW (2000 hour rating) and verifying that the voltage regulation and overspeed limits are not exceeded. We feel this transient is more severe than the load shedding requirements identified in the regulatory guide.

Paragraph c.2a(5) - We will perform the test described in this section but due to the sequence of testing it may not be immediately after the test described in c.2.a(3). The generator systems will, however, be at full load temperatures.

Paragraph c.2.a(6) - Our plant is not designed to perform the test described in this section.

Paragraph c.2.a(9) - To accomplish this reliability demonstration, we will increase the frequency of surveillance testing to acquire the 23 starts per diesel prior to proceeding beyond the Zero Power Physics Test Program. To accomplish this we intend to take credit for those diesel starts accomplished to date or scheduled during Integrated Safeguards Testing, as long as the diesels are loaded to a minimum of approximately 25% and the run durations are approximately 30 minutes or more. All additional starts will comply with the regulatory guide criteria for valid tests.

QUESTION 13.9(d)

The staff has concluded that Reg. Guide 1.68.2 "Initial Start-up Test Program to Demonstrate Remote Shutdown Capability for Water-Cooled Nuclear Power Plants" is applicalbe for the Salem 2 facility. NRC requires that your application be corrected and modified to describe the tests planned to conform with the guide or show that equivalent testing will be conducted. State your intent to comply with our requirement.

ANSWER

The Salem plant was designed for remote hot shutdown from outside the control room. This was described in Section 7.7 of the FSAR. Our capability to go to a cold shutdown condition through the use of procedures and temporary modifications was described in the Response to Question Q9.45.

General Design Criterion 19 of 10CFR50 Appendix A requires a design capability for remote hot shutdown with a potential capability for subsequent cold shutdown through suitable procedures. A detail procedure will be written explaining the actions to be taken to bring the plant from a hot shut-down to a cold shut-down condition from outside the control room. This procedure will be completed by February 19, 1979.

A trial run, not an actual test however, will be performed to demonstrate the communication, coordination and capabilities of the procedure to achieve cold shutdown conditions.

A functional outline will be submitted to the staff which will present the high lights of the detail procedure

indicating how cold shutdown will be achieved. This will be transmitted for the staffs review by February 5, 1979.

Inspections shall be performed by personnel who are qualified in accordance with Regulatory Guide 1.58 as noted in D.5.2 Item g other than those who performed the activity being inspected. When the inspection requires special skills (such as radiography), arrangements shall be made to have appropriate inspectors perform this work. These inspectors may be from within the company or from outside organizations.

Testing, repair and maintenance activities shall be inspected by qualified individuals other than those who performed or directly supervised the activity being inspected. Inspection of operating activities (work functions associated with the normal operation of the plant, routine maintenance, and certain technical services routinely assigned to the onsite operating organization) may be conducted by second-line supervisory personnel or other qualified personnel not assigned first-line supervisory responsibility for conduct of the work. The signature of the respective supervisor on the work package signifies that all inspection and/or test requirements have been satisfactorily completed or completed with nonconformances, as noted.

Station Department Heads are responsible for inserting mandatory inspection hold points in procedures they approve. The Station Operations Review Committee (SORC) may recommend to the Station Manager, additional or different hold points, as a result of their review. The Station QA Engineer can also require that additional inspection hold points be added to a procedure.

The Station Administrative Procedure Manual establishes the requirement that Station Department Heads are responsible for the preparation of procedures for activities affecting nuclear safety and for the SQAE and SORC review of such procedures prior to implementation. Department manuals identify the requirement that hold point inspections must be considered for inclusion in procedures. When a "Hold for QA Inspection" is identified, a qualified individual assigned by the SQAE will perform the inspection.