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April 23, 1984

Dr. Harold R. Denton
Director of Nuclear Reator Regulation
U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION
VALUE-IMPACT ANALYSIS FOR ELIMINATION OF
LARGE PRIMARY LOOP PIPE RUPTURES

Dear Dr. Denton:

Enclosed please find forty (40) copies of the CPSES Value-Impact Analysis associated with the use of the alternate pipe break analysis to eliminate the need to postulate large primary loop pipe ruptures.

Should you have any questions concerning this matter please contact this office.

Sincerely,

HC Schmidt

Homer C. Schmidt

BSD:bjm
Attachments

B001
1/1

50-445

VALUE-IMPACT ANALYSIS OF NOT ADDING PROTECTIVE STRUCTURES FOR RC LOOP BREAKS

1.0 Introduction

This analysis presents a value-impact assessment of the consequences of exempting CPSES from having to install protective structures to mitigate the effects of reactor coolant (RC) loop breaks. These protective structures include both jet shields to protect targets from jet impingement loads and RC loop equipment restraints. This report relies upon previous structural target interaction evaluations.

The proposed exemption will efficiently allocate public resources in the generation of electric power and decrease occupational radiation exposure. Additional protective structures in already congested areas would incur large costs and significant occupational doses.

The safety concerns involve the effects of a postulated major double-ended pipe break in a reactor coolant loop. Unanalyzed loads on an essential structural or piping target could cause a loss of the safety function of the target.

2.0 Proposed Action and Potential Alternatives

It is proposed that CPSES be exempted from adding protective structures that either mitigate jet impingement loads on essential targets or restrain RC loop piping from damaging RC loop equipment after a RC loop line break. This proposal is based on consideration of occupational dose and cost impacts. The alternative would be to require adding protective structures to withstand the jet impingement loads and restraint structures to protect RC loop equipment.

3.0 Value-Impact Assessment Results Summary - Total For 2 Units

Value*	(man-rem)
Occupational exposure (operational)	156 man-rem
Public Health	much less than -0.8 man-rem
Total Quantified Value	155.2 man-rem

Impacts*	($)
Jet Shield Implementation Cost	-2,464,000
Restraint Shim Cost	- 276,840
Total Quantified Value	-2,740,840.
and Fuel Load Delay	and 25 weeks (unquantified)

*Value and impact analyses based on Unit 1. For Unit 2 both the value and the negative impact will increase (except Fuel Load Delay which would be minimal at this point).

4.0 Development of Qualification - Based on Unit 1 Data

A.0 General Exposure and Cost Criteria

A.1 For Jet Impingement Protection

This report applies to the following reactor coolant line breaks: (Ref. 1)

101 CWA/B	201 CWA/B	301 CWA/B	401 CWA/B
102 CWA/B	202 CWA/B	302 CWA/B	402 CWA/B
103 CWA/B	203 CWA/B	303 CWA/B	403 CWA/B
104 CWA/B	204 CWA/B	304 CWA/B	404 CWA/B
105 CWA/B	205 CWA/B	305 CWA/B	405 CWA/B
106 CWA/B	206 CWA/B	306 CWA/B	406 CWA/B
107 LWR	207 LWR	307 LWR	407 LWR
1081 CWA/B	2081 CWA/B	3081 CWA/B	4081 CWA/B

The essential targets of these breaks can be divided into three categories; structural; of Westinghouse piping scope; and of Gibbs & Hill (G&H) piping scope. The target/break interactions are identified below:

109 Structural Targets (Ref. 1)

Break Nos.	Targets For Each Break
101, 102, 201, 202 301, 302, 401, 402	1 Pen. Sleeve
103, 104, 105, 204, 303, 304, 305, 404, 405	6 Walls/Floors
106, 203, 206, 306	3 Walls/Floors
107, 207, 307, 407	1 Wall/Floor
1081, 2081, 3081, 406	4 Walls/Floors
205, 403, 4081	5 Walls/Floors

27 Westinghouse Scope Piping Targets (includes valves) (Ref. 2)

Target Line No.	Break Nos. (Info.)	Target Line No.	Break Nos. (Info.)
10" SI-1-103-2501R-1	103, 104, 105, 405, 106, 1081	3" CS-1-235-2501R-1	106, 304
10" RC-1-21-2501R-1	103, 104, 106, 1081	6" SI-1-101-2501R-1	203, 205, 206
1-1/2" SI-1-199-2501R-1	103	10" RC-1-37-2501R-1	203, 206
4" RC-1-18-2501R-1	103	10" SI-1-180-2501R-1	204, 2081
12" RH-1-1-2501R-1	103, 104, 105, 106, 405,	3" CS-1-1-2501R-1	204, 2081
12" RC-1-7-2501R-1	104, 105, 405	2" RC-1-53-2501R-1	205, 303, 304
12" RH-1-2-2501R-1	104, 105, 403, 404, 405, 406	6" RC-1-29-2501R-1	207
10" SI-1-106-2501R-1	105, 405, 406	6" SI-1-102-2501R-1	303, 305, 306
12" RC-1-69-2501R-1	105, 404, 405	6" RC-1-46-2501R-1	303, 307
10" SI-1-181-2501R-1	303, 304	10" RC-1-78-2501R-1	403, 404, 406, 4081
10" RC-1-55-2501R-1	306	10" SI-1-182-2501R-1	403, 404, 405, 406, 4081
10" SI-1-105-2501R-2	3081	3" CS-1-79-2501R-2	403
14" RC-1-135-2501R-1	403	4" RC-1-75-2501R-1	403
6" RC-1-70-2501R-1	403		

27 Total Westinghouse Scope Targets

16 G&H Scope Piping Targets (includes valves) (Ref. 2)

Target Line No.	Break Nos.	Target Line No.	Break Nos.
3/4" PS-1-6-2501R-2	103, 403, 404	2" MS-1-206-1303-2	1081
3/4" PS-1-28-2501R-2	103	2" MS-1-341-1303-2	1081
18" FW-1-19-1303-2	104	18" FW-1-18-1303-2	204
3/4" MS-1-6-2505-2	104, 105, 106 204, 205, 304 305, 3081, 404 405	1 MS-045 & Tubing 2" MS-1-199-1303-2	2081 2081
3/4" MS-16-2505-2	104, 105, 106	2" MS-1-339-1303-2	2081
3/4" MS-1-11-2505-2	104, 106, 203 204, 205, 304 305, 3081, 404 405	18" FW-1-17-1303-2 2" MS-1-218-1303-2	304 403
3/4" MS-1-21-2505-2	104, 105, 106 403, 405, 406	18" FW-1-20-1303-2	404

43 total G&H scope break-target interactions

Among the many assumptions in this analysis, it is first assumed that the breaks would not be shielded at their source. This is unfeasible per an earlier investigation. Therefore, any target requiring protection would be shielded at the target itself. Secondly, it is assumed that after the stress analyses on structural targets are completed the result would be that there are no unacceptable structural interactions. This is based on CPSES structural target interaction evaluations to date. Therefore, no shields will be designed to protect structures from the reactor coolant line breaks.

As for the above Westinghouse scope piping targets, Westinghouse has completed the stress analysis and has determined new support load data for 195 supports. These new loads must be analyzed to determine if jet load protection is required. Based on Westinghouse experience at other plants, the results of further analyses will be at most the addition of a very few jet bumpers. It is therefore assumed for this analysis that no jet bumpers will be required. These assumptions have a conservative effect on both the value and impact results.

A field walkdown of the above G&H piping targets was conducted to make general assumptions on the locations, sizes, configurations of the jet shields and their supporting members. It is assumed that there is one jet shield for each piping target even though the shield may be very large or long to protect from several breaks and from several directions. Therefore, there would be only 16 shields to be added. All shields would require periodic painting inspection and painting.

A.2 For RC Equipment Restraints

This analysis applies to the following restraints which are designed to prevent damage to RC loop equipment after a postulated line break: for each of 4 loops there are two restraints on the crossover leg elbows, 1 restraint on the crossover leg vertical run, and 1 restraint on the steam generator inlet line elbow.

As these restraints are designed only to operate after an RC line break, the gap between the shim on the restraint and the piping must be maintained under all other conditions including shutdown, normal operating, seismic, and water/steam hammer loadings (Ref. 3). Exempting CPSES from these protective structures for an RC line break eliminates these sources of possible unaccounted for interactions in cases where the gaps are not maintained.

B.0 <u>Occupational Exposure-Operational</u>

B.1 From Jet Shields

Operational occupational exposure dose due to additional protective structures is avoided by the proposed exemption to protecting essential targets from RC loop breaks. This dose would be incurred due to the slowing down of normally anticipated work activities plus newly added routine maintenance of these jet shields in the steam generator compartments.

To calculate the dose rate portion due to work slowdowns the normal manpower traffic into the steam generator compartments in the jet shield areas during reactor shutdowns in a plant year (py) is estimated as follows:

In Service Inspection -	18 men @ 1 wk ea.
Maintenance (tube cleaning and plugging; manway cover handling; pump, valve, flange, and tank work) -	4 men @ 0.5 wk ea.
Eddy Current Testing -	3 men @ 1 wk ea.
Operations (supervise various activities)	3 men @ 1 wk ea.
Radiation Protection -	3 men @ 1 wk ea.
Misc (painters, scaffold builders, laborers, inspectors and engineers)	11 men @ 1 wk ea.
TOTAL	40 man wks/py

The installation of these massive jet shields in congested areas would cause an assumed 3% increase in each workers time spent nearby. Contributing factors to the slowdown include increased inaccessibility for personnel and equipment to and from primary system components, increased congestion between adjacent compartments, occasional jet shield removal and replacement (often requiring polar crane time) to gain access to valves and equipment, and more difficult housekeeping in areas of high contamination possibility. Thus the extra time in this radiation area due to slowdown is as follows:

$$.03 \times 40 \text{ man wks/py} \times 40 \text{ py} = 48 \text{ man wks}$$

The portion of increased dose rate for new routine maintenance includes periodic paint inspection and repainting of the shields and would require support from scaffold builders, laborers, inspectors and radiation protection personnel. It is assumed that in the 40 year plant life the 16 shields will require painting 5 times each and require 8 workers at a conservative 15 manhrs per shield. Thus the painting time over 40 years is as follows:

$$16 \text{ shields} \times 15 \text{ manhrs/shield} \times 5 \text{ times} \times \frac{\text{man wk}}{40 \text{ manhrs}} = 30 \text{ man wks}$$

Then, the total increased time in the shield area is the following:

$$\text{TOTAL} = 48 \text{ man wk} + 30 \text{ man wk} = 78 \text{ man wks}$$

Now it can be assumed that all workers will receive an average 25 mR/hr. This is inferred using an exposure rate of 50 mR/hr just at the outside channel head manway cover (Ref. 4) where several workers will be located (near jet shields). However, many personnel will be located on the floor level where the exposure rate has fallen off very sharply with distance. Thus 25mR/hr is a realistic assumption causing the total increased dose due to the addition of the jet shields to be

$$78 \text{ man wks} \times 40 \frac{\text{man hrs}}{\text{man wk}} \times 25 \frac{\text{mRem}}{\text{man hr}} = 78 \text{ man Rem}$$

B.2 From RC Equipment Restraints

There is no significant occupational exposure dose to be saved at this point in Unit 1 by exempting CPSES from fully installing the RC Equipment Restraints. This is because with the exception of the properly sized shims the restraint structures are fully installed. While there would be some removal of pipe straps, pipe clamps and a few restraint kickers (most of which have had other items attached to them by now) so that the pipe can be fully insulated these individual items are not located such that they impede workers progress measurably. An exemption for Unit 2 however, would save the entire restraint structure from being installed which would save several man-rems (unquantified for this study).

There is no requirement to inspect these restraints after plant operation nor will they be painted so there is no exposure for those activities.

C.O Public Health

It is assumed that the risk to public health of not adding jet shields and equipment restraints is similar to the risk of not adding modifications to mitigate asymmetric blowdown loads on primary system components which is assessed in Ref. 5. This analysis shows that the risk to public health of the proposed exemption for Comanche Peak will be more conservative than the risk to public health determined in Ref. 5. This is accomplished by performing a simple weighted average population density calculation. This shows that the population, per individual, closest to the plant has a heavier worth than the population, per individual, furthest from the plant.

Ref. 5 used a uniform population density of 340 people per square mile (which is an average of all US nuclear power plant sites). From Ref. 6 using the cumulative populations projected for 1990 (further contributing to a conservative risk value) we get the following:

CUMULATIVE POPULATION
(Miles from Site)

0-10	0-20	0-30	0-40	0-50
17,930	37,843	120,827	594,707	1,198,040

The simple unweighted population density figure for the 50 mile radius is

$$\frac{1,198,040 \text{ people}}{\pi (50)^2 \text{ miles}} = 152.5 \text{ people/sq. mile}$$

Then from this data we can show the population is heavily distributed at the outer fringes of the 50-mile radius model as follows:

0-10	10-20	20-30	30-40	40-50
17,930	19,913	82,984	473,880	603,333

The areas that the above populations occupy as functions of outer radius r_x and a inner radius r_{x-1}

$$A_x = \pi (r_x^2 - r_{x-1}^2)$$

The population densities as a function of their distances from the site shows there are more people in the outer sections of the 50 mile radius. This is figured:

POPULATION DENSITY(PEOPLE/SQ.MI)

0-10	10-20	20-30	30-40	40-50
$\frac{17,930}{\pi(10^2)}$	$\frac{19,913}{\pi(20^2-10^2)}$	$\frac{82,984}{\pi(30^2-20^2)}$	$\frac{473,880}{\pi(40^2-30^2)}$	$\frac{603,333}{\pi(50^2-40^2)}$
= 57.1	= 21.1	= 52.8	= 215.5	= 213.4

The simple weighted average population density is:

$$\frac{57.1 + 21.1 + 52.8 + 215.5 + 213.4}{5}$$

$$= 112 \text{ people/sq. mi.}$$

To insure conservatism throughout the 40 year plant life, using the Ref. 5 values for the year 2020, the

simple weighted average population density is:

$$\frac{98.9 + 36.0 + 85.0 + 375.7 + 376.9}{5}$$

$$= 194.5 \text{ people/sq. mi.}$$

These results show that in all cases for the years 1990 and 2020 both the unweighted population densities and the simple weighted average population densities the Comanche Peak specific case will result in a much lower public health risk than the 340 people/sq. mo. figure used in Ref. 5.

The other factor that makes the Comanche Peak risk less than the value of Ref. 5 is the considered number of plant years. Ref. 5 considered the number of remaining plant years for 16 plants at 23.6 yr. to give a total of 377 py. As the number of plant years is a multiplying factor to give total risk then again the Comanche Peak specific risk is less and by a factor here of 9.4.

Assuming all the other assumptions of Ref. 5 apply to the Comanche Peak case, we know the value to public health of not adding protective structures for RC loop breaks at Comanche Peak will be much more conservative than the Ref. 5 nominal estimate of industry total (16 plants) public risk value of -3.4 man-rem. Using the 9.4 factor,

CPSES Public Health Value much less than -0.4 man-rem.

D.0 Implementation Cost

D.1 Jet Shields

The impact to CPSES of not installing the jet shields is avoidance of analysis, design, fabrication, installation and maintenance costs as well as replacement power costs due to fuel load delay.

If jet shields were to be required the first step would be to perform the analyses for all break-target interactions to determine if a shield is necessary in each case. The costs of these are as follows:

1. Stress Analysis

For 109 Structural Interactions - 48 man hrs. ea. @ $65/man hr = $340,080.

For 43 G&H Piping Interactions - 16 man hrs. ea. @ $65/man hr = $ 44,720.

For 195 Supports of Westinghouse Scope lines - 10 man hrs. ea. @ $55/man hr = $107,250.

TOTAL STRESS ANALYSES = $492,050.

As discussed above, this analysis assumes the results of analysis on both structural targets and Westinghouse line supports to be that no shields or jet bumpers will be required. So, only the 16 G&H target shields would be designed. Then, two conservative assumptions are made that minimize the time and cost factors. For one, the three stress analyses will be performed simultaneously by separate groups. The other is that as soon as a group of these targets which are located closely together (estimate 35% per field check) are analyzed then design may begin rather than waiting for all 43 analyses to be completed. It follows then the fuel load delay (before start of design) due to analysis is

[43 G&H Interactions x 0.35 x 16 man hrs/Interaction x 1 man wk/40 man hrs] ÷ 3 workers = 2.0 man wks.

2. Design, Fabrication, and Installation

In order to further facilitate minimum fuel load delay it is assumed that 3 designers and 1 checker can produce a total 3 designs in each 3 week period and also that staffing is increased enough to complete installation of the 3 designs within the next 3 week period and so on. This is a very conservative assumption as many problems could be encountered that would add significant cost and delay. If the above schedule is followed, then the delay attributable to design, fabrication and installation is

Design of 3 shields		- 3 weeks
Design of 3 shields & install previous 3 shields		- 3 weeks
Design of 3 shields & install previous 3 shields		- 3 weeks
Design of 3 shields & install previous 3 shields		- 3 weeks
Design of 3 shields & install previous 3 shields		- 3 weeks
Design of 1 shield & install previous 3 shields		- 3 weeks
Install previous 1 shield		- 3 weeks
Total shields -16	Total time required	-21 weeks

Costs for the design, fabrication and installation of those 16 shields is extrapolated from costs of previous shields. Designing costs will be the same as presently encountered because the manpower now available can support this schedule. However, fabrication and installation during heavy load periods would require more staff. The number of Civil Engineers and drafters who check fabrication drawings and hilti bolt locations would double and an increase in CBI, welding and NDE personnel who initiate drawings, check, fabricate, install, inspect and paint would be required. These costs are

Designers - design & check 16 shields @ $19,500 ea. = $312,000.
Civil Engr. - 4 men @ $44.44/man hr. @ 40 man hrs/wk @ 18 wks = $127,987.
- 2 men @ $44.44/man hr. @ 40 man hrs/wk @ 3 wks = $10,666.
Installation + materials = 16 shields x ($9400 CBI cost/shield + $1410 others cost/shield + $1410 materials) = $195,520.
Extra personnel for peak periods = $4500/wk @ 15 wks = $ 67,500.
Total design, fabrication, installation $713,673.

D.2 Restraint Shim Installation

The impact to CPSES of not installing the shims to complete the design of the RC loop equipment restraints is avoidance of machining and installation costs as well as replacement power costs due to fuel load delay. These costs are as follows.

1. Offsite machining = $ 30,000
2. Manhours
   a. Craft - 140 manhours @ $35/hr = $ 4,900
   b. Engineering - Westinghouse and site - 8 men @ 8 days @ 24 hrs/day @ $75 avg. cost/hr = $115,200

Total Cost Shim Installation = $150,100

All shims are not required the pipe straps, pipe clamps, and any restraint kickers that were not used for other purposes could be removed so that the insulation could be patched. Estimated costs for these are:

1. Manhours-craft to remove straps, clamps, kickers -12 manhrs @ $35/hr = $ 420
2. Insulation
   a. Material = $ 60
   b. Craft time - 20 manhrs/joint @ 16 joints @ $35/manhr = $ 11,200.

Total Cost to Fully Insulate (amount saved if shims required) 11,680.

Net Restraint Shim Installation Cost = $150,100 - $11,680 = 138,420.

The shim replacement alone will impact compartment closure and therefore building closure and therefore fuel load by an estimated conservative 2 weeks.

E.0 Maintenance Costs

E.1 For Jet Shields

As mentioned previously these 16 shields will require periodic inspection and occassional repainting. This requires support personnel for a total of 8 workers for 5 paint jobs in the 40 year plant life. Assuming a time requirement of 15 man hours per shield and a continued manpower cost of $22/man hr. and not including material costs all of which are conservative will yield the following:

16 shields x 15 manhrs/shield x (5 times/40 yrs) x $22/man hr
= $26,400 total painting costs

E.2 For Restraints

No painting or other inspection of the restraints is required after the shims are first verified.

5.0 Conclusions

The summary results for the value-impact assessment as shown below. The estimates for cost and dose indicate that the proposed action should be recommended. These estimates do not show negative benefits for either dose or cost. The following observations can be made:

- This analysis assumed that if implementation of jet shields were required, a fuel load delay is preferable to installation during plant outages. The after power work in containment would increase the occupational dose rate, require more worker and support personnel time and still require some additional downtime leading to replacement power costs.
- This analysis does not address values or impacts of accidental occupational exposure, public property nor onsite property effects. Ref. 4 values for these can be used as approximate figures for comparison.

Summary of Value-Impact Assessment

Value	Impact
152.2 man-Rem	- $2,740,840 as well as 25 weeks fuel load delay to Unit 1.

REFERENCES

1. CPSES - Field Damage Study Group Field Walkdown Package of Unit 1 Containment, Problem 149A, B, C, & D, Rev. AB-0, 10-8-83.

2. WPT-6834, Jet Impingement Loads from RCL Breaks, T. R. Puryear to J. B. George, December 6, 1983.

3. NUREG 2136 Effects of Postulated Event Devices on Normal Operation of Piping Systems in Nuclear Power Plants, May 1981.

4. Designers Radiation Exposure ALARA Manual, Westinghouse Electric Corp. Table 4-2, Rev. 2 (Draft), 1982.

5. Leak Before Break Analysis by Pacific Northwest Laboratory as Attachment to Enclosure 4, Regulatory Analysis of Mechanistic Fracture Evaluation of Reactor Coolant Piping A-2 Westinghouse Owners Group Plants, WCAP 9558, Rev. 2, May 1982.

6. CPSES Final Safety Analysis Report, Table 2.1-5, Rev. 0.