VALUE-IMPACT ANALYSIS
FOR
USI A-43, CONTAINMENT EMERGENCY
SUMP PERFORMANCE

Enclosure 2

VALUE-IMPACT ANALYSIS
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I. The Proposed Action(s)

A. Summmary of Problem and Proposed Action

Unresolved Safety Issue (USI) A-43 deals with safety concerns related to containment emergency sump performance during the post-LOCA period wherein long-term recirculation cooling must be maintained to prevent core melt. These safety concerns can be summarized in the following question:

> "In the recirculation mode, will the sump design provide water to the RHR pumps in sufficient quantity, and will this water be sufficiently free of LOCA-generated debris and air ingestion so as not to impair pump performance, while providing adequate net positive suction head (NPSH)?"

These concerns have been addressed in three parts, namely:

a. Sump hydraulic performance under post-LOCA adverse conditions such as air ingestion, elevated temperatures, break and drain flow, etc.

b. LOCA-generated debris arising from the break jet destroying large quantities of insulation, this insulation debris being transported to the sump screen(s), and the resulting screen blockage being sufficient to reduce NPSH significantly below that required to maintain adequate pumping.

c. The performance capability of RHR and CSS pumps to continue pumping when subjected to air ingestion, debris ingestion and effects of particulates.

These concerns have been investigated on a generic basis, and the findings can be summarized as follows:

a. Measurements in extensive, full-scale sump hydraulic tests have shown low levels of air ingestion (i.e., 1-2%) and demonstrated that vortex observations cannot be used to quantify sump performance. These experimental results have been used to develop sump hydraulic design guidelines and acceptance criteria.

b. Generic plant insulation surveys and development of debris calculational methods have show that debris effects are dependent on the type and quantities of insultion employed and plant layout. The results also show that the 50% screen blockage guidance provided in the current Regulatory Guide (RG) 1.82, "Sumps for Emergency Core Cooling and Containment Spray Systems," should be replaced with a more comprehensive requirement to assess debris effects on a plant-specific basis.

c. Reviews of available data on pump air ingestion effects and discussions with the U. S. manufacturers of RHR and CSS pumps show that low levels of air ingestion ($\leq$ 2%) will not significantly degrade pumping performance, and that the types of pumps employed will tolerate ingestion of insulation debris and other types of post-LOCA particulates, which can pass through sump screens.

These results reveal a significantly lesser safety concern with respect to vortex formation and sump hydraulic effects than previously hypothesized but a greater concern for loss of recirculation cooling capability from debris effects. Thus, the results warrant the recommendations set forth next. The following actions are proposed:

1. Revise the NRC Standard Review Plan, Section 6.2.2, "Containment Heat Removal Systems," and Section 6.3, "Emergency Core Cooling Systems" to incorporate the technical findings and sump design review guidelines set forth in NUREG-0897. This action will provide for review consistency based on the extension data base acquired for the resolution of USI A-43, and can remove the need for "in-plant" sump tests or sump model tests.

2. Revise RG 1.82, to reflect the findings contained in NUREG-0897, "Containment Emergency Sump Performance," July 1982. In particular, the 50% screen blockage guidance should be removed and replaced with a requirement for plant-specific debris evaluations based on the technical findings described in NUREG-0897.

3. Operating plants should be assessed for determination of the extent of debris blockage potential and based on the outcome of those plant analyses, action should be taken to correct unacceptable conditions.

The debris blockage concern stems from use of certain insulations such as mineral wool and/or fiberglass which can lead to excessive sump screen blockages with attendant loss of recirculation pump NPSH margin. The USI A-43 surveys (for 19 plants) have shown that some older plants employ such insulations, and plant-specific calculations reveal (i.e., Maine Yankee) that excessive screen blockage could occur. Thus operating plants (PWRs in particular) should be required to provide their assessment of debris induced screen blockage utilizing the criteria and guidelines set forth in Appendix A of the revised RG 1.82.

Generally speaking, it is not expected that BWRs will encounter a debris blockage problem, nor will PWRs that extensively use reflective metallic insulations. The unencapsulated fibrous insulations are believed to present the principal debris problem and it is estimated that six to ten PWRs may require some type of corrective action. BWR insulation debris problems are not expected to arise since BWRs make extensive use of reflective metallic insulation and the design of the suppression pool vent's missile cover is such that it will block insulation migration to the pool.

B. Need for Proposed Action(s)

The need for the proposed actions is as follows:

1. Issuance of the proposed revision to SRP Section 6.2.2 is needed to correct previous sump review criteria which are not supported by current findings (i.e., judgment of sump hydraulic acceptability principally on vortex formation). SRP Section 6.2.2 has been revised to reflect findings from full-scale sump tests and generic plant studies, the net result is the clear identification of the need to assess sump hydraulic performance, LOCA generated debris effects (i.e., sump screen blockage) and recirculation pump performance under post-LOCA conditions. Current findings do not support the

need for continued in-plant sump tests (per RG 1.79) or more sump model tests (w/o measurement of air ingestion)

2. RG 1.82 requires revision to incorporate the results of two years of sump testing and generic plant studies. There is also the need to correct deficiences in the current RG 1.82, such as the 50% screen blockage rule. Generic plant calculations addressing LOCA-generated debris effects have shown that the 50% blockage rule can be excessive in some plants, and non-conservative for other plants. Continued use (without revision) of this Regulatory guideline would permit the [illegible] designer to bypass the need to assess debris blockage effects and to continue to show that a 50% blocked screen does not result in excessive head loss.

Appendix A has been included in the revised RG 1.82 to provide guidance and acceptance criteria for assessing sump hydraulic performance, LOCA-induced debris effects and pump performance under adverse conditions. A combined consideration of these three aspects is necessary to determine overall sump performance and acceptability with respect to assurance that adequate pump NPSH margin will exist.

3. An assessment of the possible extent of debris blockage effects is needed since previous reviews have been based on the current RG 1.82 50% blockage guidance and (as noted above)

this has been shown to result in non-conservative assessments in some cases. Based on USI A-43 evaluations, it is concluded that the debris blockage question is dependent on the type of insulation employed (i.e., unencapsulated fibrous insulations transport and block screens) and containment design, or layout. Although these A-43 evaluations show plant-specific concerns (i.e., the Maine Yankee* plant insulation debris assessment), they do not suggest the existence of a widespread problem warranting immediate action. Newer plants employ mostly reflective metallic, or encapsulated insultions--some of the older plants employ a higher percentage of unencapsulated, or fibrous type insulations (see Table 1). BWRs appear to use predominantly reflective metallic insulation.

Since it is not clear which of the operating plants (or NTOL's) have addressed the debris blockage question adequately, it is recommended that a systematic plant evaluation for all operating reactors be undertaken utilizing the guidance provided in Appendix A of the revised RG 1.82. If such evaluations reveal plants where corrective actions should be undertaken, then such cases should be

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*It should be noted that Maine Yankee staff have indicated that some insulation replacement was planned and also the possibility of installing additional debris capture screens is being considered.

Tal 1

Types of Insulation Used Within the Primary Coolant[1] System Shield Wall in Plants Surveyed

Plant	Types of Insulation and Quantity in ft^2					
	Reflective Metallic	Totally Encapsulated	Mineral Fiber/Wool Blanket	Calcium Silicate Block	Unibestos Block	Fiberglass
Oconee Unit 3	14,500	--	--	--	--	300
Crystal River Unit 3	12,500	715	150	--	--	--
Midland Unit 2	15,750	--	--	--	--	4,400
Haddam Neck	450	--	--	--	14,200[3]	150
Robert E. Ginna	--	--	1,000	22,300	2,800	--
H. B. Robinson	--	--	--	3,800	21,800	--
Prairie Island Units 1 & 2	19,200	--	--	--	--	500
Kewaunee	5,200	--	--	--	4,500	--
Salem Unit 1	17,100	3,400	23,300[2]	--	--	--
McGuire Units 1 & 2	18,000	--	--	--	--	--
Sequoyah Unit 2	18,500	--	--	--	--	--
Maine Yankee	1,600	--	5,700	3,00[illegible]	1,600	100
Millstone Unit 2	6,300	9,100	1,300	7,200	--	--
St. Lucie Unit 1	1,500	--	--	17,300	--	--
Calvert Cliffs Units 1 & 2	4,400	7,300	--	--	--	--
Arkansas Unit 2	6,300	7,400	--	--	--	200
Waterford Unit 3	2,300	15,500	--	--	--	--
Cooper	30 %	70 %	--	--	--	--
WPPSS Unit 2	100 %	--	--	--	--	--

1) Tolerance is ± 20 percent

2) Both totally and semi-encapsulated Cerablanket is used; however, inside containment only totally encapsulated is employed.

3) Unibestos is currently being replaced by Calcium Silicate. However, both types of insulation have the same sump blockage characteristics.

pursued accordingly. A generic letter requesting such evaluations would be used for such implementation.

C. Value-Impact of the Proposed Actions

1. Risk Analysis Results

A risk analysis was performed to assess the effects of loss of the containment emergency sump; for example: due to LOCA debris blockage. Three plants and their corresponding PRAs were selected, these being: Crystal River, IREP-PRA; Calvert Cliffs, RSSMAP-PRA; and Surry, RSS-PRA. The PRA event trees were reanalyzed to determine the effects of sump loss following a large LOCA. Whereas previously these event trees assumed availability of the sump, this analysis assumes total sump failure for 50% of the large LOCAs; the resulting core melt frequencies and release category frequencies were then computed. The 50% assumption reflects the fact that not all large LOCA's will result in total sump failure. Table 2 summarizes results obtained.

The release category frequencies were converted to public dose via the airborne pathway utilizing the following values:

Release Category	Core Melt Release (man-rem)
PWR 1	5,400,000
PWR 2	4,800,000
PWR 3	5,400,000

PWR 4	2,700,000
PWR 5	1,000,000
PWR 6	150,000
PWR 7	2,300

These values were derived using the CRAC code and assuming the guidelines and quantities of radioactive isotopes used in the Reactor Safety Study (WASH-1400), the meteorology at a typical mid-West site (Byron-Braidwood), a uniform population density of 340 people per square-mile (which is an average of all U.S. nuclear power plant sites) and no evacuation of population and are based on a 50 mile release radius model.

The release values used are similar to the those shown in WASH-1400, but with some modifications to arrive at a reference plant value. Generally speaking, release categories 2 and 3 were the major constributors to public dose. Averaging the change in calculated public dose (or change between w/o sump loss and w/sump loss) results in an average increase of public dose of 65 man-rem/plant year due to loss of the sump (see also Table 2).

TABLE 2, SUMMARY OF RISK ASSESSMENT CALCULATIONS

Calculated Core Melt Frequency $(plant\text{-}yrs)^{-1}$:

	Base Case w/o Sump Loss	Adjusted Case w/Sump Loss(3)	Increase in Core Melt Frequency
Crystal River	3.7×10^{-4}	4.2×10^{-4}	5×10^{-5}
Calvert Cliffs(1)	2×10^{-3}	2.05×10^{-3}	5×10^{-5}
Calvert Cliffs(2)	4.0×10^{-4}	4.5×10^{-4}	5×10^{-5}
Surry	5×10^{-5}	1×10^{-4}	5×10^{-5}

Calculated Public Dose (man-rem/plant-year):

	Base Case w/o Sump Loss	Adjusted Case w/Sump Loss(3)	Calculated Increase In Public Dose
Crystal River	926	983	57
Calvert Cliffs(1)	7,617	7,698	81
Calvert Cliffs(2)	653	734	81
Surry	52	108	56
		Average =	65

(1) Calvert Cliffs w/o AFW improvement

(2) Calvert Cliffs w/AFM improvement

(3) These values are based on the assumption that only 50% of the large LOCAs lead to sump loss.

Reference: Probabilistic Risk Assessment of Unresolved Safety Issue A-43, September 1982, by Science Applications Inc. (Ref. 12)

Given the results of the risk analyses summarized above, and utilizing "averaged" numbers, the following quantities can be calculated:

$$\text{Public Dose Averted} = \left(65\ \frac{\text{man-rem}}{\text{plant-yr}}\right)\left(\frac{23\text{ years outstanding}}{\text{plant life}}\right)$$

$$= 1487\ \text{man-rem/plant}$$

The avoided on-site dose (due to core melt) can also be calculated as:

$$\text{Avoided On-site Dose} = \left(19{,}860\ \frac{\text{man-rem}}{\text{accident-yr}}\right)(\Delta\text{f core-melt})\ (23\ \text{yrs})$$

$$= 23\ \text{man-rem/plant}$$

The potential to avoid a public dose of 1500 man-rem/plant is a significant risk/consequence finding.

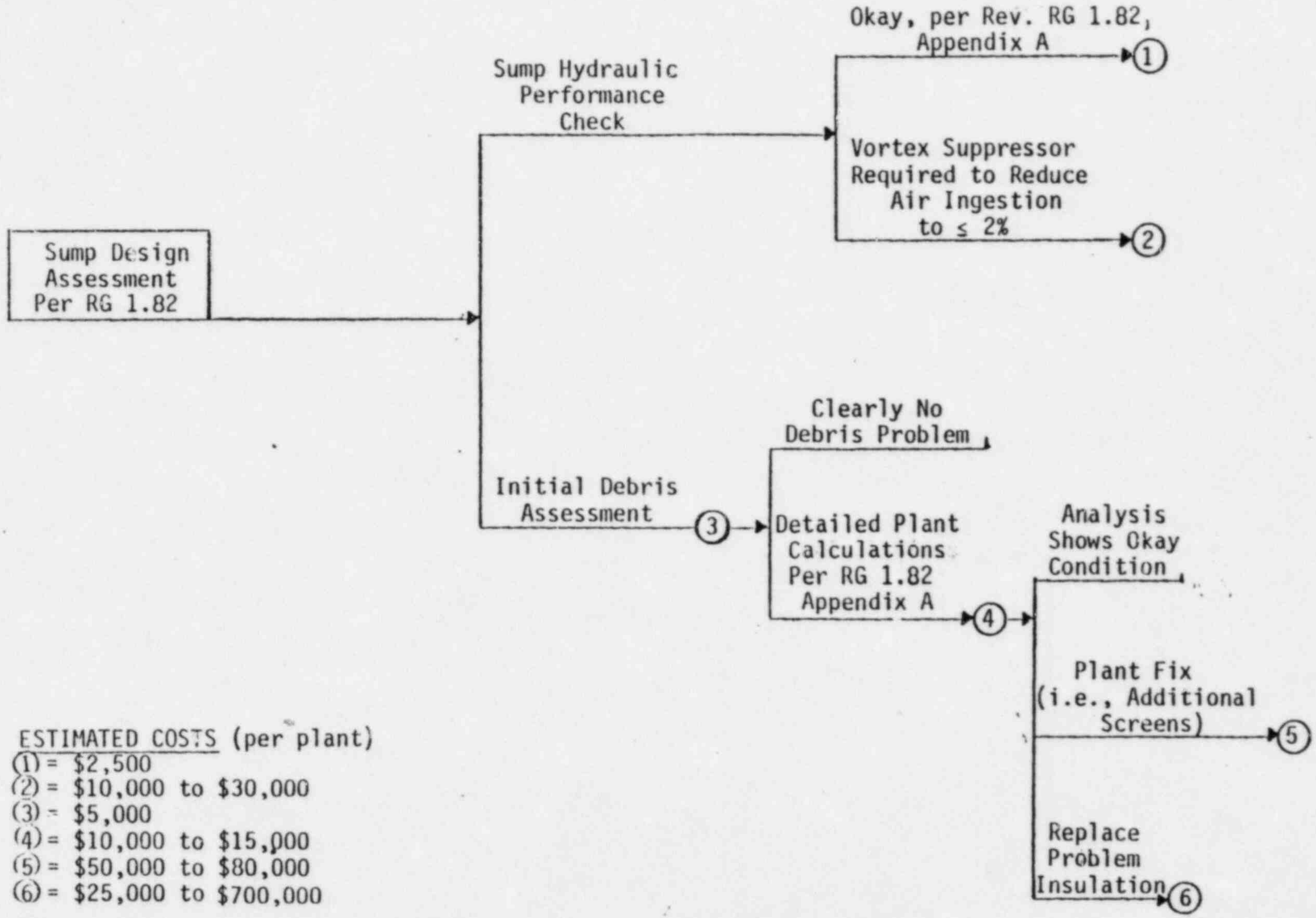
2. Industry Impact

Industry impact will vary from plant-to-plant. As stated previously, not all plants will be found to have large quantities of non-encapsulated fibrous insulations (the type which could lead to severe screen blockage and loss of NPSH). To facilitate understanding of potential impacts on industry, Figure 1 is provided. Also shown on Figure 1 are the estimated costs which might be incurred, depending on the extent of the problem. The major impact would result if the determination is made that large quantities of insulation must be replaced (e.g., 2,000-7,000 ft^2 of insulation). Actual determination of quantities and location of insulation requiring replacement would reduce the impact; also use of alternative methods such as intermediate screens should be evaluated. The sections which follow provide more insight into the expected impacts.

a. Given the guidelines set forth in revised RG 1.82, the initial sump hydraulic design evaluation will take very little time through use of acceptance criteria tables. If sump design and operating conditions show less than 2% air ingestion potential, and if predominantly reflective metallic insulation is employed, the methods and tables as contained in Appendix A of RG 1.82 will allow a sump design review in less than 1 man-day. A conservative impact would be 1 man-week of professional effort (est. $2,500), see also (1) in Figure 1.

b. If the results of the sump hydraulics evaluation show a need for fixes (i.e., the need for vortex suppressors to reduce the estimated air ingestion), an additional impact occurs. Design, fabrication and installation of a vortex suppressor

FIGURE 1. IDENTIFICATION OF IMPACTS RESULTING FROM PROPOSED CHANGES TO RG 1.82 AND SRP 6.2.2



ESTIMATED COSTS (per plant)
(1) = $2,500
(2) = $10,000 to $30,000
(3) = $5,000
(4) = $10,000 to $15,000
(5) = $50,000 to $80,000
(6) = $25,000 to $700,000

consisting of floor grating materials (either horizontally mounted, or formed into a cage) is estimated to cost $10,000 to $30,000 depending on installation complexity, see also (2) in Figure 1.

c. The initial debris assessment will need to consider the types, quantities, methods of fabrication and installation, mechanical attachments, and hygroscopic characteristics of the insulation employed on primary and secondary system piping, reactor pressure vessel, and major components (e.g., steam generators, reactor coolant pumps, pressurizer, tanks, etc.) that can become targets of expanding "break" jet(s) occurring in the primary coolant system. For plants employing essentially all reflective metallic insulations [which can better survive break jet loads and will transport only at high water velocities (_ 2.5 ft/sec)], this assessment can be done quickly. Assuming that the licensee knows what insulations are within containment, such an evaluation should not require over 1 man-week's effort. Reporting the results to NRC might require another week. An impact of $5,000 is estimated, see also (3) in Figure 3.

d. If Step "c" indicates a need for detailed plant calculations to determine quantities of debris generated, what fraction gets to the sump, screen blockage effects, etc., an estimated time of three to four man-weeks i[illegible]cted based on the level of effort expended for the generic plant-specific studies carried out for USI A-[illegible] resolution.

An impact of $10,000 to $15,000 per detailed plant analysis is projected, see also (4) in Figure 1. Since it is expected that this debris related analysis will be required for some of the older plants employing unencapsulated mineral wool, or fibrous insulations. A four to six plant estimate is projected, which would result in a total industry impact to $40,000 to $90,000.

e. If plant-specific calculations reveal unacceptable sump screen debris blockage, design modifications then need to be considered. Possible solutions include utilization of intermediate screens which would intercept the debris deposition on the local sump screen occurs, encapsulation of insulation, shielding structures to prevent break jet impingement, etc. Use of interception screens is estimated to cost $50,000 to $80,000 (see also (5) in Figure 1) and is based on a potential fix discussed that four to six plants may require corrective actions and this would place the total industry impact at $200,000 to $480,000.

It should be noted that the detailed plant calculations (per RG 1.82, Appendix A guidance) will reveal location and quantities of insulation requiring attention. The existence of such problem areas does not imply the need to replace all the insulation. A more cost effective alternative would be selective insulation replacement.

f. The most severe impact would result if it were found necessary to replace all fibrous insulation, see also (6) in Figure 1. This case is considered in this value-impact analysis since it represents the severest fiscal impact.

Table 3 illustrates cost estimates for insulation replacement for several plants to illustrate plant dependency and is based on cost and exposure data derived from actual man-hours and exposures for steam generator replacement at the Surry Units 1 and 2, plus follow-up discussions with onsite staff. Two additional cost estimates were developed from contacts with the insulation suppliers noted. Estimated cost impacts can range from $25,000 to $700,000 depending on insulation quantities requiring total replacement for the plant in question. Given the costs shown in Table 3, an "averaged" cost impact of $550,000/plant will be assumed for value-impact calculations which follow.

In addition to labor costs, the radiological exposure impact must be considered and is derived from the values shown in Table 2. The dependence on level of insulation replace must required is evident, with a range of 10 to 100 man-rem being forecast. An insulation replacement exposure impact of 50 man-rem/plant was therefore assumed for the value-impact analyses which follows.

In addition, the assumption is made that plant shut downs solely to replace undesirable insulations will not be required (thus purchase of replacement power has not been included) since the risk/consequence calculations do not support shutting down operating plants. Based on discussions with Maine Yankee staff, the plant owner indicated corrective actions (e.g., installation of additional screens and selective removal of mineral wool insulation) could be carried out during scheduled refueling outages. If necessary, the work involving replacement of insulation could be performed at two or more refueling outages.

With respect to new plants, or those applicants in the OL review cycle, the sump hydraulic performance data contained in NUREG-0897 and related references are a "value" since: (a) the extensive sump hydraulics data base (which has been incorporated into the revised RG 1.82) can remove the need for

TABLE 3, ESTIMATES OF INSULATION REPLACEMENT COSTS AND ASSOCIATED EXPOSURES

Plant	Unencapsulated Insulation (Ft^2)	Cost Est.[1] No. 1 ($\$ \times 10^3$)	Cost Est.[2] No. 2 ($\$ \times 10^3$)	Cost Est.[3] No. 3 ($\$ \times 10^3$)	Estimated[4] Exposure (man-rem)
Salem Unit 1	13,200	281	238	660	99
Maine Yankee	6,700	142	121	335	47
Ginna	1,000	21	18	50	8
Millstone Unit 2	1,300	28	23	65	10

[1] These costs are derived from Surry Units 1 and 2 steam generator removal and reinstallation data, and discussions with onsite staff. A "per-unit" cost of $0.85/ft^2$ for replaced insulation was derived and labor costs of $25.00/hr were assumed.

[2] Telephone estimates from New England Insulation Company (Maine Yankee has employed this firm) were: $3/ft^2$ to remove, $11/ft^2$ to fabricate new panels, $3-5/ft^2$ to install.

[3] Telephone estimates of $35-50/ft^2$ for mirror-insulation fabrication and installation were obtained from Diamond Power who supplies such insulation. A value of $50/ft^2$ was employed.

[4] Exposure data were derived from Surry 1 and Surry 2 data. Discussions with Surry site staff indicates that a 50 man-rem exposure level for insulation replacement is realistic if the job is pre-planned. An equivalent dose of 7×10^{-3} man-rem/ft^2 of insulation replaced can be derived.

additional sump model tests which have previously cost $50,000 to $150,000 per plant, and (b) can remove the need for "in-plant" tests designed to demonstrate sump hydraulic design adequacy by visual observations for air-entraining vortex formation.

3. NRC Operation

The "impact" of proposed changes with respect to staff review time will be minimal making use of the guidelines contained in Appendix A of the Revised RG 1.82. NUREG-0897 and supporting reference provide additional technical information which will assist the staff reviewer. It is estimated that less than 1 man-week of staff review time would be required (Estimated cost = $1500/plant).

The experimental data and generic plant information and calculations contained in NUREG-0897 (and supporting references) represents a funding investment of approximately $3.0 million on the part of the NRC and DOE and this information is a "value" to both the NRC and industry. This extensive data base provides a basis for eliminating unnecessary in-plant testing, or sump model tests.

4. Other Government Agencies

Since sump design review and acceptance are carried out solely by NRC staff, no impact on other government agencies is projected.

5. Public

The "value" to the public would be avoidance of public dose from addditional core melts, due to sump failure, if the recommendations are adopted. Based on the PRA results noted in Table 1, the calculated average public dose which could be averted is 1500 man-rem/plant. Given the projection of six to ten plants which may have a debris blockage problem, the total public "value" is 9,000 to 15,000 man-rem potential reduction.

6. Overall Value-Impact of the Proposed Actions

These value-impact results can be summarized as follows:

Avoided Public Dose = 1500 man-rem/plant Avoided Plant Site Dose = 23 man-rem/plant Estimated Implementation Dose = 50 man-rem/plant Core Melt Frequency Decrease = 5×10^{-5}/(plant-yrs) Core Melt Reduction = 11.5×10^{-4} accidents/plant remaining life

The estimated present-worth of plant cost due to a core melt accident is $1.65 billion. Therefore, the proposed changes provide a means to avoid an accident cost of:

Avoided Accident Cost = (Core Melt Reduction) (Plant Cost)

$$= (11.5 \times 10^{-4}) (\$1.65 \times 10^{9})$$

$$= \$1.9 \times 10^{6}/\text{plant}$$

or nearly $2 million per plant.

These "values" can be compared with estimated "impacts" of $100,000 for plant fixes (such as supplemental debris screens) to $400,000 to $700,000 per plant for replacement of large quantities of troublesome insulation.

The overall impact on operating reactors is shown in Figure 2, which follows the same implementation actions and costs identified in Figure 1. Assuming 75 OL's, the estimated impact for determining the extent of the screen debris blockage problem is $0.7M; another $3.0M is projected for plant fixes (or retrofits).

The above value-impact data can be viewed as a ratio of value gained versus cost to implement (or a V-I ratio), which is defined as:

$$\text{V-I} = \frac{\text{Avoided Public Dose}}{\text{Cost of Implementation}}$$

For operating plants, this ratio computes to:

$$\text{V-I} = \frac{(1500 \text{ man-rem/plant}) (5 \text{ plants})}{\$(.7 + 2.5)\text{M}} = 2344 \frac{\text{man-rem}}{\$\text{Million}}$$

FIGURE 2, ESTIMATE OF OVERALL INDUSTRY COST IMPACT FOR OL'S

Determines Extent of Debris Problem ← → Plant Backfits Required

75 OL's
- → 25 BWR's = (25)($5000/plant) = $125,000
- → 50 PWR's
  - → (40)($7500/plant) = $300,000
  - → (10)($22,500/plant) = $225,000

Total = $650,000

→ (5)($80,000/plant) = $400,000 (Alternate fixes, Rg-additional screens)

→ (5)($500,000/plant)* = $2,500,000

Total = $2.9 Million

*for replacement of large amounts of troublesome insulations.

$$\text{or} = (1500)(5)/(.7 + .4) = 6818 \frac{\text{man-rem}}{\$\text{Million}}$$

The reader is cautioned against over optimism regarding values to be gained versus impacts from these V-I's. There are uncertainties attributable to costs and avoided doses. However, the V-I computed value supports moving forward with the proposed actions. Generic studies have already identified one plant having potential debris blockage problems. A systematic determination of the extent of the problem is warrented from safety consideration aspects. The V-I ratio, based on a single problem plant assumption would be:

$$\text{V-I} = \frac{(1500 \text{ man-rem/plant})}{(\$.525\text{M})} = 2857 \frac{\text{man-rem}}{\$\text{Million}}$$

The radiological impact versus local plant radiological gain (50 man-rem incurred versus 23 man-rem avoided) should be considered offsetting due to the averaging methods used in these analyses and associated uncertainties.

II. Technical Approach

A. Technical Alternatives

a. Proceed with the proposed recommendation, including backfit correction to operating plants, only where plant specific analysis reveal a change is needed.

b. Issue NUREG-0897 and the proposed changes to SRP Section 6.2.2 and RG 1.82, but with implementation required only on new plants.

c. Issue NUREG-0897 and associated references for information only, but take no other action.

B. Discussion and Comparison of Technical Alternatives

a. Proceeding with the proposed recommendations will incur the values and impacts discussed in Section I.C and as summarized in Section I.C.6. A value-impact ratio of 2300-6800 man-rem avoided per million $'s to backfit has been computed. It is clear (with the exception of massive insulation backfits) that the benefits out weigh the impacts. Maintaining the current versions of RG 1.82 and SRP Section 6.2.2 runs contrary to technical findings presented in NUREG-0897 and associated references which reveal a much less severe sump air ingestion picture, but also reveal a deficiency in current assessments of debris blockage effects on sump operation.

b. Accepting the proposed changes to RG 1.82 and SRP Section 6.2.2, for implementation on those plants where a SER will be issued following implementation of the proposed changes is the minimal route which should be considered. The technical findings presented in NUREG-0897 and references, reveal a significantly different picture then previously hypothesized and show that the prior accepted levels of risk may not exist in some plant. However, ignoring the implications of the results of the A-43 debris blockage effects with respect to OL's and NTOL's is not acceptable. ECCS analysis have assumed an operable sump; findings indicate screen blockage potential for plants using unencapsulated fibrous insulations.

c. To continue to use the current RG 1.82 and SRP Section 6.2.2, would ignore the experimental data base and plant analyses which clearly point out the need for these recommended changes. This is not an acceptable alternative since A-43 plant-specific calculations have shown that the 50% screen blockage guidance in the current RG 1.82 can result in erroneous and non-conservative plant results.

C. Decision on Technical Approach

Given the positive-finding from the value-impact analysis (See Section I.C.6) and the need to correct current Regulatory technical deficiencies, the recommendation is, therefore, made to revise SRP Section 6.2.2 and RG 1.82 which reflect the technical findings contained in NUREG-0897, and also backfit the licensing positions set forth in Appendix A of RG 1.82 to operating plants and NTOL's which have received a SER.

III. Plan for Implementation

A. Safety or Environmental Significance of Proposed Action

As noted previously, the estimated avoided public dose is approximately 1500 man-rem/plant. Since it is projected that six to ten PWRs may be found to have debris blockage potential that requires corrective action, proposed changes have the potential for avoiding a 9,000 to 15,000 man-rem public dose due to a blocked (or failed) sump.

B. Decision on Plan for Implementation

Given the technical findings and these value-impact assessments, the recommendation is made to proceed with the recommended changes to SRP Section 6.2.2 and RG 1.82, both of which incorporate the technical findings contained in NUREG-0897 and related references. This will provide the necessary safety assurance for new plant designs, and as a "forward fit" would represent a minimum impact route.

With respect to operating plants, and NTOL's for which an SER has already been issued, the applicant or licensee should be required to show an acceptable sump design utilizing the guidelines and criteria set forth in Appendix A of the revised RG 1.82. In particular, the applicant/licensee should demonstrate that potential LOCA generated debris effects do not result in excessive screen blockage leading to loss of NPSH margin for the recirculation pumps. It is expected that a few of the older plants employing unencapsulated fibrous insulations will require follow-up on corrective measures which may be submitted. It is also expected that PWRs would incur the major impact of reanalysis via Appendix A of the revised RG 1.82.

Implementation would follow issuance of the revised SRP Section 6.2.2 and RG 1.82 following receipt and consideration of public comments on the proposed revisions, and resubmitted to the CRGR for review prior to implementation. The generic letter would result in a two step operation which:

a. Identifies the extent and severity of the problem, and proposed fixes if required.

b. Establishes of a schedule for implementation which minimizes impact on plant operation.

Although BWR's are not expected to incur insulation debris problems, operating BWRs should be required to show that plant insulations employed will not result in unacceptable debris blockages for the RHR suction intakes utilizing the methods outlined in the Revised RG 1.82, Appendix A, or an equivalent alternate.

A "draft" generic letter which would implement these requirements for OL's and NTOL's is provided at the end of this enclosure.

IV. Procedural Approach

A. Procedural Alternatives

a. Issue NUREG-0897, for information only; take no other action.

b. Implement use of the revised SRP Section 6.2.2 and RG 1.82, for only those plants not having a SER at time of implementation, or a "forward-fit" only.

c. Require that all plants (including operating plants and NTOL's) evlauate sump design adequacy per Appendix A of the revised RG 1.82, and in particular assess the sump screen blockage effects associated with LOCA generated debris.

B. Value-Impact of Procedural Atlernatives

a. The "impact" of alternative (a) is zero since no changes are implemented. There is a "value" associated with the information provided in NUREG-0897 and related references. This option is, however, unacceptable since deficiences have been identified in the current version of RG 1.82 with respect to debris assessment.

b. The "value" associated with alternative (b) is related to the data contained in NUREG-0897 (and references) which can replace in-plant and sump model tests. The "impacts" are associated with designing for avoidance of sump air ingestion, use of less troublesome insulations, etc. Since option (b) is a forward fit, plant cost impacts should be minimal. An "impact" of $10,000 to $15,000/plant is estimated (see also Section I.C.2).

c. Alternative "c", which is the recommended action, would have a "value" of an avoided accident dose of 1500 man-rem/plant (overremaining plant life) with an attendant impact of $100,000 to 550,000/plant (see again Section I.C.6). In addition, avoidance of any accident situation which could lead to core melt should be pursued. Failure of the sump for those accidents requiring long-term recirculation capability can lead to core melt. The calculated reduction in core melt frequency attributable to sump failure was 5 x 10^{-5}/reactor-year.

C. Decision on Procedural Approach

Given the results of this "value-impact" assessment on the procedural approaches, the recommendation is made to proceed with Alternative "c"; namely, require that plants show by analysis that sump design is adequate and that debris blockage effects do not lead to excessive sump screen blockage per Appendix A of the Revised RG 1.82. As noted previously, the severity of the identified problem should be reviewed by both applicant and staff prior to embarking in extensive fixes.

V. Statutory Considerations

A. NRC Authority

Since the proposed changes are revisions to RG 1.82 and SRP Section 6.2.2, these actions fall within the statutory authority of the NRC. Furthermore, the recommendation to require applicants to demonstrate adequate sump performance falls within the statutory authority of the NRC to regulate and assure the safe operation of nuclear power plants.

B. Need for NEPA Statement

The proposed changes and potential plant retrofits do not warrant a NEPA statement.

VI. Summary and Conclusions

1. Issue the Revised SRP Section 6.2.2 and RG 1.82 for public comment.
2. Issue NUREG-0897 for public comment. This staff report summarizes USI A-43 technical findings.
3. After resolution of public comments and CRGR approval to proceed, issue the Revised RG 1.82 and SRP Section 6.2.2 and require that

new plants, operating plants, NTOL applicants* assess their sump design and debris blockage potential as outlined in Appendix A of the Revised RG 1.82, or by other equivalent methods.

4. Upon receipt of the findings submitted under Item 3, and staff evaluations, determine what (if any) corrective plant actions may be required.

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*If the staff Safety Evaluation Report has already been issued at the time the RG 1.82 revision is issued in effective form, the assessment for a NTOL would be made after issuance of the OL.

REFERENCES

1. Revised Standard Reviw Plan Section 6.2.2, "Containment Heat Removal Systems."

2. Revised Regulatory Guide 1.82, "Sumps for Emergency Core Cooling and Containment Spray Systems."

3. NUREG-0897, "Containment Emergency Sump Performance," Technical Findings Related to USI A-43, September 1982, "For Public Comment."

4. Padmanabhan, M. and Hecker, G.E., "Assessment of Scale Effects on Vortexing, Swirl, and Inlet Losses in Large Scale Sump Models," NUREG/CR-2760, Alden Research Laboratory, Worcester Polytechnic Institute, Holden, MA, June 1982.

5. Padmanabhan, M., "Hydraulic Performance of Pump Suction Inlet for Emergency Core Cooling Systems in Boiling Water Reactors," NUREG/CR-2772, Alden Research Laboratory, Worcester Polytechnic Institute, Holden, MA, June 1982.

6. Padmanabhan, M., "Result of Vortex Suppressor Tests, Single Outlet Sump Test and Miscellaneous Sensitivity Texts," NUREG/CR-2761, Alden Research Laboratory, Worcester Polytechnic Institute, Holden, MA, September 1982.

References (Continued)

7. "Results of Vertical Outlet Sump Tests", Joint ARL/Sandia Report, ARL47-82/SAND82-1286/NUREG/CR-2759, September 1982.

8. Reyer, R., et.al., "Survey of Insulation Used in Nuclear Power Plants and the Potential for Debris Generation," NUREG/CR-2403, Burns and Roe, Inc., Oradell, NJ, October 1981.

9. Kolbe, R. and Gahan, E., "Survey of Insulation Used in Nuclear Power Plants and the Potential for Debris Generation," NUREG/CR-2403, Supplement I, Burns and Roe, Inc., Oradell, NJ, May 1982.

10. Wysocki, J. J., et.al., "Methodology for Evaluation of Insulation Debris," NUREG/CR-2791, Burns and Roe, Inc., Oradell, NM, (to be published).

11. Kamath, P., Tantillo, T., and Swift, W., "An Assessment of Residual Heat Removal and Containment Spray Pump Performance Under Air and Debris Ingesting Conditions," NUREG/CR-2792, Creare, Inc., Hanover, NH, (to be published).

12. Ferrell, W. L. et al, "Probabilistic Assessment of USI A-43," Science Applications Inc. report, September 1982.

10/8/82

DRAFT GENERIC LETTER

TO: All Licensees of Operating Reactor Plants and Holders of Construction Permits

Gentlemen:

SUBJECT: ASSESSMENT OF CONTAINMENT EMERGENCY SUMP PERFORMANCE DURING THE RECIRCULATION MODE (GENERIC LETTER)

The purpose of this request is to establish containment emergency sump operability in the post-LOCA period wherein long-term recirculation must be maintained. Our principal concern relates to LOCA generated debris which could lead to severe screen blockage and result in loss of pump net positive suction hand (NPSH). The technical aspects of this issue (namely sump hydraulic performance, debris effects and pump operation under adverse conditions) have been extensively studied and the results are contained in NUREG-0897, "Containment Emergency Sump Performance." Non-encapsulated fibrous insulations appear to pose the potential for excessive screen blockage. These technical findings have been incorporated into NRC's Standard Review Plan, Section 6.2.2, Revision 4 and RG 1.82, Revision 1. Appendix A of RG 1.82 provides evaluation guidelines which can be used to evaluate sump performance. These revised documents form the criteria for licensing reviews and will be applied to plants for which the NRC Safety Evaluation Report is not yet issued. Copies of these documents are provided for your use.

Therefore, for operating reactors and for those plants where the NRC Safety Evaluation Report (SER) has already been issued an assessment of containment emergency sump performance will be made for determination of:

(a) Sump hydraulic performance, including an assessment of levels of air ingestion. Air ingestion $\leq$ 2 volume % is considered acceptable.

(b) The amount of insulation debris which might be generated by the postulated pipe break(s), the transport of such debris to the sump screen and attendant screen blockage which might occur. The resulting screen blockage calculated must be used to determine estimated head loss for estimating NPSH impact. The previously employed 50% blockage guidance no longer applies.

(c) The available NPSH margin for the recirculation pumps when the combined effects of Items (a) and (b) are considered. The NPSH margin so identified must be sufficient to assure acceptable pump performance during the required period of operation.

Appendix A of RG 1.82, Revision 1 provides an acceptable method, or guidelines, for carrying out the analyses requested above.

The primary purpose of these evaluations is to demonstrate that adequate recirculation pump NPSH margin exists, as previously assumed. If these calculations indicate deficiencies, the respondee will identify corrective measures or plant modifications which would be required.

Accordingly, licensees of operating plants and applicants who have received an OLSER, should submit their evaluation of sump performance and available NPSH within 150 days from the date of this letter, or submit within 30 days an alternate analysis schedule for responding to this generic letter. Based on these evaluations, an if corrective measures are identified, also provide us with your proposed schedule for implementing any modifications which may be required.

This request for information has been approved by the Office of Management and Budget under clearance number ___________ which expires ___________.

Sincerely,

Darrell G. Eisenhut, Director
Division of Licensing
Office of Nuclear Reactor Regulation

Note to: Accession Unit
Room 050
Phillips Building

From:

Please place the attached document in the PDR using the following file and file points:

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Subject: Revision 1 to R.G. 1.82 "Sumps for Emergency Core Cooling and Containment Spray Systems"

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