COST ANALYSIS FOR GSI-191, "ASSESSMENT OF DEBRIS ACCUMULATION ON PWR SUMP PERFORMANCE"

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1.0 Assumptions and Bases

The staff's best estimate is that 32 of the 69 pressurized water reactors (PWRs) currently in operation could potentially benefit from corrective action to control sump debris. For sensitivity analysis purposes, the staff adopts high and low estimates of the number of PWRs requiring a sump modification of 40 and 23 PWRs, respectively. These estimates are based on Los Alamos National Laboratory's (LANL) work on GSI-191, Sump Debris, and are consistent with the assumptions employed in the preceding benefit analysis.

Consistent with LANL's findings, the corrective action to control sump debris for all affected reactors is assumed to be a physical modification that increases the screen area.

All costs are expressed in year 2001 constant dollars, and all costs incurred in the future are present valued to 2001 based on a 7 percent per annum real discount rate. Discounting all costs to year 2001 adjusts for the fact that costs incurred at different points in time are not equivalent.

All costs are categorized as either: (1) Up-front analytical activities; (2) physical modification activities; and (3) other cost elements. For the purposes of this cost analysis, the up-front analytical costs are assumed to occur in mid-year 2003, whereas the physical modification and other cost elements are expected to be borne in mid-year 2004.

NRC and utility wage rates are both estimated at $80.00 per hour in 2001 constant dollars. This represents a composite labor rate for engineering/technical staff with an allowance for management and clerical support. These wage rates represent the incremental cost to the NRC and the licensee and as such, only include wages and associated fringe benefits.

Contractor support to the NRC and licensee is costed at $140.00 per hour in 2001 constant dollars. This higher value reflects the fact that in addition to the direct cost of labor, contractors will also recover all overhead, general and administrative expenses, and profit or fees from the NRC and licensees. In effect, the contractor's total cost structure is incremental to the client.

Following is a discussion of the major NRC and industry costs likely to be associated with a requirement to increase the screen area at select PWRs.

2.0 Up-Front Analytical Activities:

If the NRC determined that resolution of GSI-191 would require further evaluation by licensees and possible modifications at select PWRs, it is assumed the following up-front analytical activities would be performed:

Revise Regulatory Guide and Issue Generic Communication

It is expected that NRC would revise Regulatory Guide (RG) 1.82, "Water Sources for Long-Term Recirculation Cooling Following a Loss of Coolant Accident." The revision would provide non-prescriptive performance criteria that PWRs must meet in order to control sump debris. Development of this RG would likely entail public meetings, preparation of a draft RG, a public comment period, and issuance of a final RG. For the purposes of this cost analysis, it is assumed that this would be followed by the development of a generic communication that would advise the affected licensees of their responsibilities pursuant to this issue. Activities of this nature were performed by the NRC to support resolution of the Boiling Water Reactor (BWR) Strainer Blockage issue. Based on this BWR experience and discussion with NRC staff that would be responsible for this new effort, it is estimated that the revision and issuance of the RG and generic communication would involve about 1.5 person-months of contractor effort and about 10 person-months of effort on the part of the NRC. This results in a total cost of about $170k.

Develop Uniform Guidelines

It is expected that industry would prepare utility resolution guidance that lays out uniform guidelines on how licensees' are to interpret revised RG 1.82. This industry document would tend to prescribe in considerable detail precisely how licensees are to respond to NRC's guidance. Assuming a similar industry effort as for the BWR Strainer Blockage study conducted by industry (Boiling Water Reactor Owners Group (BWROG) and General Electric (GE)), it is estimated that the cost to industry to develop this document would be on the order of $900K, based on a level of effort of about 5.5 person-years. In addition, the NRC would be expected to participate during development and in the review of the industry guidelines. Based on NRC's involvement for BWRs, the staff estimates NRC's costs at about $250k which represents about 4 person-months of NRC staff time and about $200K in contractor support.

Reactor-Specific Engineering Analysis

An up-front engineering analysis would be required at each PWR to assess whether a reactor has a sump debris problem that requires remedy. Reactor-specific analyses of this nature have already been conducted by Pacific Gas & Electric (PG&E) for one of their nuclear power plants. PG&E estimates that such an analysis for a two unit plant required an in-house effort of about 6 person-months. This results in a cost estimate of about $40k per reactor. Alternatively, a commercial vendor has estimated that the cost of such an engineering analysis would be about $225K per reactor. Part of this cost differential can be explained by the contractor's higher labor charge because their rates recover fixed costs. In addition, PG&E's per reactor cost reflects certain economies in performing similar analyses for two reactors whereas the contractor's estimate likely assumes a single unit plant.

Recognizing that contractor support and single unit plants are likely to be involved in a number of these analyses, the staff adopted an average value that gives equal weight to the PG&E and vendor estimates. This results in an average industry cost of about $130K per reactor, and the corresponding industry cost for the total PWR population of 69 reactors is estimated at about $9,000k. (Note, that although only a subset of the PWRs are assumed to require a fix, the

industry-wide cost recognizes that all 69 PWRs would require an up-front engineering analysis in order to assess whether a fix is needed or not.

In summary, if the NRC determined that the resolution of GSI-191 would require further evaluation by licensees, the up-front analytical costs in the aggregate are estimated at $420k for the NRC and $9,900k for industry. On a 2001 present value basis, the NRC and industry costs are about $370k and $8,650k, respectively.

3.0 Physical Modification - Increase Screen Area

As indicated above, for the staff's base case, it is assumed that approximately 32 PWRs may require modifications to increase the screen area. Modifications of this nature have been performed at one nuclear power plant, and according to the licensee (PG&E), its cost was on the order of $600k for unit 1, and $320k for unit 2. The lower cost for the second unit is largely attributable to learning curve efficiencies.

These estimates comprise five broad categories of cost. The first is engineering and drafting which covers costs for such activities as drawings, loadings, design packages and technical specifications. The second is engineering effort and expenses incurred in developing a mock-up and utilizing the mock-up to model and test the design against simulated levels of debris. The third category is implementation and largely includes labor and material costs for demolition and installation. The fourth is the disposal of radioactive waste, and the fifth category is for miscellaneous expenses which are largely administrative in nature.

The staff also obtained a vender's estimate on the order of $1 million per PWR for a reactor-specific design and installation. This estimate also includes allowances for materials, manufacturing, and inspections/quality control, and assumes a safety grade system.

The staff views the PG&E and vendor estimates as providing a reasonable range of installation costs. The PG&E estimates are reasonable given that the entire installation effort, including manufacture of the redesigned screen, was performed in-house by PG&E staff, and there were no major constraints adversely affecting design and installation activities. Alternatively, the higher vendor estimate is viewed as a reasonable value because other licensees may require outside contractors and manufacturers for this work and this could have a significant impact on these costs. In addition the staff anticipates that space constraints which were not a factor at the PG&E plant could be an issue at other PWRs and could inflate costs significantly.

Based on these findings, for the purposes of this cost analysis, the staff assumes the average cost for a reactor-specific modification at $750k per reactor. This estimate is an average of the PG&E and vendor estimates assuming equal weight for each. Given that the best estimate of the number of reactors requiring such a fix is 32, the industry-wide cost is estimated at $24,000k. On a 2001 present value basis, the per reactor and industry-wide costs are $612k and $19,600k, respectively. Under the high and low scenarios of 40 and 23 PWR's, the industry-wide cost on a 2001 present worth basis is $24,500k and $14,100k, respectively.

Furthermore, since the work is being performed in a radioactive environment and requires the reactor to be in a shutdown mode, the staff also considered additional cost elements during

implementation to account for occupational exposure and replacement energy costs. Occupational exposure averaged 2 person-rem per reactor for the modifications performed by PG&E. Based on NRC's $2000/person-rem valuation, this would result in a cost of $4K per reactor which is viewed as negligible. In addition, based on PG&E's experience, the staff concludes that no replacement energy cost penalties should be ascribed to this modification. The PG&E modifications required no incremental downtime as the work was completed within a relatively short duration and was easily accommodated within a normal outage period,

4.0 Other Cost Elements

Based on the BWR experience, it is anticipated that the licensees' reactor-specific engineering analyses and the actual modifications would be subject to NRC audits and inspections. For BWRs, audit reports and site visits were performed for a sample of 4 sites involving a total of 6 reactors. Assuming the same number of site visits and audit reports are conducted for PWRs, and costs comparable with the BWR experience, the total NRC cost for this activity is estimated at about $200k. This estimate assumes about $125k in contractor support and about $75k in NRC staff costs. On a 2001 present worth basis, this cost is about $160k.

The staff also considered whether there were likely to be any recurring costs associated with a redesigned sump screen. This could include such activities as periodic maintenance on the part of the licensee and periodic inspections by the NRC. However, given that the sump screen is a passive system, the need for these activities is unlikely and no recurring costs are assumed in the staff's estimates.

5.0 Total Costs

The staff's best estimates of NRC and industry-wide 2001 present value costs are $0.53M and $28.23M, respectively. In the aggregate, the total present worth cost is estimated at approximately $28.8M. Distributing this cost among the 32 reactors that are assumed to require a modification, results in a per reactor cost of $0.9M.

For sensitivity analysis purposes, the staff assumed that the number of reactors requiring a physical modification could range between 23 and 40. At the low end this translates into a total present worth cost of about $23.3M. At the high end, the total present worth cost is estimated at about $33.7M.