Indian Point Nuclear Generating Units 2 and 3
Docket Nos. 50-247/ 50-286-LR

NRC Staff's Response in Opposition to State of New York's Motion for Partial Summary Disposition of NYS Contention 16/16A

Exhibit I

NUREG/CR-2300
Vol. 1

PRA PROCEDURES GUIDE

A Guide to the Performance of Probabilistic Risk Assessments for Nuclear Power Plants

Final Report
Vol. 1 - Chapters 1-8
Vol. 2 - Chapters 9-13 and Appendices A-G

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Table 2-2. Estimated total manpower for PRAs of various levels

Function	Manpower estimate (man-months) Level 1	Level 2	Level 3
Analysis	51-89	75-288	80-298
Reporting	11-22	19-38	23-43
Assurance of technical quality	7-12	10-20	11-21
Management	14-19	19-21	21-24
Total	83-142	123-367	135-386

2.4.1.1 Level 1 PRA

Task 1, initial information collection, begins on deciding to perform the PRA. It is important that the analysis team have available a substantial amount of information on beginning the analysis to avoid delays and misinformation. The information-collection task is an activity that continues throughout the PRA, and as the analysis proceeds, more information will be needed regarding specific aspects of plant design and operation. For the initial accumulation of information, however, it is estimated that 1 to 2 man-months will be needed.

The development of plant models and particular analyses germane to this development may proceed in parallel. Event-tree development (subtask 2a) and system modeling (subtask 2b) use much of the same information. The models are generally separate, although some insights from each development may influence the other. In particular, the development of event trees helps to clearly define the events to be modeled in system modeling. The effort required for event-tree development and the development of models representing all systems included in the analysis is estimated to be 29 to 38 man-months.

The development of plant models is supported by an analysis of human reliability and operating procedures (subtask 2c) and the development of a data base (subtask 2d) for assessing component reliabilities and initiating-event frequencies. Both activities are performed in parallel with the model development. This ensures that human errors are incorporated into the models. The data-base-development subtask assists in establishing the appropriate level of detail for the models and provides data for accident-sequence quantification. The human-factors analyst assisting in the analysis of human reliability and procedures is estimated to need 2 to 6 man-months; the development of a data base, 5 to 6 man-months.

The accident-sequence quantification (subtask 2e) integrates the plant models and data to quantify accident sequences. This subtask follows the plant-modeling effort and the development of the data base. Considerable iteration can be expected during this activity. The manpower needed to complete this task is estimated to be 9 to 12 man-months.

If an external events analysis is included, it proceeds concurrently with the development of plant models and uses information contained therein. The system analysis is completed before the quantification of accident sequences to permit the inclusion of its results in the accident-sequence analysis. Manpower needs depend on the number and the type of external events considered. If seismic, fire, and flood analyses are performed, it is estimated that 14 to 18 man-months will be needed for this task.

An uncertainty analysis is performed in a level 1 PRA. The manpower needs depend on the depth of this analysis, but 3 to 4 man-months is a representative figure. An additional effort of 2 to 3 man-months is estimated for the development and interpretation of results.

The above tasks constitute a PRA of level 1. Their performance is estimated to require 51 to 89 man-months. In addition to these technical tasks, however, the PRA requires program management, assurance of technical quality, and report preparation. Program management is estimated to require an additional person working full time; the team responsible for ensuring technical quality is assumed to need 7 to 12 man-months. Report preparation for a level 1 PRA is estimated to require 11 to 22 additional man-months (see Section 2.4.3). Given a representative schedule (see Section 2.4.2.2), the total manpower needed to perform, review, and publish a level 1 PRA is estimated to be 83 to 142 man-months.

2.4.1.2 Level 2 PRA

Two additional tasks are performed in a level 2 PRA: the analysis of the physical processes of accidents and the analysis of radionuclide releases to the environment. These tasks generally require people with substantially different backgrounds and expertise from those involved in the level 1 PRA.

Some analysis of physical accident processes is required early in the PRA effort to support the activities of task 2 related to event-tree development and system modeling. This is a comparatively small effort that is required in a level 1 as well as a level 2 PRA. After the identification of specific system sequences in subtask 2b, the progression of accident sequences must be analyzed in order to be able to estimate their radiological consequences. Because of the large number of system sequences identified, it is not practical to analyze the physical processes of every sequence. Either the sequences must be ranked in importance through quantification, or they must be grouped according to similar behavior, with only representative sequences analyzed. In either case, the analysis of accident processes should not be completed before subtask 2e, the quantification of accident sequences, since some iteration may be required as the dominant contributors to risk become apparent. The other major effort required in the physical-processes task is the development and quantification of the containment event tree, which describes the different possible pathways for the release of radionuclides from containment for an accident sequence.

The amount of effort required for the analysis of accident processes can vary substantially (15 to 137 man-months), depending on the expected use

of the PRA and the amount of previous experience in the analysis of a particular plant design. The state of the art of physical-process analysis is not at the point where specific computer codes can be used in the analysis without extensive checking and evaluation. The analysis of physical processes, particularly in relation to the likelihood and the time of containment failure, can, however, appreciably affect the overall risk. The high end of the estimate range is characteristic of the effort required in the Zion probabilistic risk assessment (Commonwealth Edison Company, 1981) without accounting for extensive model development. (Such model development, if required, may require as much as 20 to 25 man-months.)

The analysis of radionuclide release and transport (subtask 3b) depends on and follows the analysis of physical processes. The final product of this task is the assignment of accident sequences to release categories that describe the timing and quantity of radionuclide releases from the containment. The manpower needed for this analysis is estimated to be 5 to 20 man-months.

If external events are included in the analysis, it will be necessary to perform an analysis of the containment under the conditions of each type of external event. Such analyses are estimated to require 3 to 4 additional man-months.

The development and interpretation of results may take 2 to 4 man-months if a good correlation to previously published containment event tree(s) is obtained or if a qualitative statement is sufficient. If a detailed containment event tree is developed, up to 30 man-months should be allocated for development and quantification.

Additional uncertainty analysis is performed in a level 2 PRA, reflecting the additional modeling involved. Uncertainty analysis follows subtasks 3a and 3b, and is estimated to take 2 to 8 man-months more than it does in a level 1 PRA.

The performance of a level 2 PRA is estimated to require an additional 24 to 199 man-months of technical work beyond a level 1 PRA. Additional program management, assurance of technical quality, and reporting requirements are estimated to entail another 16 to 26 man-months. Thus, the total manpower for performing, reviewing, and publishing a level 2 PRA is estimated to be 123 to 367 man-months.

2.4.1.3 Level 3 PRA

A level 3 PRA includes an analysis of the environmental transport and consequences of radionuclide releases for each accident sequence (task 4). The collection of meteorological, topographic (if pertinent), and demographic data occurs concurrently with the radionuclide release and transport analysis. This ensures that the analysis can be performed immediately after the identification of release categories. The manpower for the analysis is estimated to be 3 to 4 man-months, with an additional 1 to 2 man-months needed should external events be considered, and 2 to 4 man-months for the uncertainty analysis and the development of results.