JUL 3 1979

INTERIM REPORT

Accession No. _____
Contractor's Report No. _____

Contract Program or Project Title: Nuclear Power Plant Design Concepts For Sabotage Protection - Fourth Quarterly Progress Report

Subject of this Document: Progress reported for Jan - March 1979

Type of Document: Quarterly Progress Report

Author(s): Dave Ericson

Date of Document: April 30, 1979

Responsible NRC Individual and NRC Office or Division: William H. Immerman, Operational Support Branch, SAFER:RES

This document was prepared primarily for preliminary or internal use. It has not received full review and approval. Since there may be substantive changes, this document should not be considered final.

DISTRIBUTION:
S. Levine, RES
C. Beck, RES
J. Durst, RES
R. DiSalvo, RES
M. Taylor, RES
W. Pasedag, NRR
T. J. Carter, NRR
T. Michaels, SD
L. Bush, I&E

Prepared by
Sandia Laboratories
P.O. Box 5800
Albuquerque, New Mexico 87185

Prepared for
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

NRC FIN No. A1210

446 161

INTERIM REPORT

NUCLEAR POWER PLANT DESIGN CONCEPTS

for

SABOTAGE PROTECTION

Fourth
Quarterly Progress Report

January - March 1979

Nuclear Power Plant Design Concepts
for
Sabotage Protection

1. Program Plan. The approved plan was published and distributed as NUREG/CR-0463 (SAND 78-1994) in January 1979.

2. Task 1, Baseline Plant Characterization. The Standardized Nuclear Unit Power Plant System (SNUPPS) is the baseline plant. The characterization work done by Dikewood Industries includes the sabotage fault trees, critical location information, and pertinent systems descriptions. The sabotage fault trees have been analyzed using SETS techniques and the event space equations established. Based upon the present development of the fault tree (and assuming a loss of off-site power) the solution in event space contains 10287 terms. Of these, 11 involve one event, 68 involve two events and the remaining 10218 involve three events. The event space to location space transformation was made and the resulting location tree has also been analyzed using SETS. In this case, the solution contains 99 terms, assuming as a starting point the loss of off-site power. In this solution, 6 terms involve a single location, 9 involve two locations, and 82 involve 3 locations. This solution is considered to be an interim solution for several reasons. One, certain events outside the buildings were arbitrarily

lumped into a single location. This may require some redefinition. Two, there may be locations which are contained within other locations as they are now defined. These questions are being reviewed concurrently with the continuing analysis of the baseline plant. An initial attempt at defining the complement to the location solution, that is, how many locations must be protected to preclude sabotage, generated an equation of 1024 terms, 384 of which contain 17 locations (the minimum number). Again, this is subject to revision as the questions outlined above are investigated. The plant has been digitized (floor plans converted to computer-stored format) in preparation for the safeguards effectiveness analyses which will continue during the next quarter.

3. Task 2, Plant Design Options. Under contract to Sandia, International Energy Associates Limited (IEAL) has nearly completed an initial cataloging of various design options which have been suggested as potential ways to enhance sabotage protection. As reported earlier, three general considerations guided the selection and organization of these options. These considerations are: 1) enhanced protection of the reactor coolant system boundary; 2) enhanced protection of the reactor trip function; and 3) enhanced protection for the decay heat removal function. The rationale for these considerations was discussed in the Third Quarterly Report. The purpose of the cataloging is to gather into one consistent set all those options

which have been mentioned in one way or another in prior studies. Once this is accomplished, then a systematic evaluation can be conducted. Based upon this perspective, some 29 options were defined. These may be grouped under the four categories defined in the program plan as follows:

Category	Number of Options
Hardening Critical Systems or Locations	8
Plant Layout Modifications	9
System Design Changes	10
Additional Systems	2

A listing of the options by title in included as attachment 1.

The 29 options were discussed in depth with the Design Study Technical Support Group (DSTSG) during a 2-1/2 day meeting in February. Based upon that review some options will be documented but receive no further analysis. For example, it was established in the review with the plant operators and reactor venders that there are already many ways to cause a reactor trip so that further redundencies or special protection for trip circuits will not enhance reactor protection. Similarly, in the context of this study, it was agreed that underground siting or further hardening of the containment are not strong candidates for enhancing protection. Individual members of the DSTSG also provided written comments and discussions

on various options. These inputs are being factored into the cataloging and descriptions being prepared by IEAL.

4. Task 3, Damage Control Options. As outlined in the last quarterly report, the approach selected for considering damage control was essentially to compare time available and time required. That is, given certain plant states are created, how long do we have to act before irreparable damage occurs or is sure to occur and how long would it take to diagnose and repair damage to safety components. Using this approach, a number of potential plant states were analyzed and several identified for which there is some time (hours at least) after an initiating event before conditions become irreversible. The concurrent analyses revealed a number of potential sabotage acts which do appear reparable or mitigatable in the time available. This preliminary analysis was reviewed with the DSTSG at which time two principal concerns were voiced. First, there was a strong feeling that the estimates of the time it would take to recognize particular problems, alert the operating staff, and take remedial actions were much too optimistic. Also, as a related issue, it was the opinion of the DSTSG that the difficulty of maintaining "emergency only" equipment integrity in the normal plant operating environment was underestimated. Second, there was major concern about the viability of repair if an adversary is intent

on preventing access to the room or area where damage was created. The concept of damage control was not discouraged, but the DSTSG suggested that a somewhat different tack be taken. They recommended that damage control be directed toward use of installed equipment that could be achieved, for example, by alternative or non-standard valve alignments. In some instances this can be done without even leaving the control room. As a starting point, it was suggested that we examine the existing abnormal operating procedures for possible adaptation or extension. The study is being reoriented to take these recommendations into account.

5. Design Study Technical Support Group (DSTSG). The DSTSG, composed of nuclear industry representatives, was established to assist Sandia in the development and evaluation of design and damage control concepts. The first meeting of this group was held this quarter, February 19-21. As indicated above, at this meeting the design options and damage control ideas were reviewed and discussed in considerable detail. The interaction with this industry group is proving to be extremely valuable and pertinent to the study. Because of their experience and familiarity with the systems involved, the DSTSG is able to highlight considerations that might otherwise be missed, but which can have significant impact upon the conclusions. In addition to the immediate contributions during the meeting, the DSTSG members have provided written comments and

suggestions which are being considered in the formulation and evaluation of the design alternatives and damage control measures. A second meeting of the group is planned for late April. After the April meeting, interaction with the DSTSG will be on an "as required" basis during the remainder of Phase I.

6. Modifications to Program Schedule. According to the original schedule (as documented in the Program Plan) Phase I of the studyis scheduled to conclude (including a report) by October 1, 1979. It is now apparent that this schedule was too optimistic and that several revisions to the schedule are necessary in order to reflect goals that are achievable. The changes are necessitated by a number of factors. It took longer than planned to generate the sabotage fault trees for the baseline plant which has slowed the analysis. Arranging the contractual coverage with the individual firms represented on the DSTSG required much more time and effort than anticipated. This, in turn, delayed the interaction between Sandia, IEAL and the DSTSG, an interaction which is vital to the successful completion of the work. Also, the actual number of potential alternatives has proven to be larger than expected which has lengthened the time required to collect and appropriately document the information on these options. Finally, the modification of the approach to damage control suggested by the DSTSG has significantly slowed our activities in this area.

With these considerations in mind, the schedule has been reviwed as shown on attachment 2. The significant changes are:

1) extending the consideration of plant design options until July 1979;
2) completion of alternate configurations and physical protection system definition delayed until August 1979;
3) completion of preliminary reference designs and evaluation in September and November 1979, respectively;
4) the Phase I report will be submitted by January 1980;
5) completion dates for Phase II activities would slip approximately 3 months. Action on final reference designs would not be initiated until late 1979.

ATTACHMENT I

CATEGORIZATION OF DESIGN OPTIONS

CATEGORY I

HARDENING CRITICAL SYSTEMS OR LOCATIONS

1. Underground Siting
2. Hardened Containment Building
3. Hardened Fuel Handling Building
4. Hardened Enclosure of Control Room
5. Hardened Enclosure for Reactor Protection and Engineered Safety Features Actuation Systems Power and Control Equipment.
6. Hardening Ultimate Sink
7. Taking Advantage of Natural Protective Feasures in Site Selection
8. Hardened Enclosures for Makeup Water Tanks

CATEGORY II

PLANT LAYOUT MODIFICATIONS

1. Separation of Containment Penetrations for Redundant Protection Systems
2. Separation of Safety Related Piping, Control Cables, and Power Cables in Underground Galleries
3. Spent Fuel Storage within Containment

4. Spent Fuel Stored Below Grade (or protected by berms)
5. Physically Separate and Protect Redundant Trains of Emergency Equipment
6. Separate Areas or Rooms for Cable Spreading
7. Alternate Control Room Arrangements
8. ECCS Components within Containment
9. Administrative, Information, and Construction Bulding Located Outside of Protected Area

CATEGORY III

SYSTEM DESIGN CHANGES

1. Isolation of Low Pressure Systems Connected to Reactor Coolant Pressure Boundary
2. Design Changes to Facilitate Damage Control
3. Alternate Containment Designs
4. Extra Redundant, Fully Separated, Self-contained and Protected Trains of Emergency Equipment
5. Additional Protected Control Rod Trip
6. Additional Protected Control Rod Trip Acting on Diverse, Protected Trip Breakers
7. Turbine Runback
8. Reduced Vulnerability of Intake Structures for Safety Related Pumps.

Attachment I (cont'd)

9. Trip Coils for Breakers/Switchgear Energized by Internal Power Source
10. High Pressure RHR System

CATEGORY IV

ADDITIONAL SYSTEMS

1. Hardened Decay Heat Removal System
2. Additional Independent, Diverse Scram System

~~446~~ ~~173~~

ATTACHMENT II

REVISED PROGRAM SCHEDULE