NRC 173

U.S. NUCLEAR REGULATORY COMMISSION

ORDER NUMBER
20-79-152

STANDARD ORDER FOR DOE WORK

DATE
August 23, 1979

ISSUED TO: (DOE Office)
Chicago Operations Office

ISSUED BY: (NRC Office)
Division of Systems Safety
Ofc. of Nuclear Reactor Regulation

ACCOUNTING CITATION
APPROPRIATION SYMBOL
31X0200.209
B&R NUMBER
20-19-03-01-2
FIN NUMBER
A3318-9

PERFORMING ORGANIZATION AND LOCATION
Brookhaven National Laboratory, Upton, N.Y. 11973

FIN TITLE
ATWS Audit Calculations

WORK PERIOD - THIS ORDER

FIXED ☐	ESTIMATED ☒
FROM: 9/1/79	TO: 3/31/80

OBLIGATION AVAILABILITY PROVIDED BY:

A. THIS ORDER	$ 100,000
B. TOTAL OF ORDERS PLACED PRIOR TO THIS DATE WITH THE PERFORMING ORGANIZATION UNDER THE SAME "APPROPRIATION SYMBOL" AND THE FIRST FOUR DIGITS OF THE "B&R NUMBER" CITED ABOVE.	$ 3,148,000
C. TOTAL ORDERS TO DATE (TOTAL A & B)	$ 3,248,000
D. AMOUNT INCLUDED IN "C" APPLICABLE TO THE "FIN NUMBER" CITED IN THIS ORDER.	$ 100,000

FINANCIAL FLEXIBILITY:

- ☒ FUNDS WILL NOT BE REPROGRAMMED BETWEEN FINS. LINE D CONSTITUTES A LIMITATION ON OBLIGATIONS AUTHORIZED.
- ☐ FUNDS MAY BE REPROGRAMMED NOT TO EXCEED ± 10% OF FIN LEVEL UP TO $50K. LINE C CONSTITUTES A LIMITATION ON OBLIGATIONS AUTHORIZED.

STANDARD TERMS AND CONDITIONS PROVIDED DOE ARE CONSIDERED PART OF THIS ORDER UNLESS OTHERWISE NOTED.

ATTACHMENTS:
THE FOLLOWING ATTACHMENTS ARE HEREBY MADE A PART OF THIS ORDER:

- ☒ STATEMENT OF WORK
- ☒ ADDITIONAL TERMS AND CONDITIONS
- ☐ OTHER

SECURITY:

- ☒ WORK ON THIS ORDER IS NOT CLASSIFIED.
- ☐ WORK ON THIS ORDER INVOLVES CLASSIFIED INFORMATION. NRC FORM 187 IS ATTACHED.

REMARKS:

AFTER SIGNATURE, PLEASE SEND A COPY OF THIS ORDER TO M. PAULETTE TRIPLETT, NRR, P-428

ISSUING AUTHORITY	ACCEPTING ORGANIZATION
SIGNATURE M. P. Triplett M Paulette Triplett	SIGNATURE
TITLE Fiscal Assistant 8/23/79	TITLE
	DATE

NRC FORM 173 (2-78)

1740 065

8001110 664

STATEMENT OF WORK

Title: ATWS Audit Calculations

FIN No.: A-3318
B&R No.: 20-19-03-01-2

Technical Monitors: A. Thadani, 492-7341, F. Odar, 492-7911
Cognizant Branch Chief: T. P. Speis, 492-7359

Purpose of Program

This program is designed to obtain expert technical assistance in developing the technical bases for a staff position for the ATWS rulemaking hearing and for ATWS impact assessment for TMI-2.

General Information

Audit calculations for selected ATWS events will be performed utilizing existing computer codes and PWR and BWR initial decks available at Brookhaven National Laboratory.

TASK 1 - PWR AUDIT CALCULATIONS

Background

Occurrence of the TMI-2 accident indicated that systems transients may lead to a small LOCA and a core uncovering coupled with shutdown problems. While previous ATWS audit calculations were performed to evaluate the overpressurization effects which occur for a short time in the beginning of the transient, the aspects of core uncovering and boiling in the primary system were overlooked.

The TMI-2 accident also proved that ATWS audit calculations must cover some failures which impact consquences, such as: stuck open valve; delay in auxiliary feedwater; and, reduction in feedwater. Also, the inadvertent opening of a safety or relief valve is an anticipated transient which may have significant consequences and must be analyzed.

Objectives

The objectives of this task are: (1) to establish the validity of the vendors codes used in ATWS anlayses in the event of boiling in the primary system, and if there is boiling, the effects of core uncovering; (2) to perform audit calculations to establish the sensitivities of ATWS event failures.

Work Requirements

Using the IRT and RELAP3B codes, perform the following analyses for the Trojan (Westinghouse), Calvert Cliffs (Combustion Engineering) and Oconee (Babcock and Wilcox) nuclear power plants.

(a) Loss of feedwater with stuck open valve

(b) Loss of offsite power with stuck open valve

For each of these two transients, calculate the following five cases:

(1) Base case - 95% moderate temperature coefficient and homogeneous equilibrium discharge model (without factor of 0.9) for the stuck open valve.

(2) 99% moderator temperature coefficient.

(3) Time delay (to be specified by the staff) in auxiliary feedwater and reduce auxiliary feedwater by 50%.

(4) Use factor of 0.9 on homogeneous equilibrium discharge model from the stuck open valve.

(5) Use different HPSI head curve (to be specified by the staff).

Scheduled Milestone

This task should be completed by March 1, 1980.

TASK 2 - BWR AUDIT CALCULATIONS

Sub-task 2.1 - Short-term Calculations

Background

Peach Bottom tests showed that steam line dynamics and space-time kinetics were important factors in predicting overpressurization events. The previous calculations performed by GE utilizing the REDY code did not model these two aspects. Previous ATWS audit calculations performed by the staff also did not model these two aspects.

Objective

The objective of this sub-task is to obtain the results of overpressurization events using steam line dynamic and space kinetics.

Work Requirements

Using the BNL/TWIGL and RELAP3B computer codes or the RAMONA III computer code, if available, perform audit calculations for ATWS events: turbine trip without bypass and MSIV closure for BWR (Peach Bottom) EOC2 conditions.

(a) Perform these calçulations on a short-term basis, i.e., one minute of transient time and evaluate the effects of steam line dynamic and point kinetics

(b) Calculate other quantities such as neutron flux, heat flux and pressure and evaluate the results.

Scheduled Milestone

This sub-task should be completed by ~~October~~ November 1, 1979.

Sub-task 2.2 - Long-Term Calculations

Background

Previous audit calculations did not extend long enough to verify GE calculations for long term behavior. The effectiveness of the fix, "Boron reactivity feedback" was never evaluated. Also, the long-term energy releases are important to evaluate torus behavior. Since the frequency and duration of the opening of the valves are governed by the effectiveness of the fix and the dynamics of the steam line, long-term calculations must be performed.

Objective

The objective of this sub-task is to evaluate the long-term behavior of the core and evaluate the effectiveness of the boron fix.

Work Requirements

Perform the same calculations as in sub-task 2.1 on a long-term basis, i.e., 10 minutes of transient time and evaluate the effects of boron injection and frequent actuation and closure of relief valves.

Scheduled Milestone

This sub-task should be completed by March 1, 1980.

Level of Effort and Period of Performance

The estimated level of effort is 1.5 man-years over a 6 month period (September 1, 1979 to March 1, 1980).

Reporting Requirements

(1) The contractor shall provide a plan of work and methodology to the Cognizant Branch Chief within 4 weeks after acceptance of this work order. The plan shall establish and identify a set of project milestones accompanied by a brief narrative description.

(2) A brief monthly business letter report is to be submitted by the 15th of the month to the Cognizant Branch Chief with a copy to the Director, Division of Systems Safety, ATTN: B. L. Grenier. These reports will contain:

- A listing of any efforts completed during the period; milestones reached, or if missed, an explanation provided.

- The amount of funds expended during the period and cumulative to date.

  Note: The first month letter report should contain the planned monthly rate of expenditure.

- Any problems or delays encountered or anticipated.

  Note: Submit a proposed resolution of the problems including the schedule for resolution.

- A summary of the progress to date.

- Plans for the next reporting period.

(3) At the completion of each sub-task, a letter report shall be provided to the Cognizant Branch Chief that describes the results and the bases upon which they were obtained.

(4) At the completion of the program, a final report shall be prepared and submitted to the Cognizant Branch Chief in accordance with NRC Manual Chapter 3202. This report shall contain a summary of the results and conclusions obtained under each task and the detailed technical bases.

Meetings and Travel

Two meetings to Bethesda, Maryland should be planned.

NRC Furnished Materials

1740 069

None.

Billing Requirements

Vouchers submitted for payment should list expenditures for manpower and any other major items of expenditures associated with review of each individual plan.

ENCLOSURE 4

STEAM GENERATOR MODEL, MAJOR STEPS FOR IMPLEMENTATION OF CANDU BOILER CODE AND IMPROVEMENT AT BNL

U-Tube Steam Generator

1. Implementation at BNL,

2. Detailed Review of Models, Numerics, Code Structure } (AECL Presentation)

3. Decision to adopt BOILER-2. If yes, then

4. Tasks as needed:

   4.1 Revision of Steam Dome Model,

   4.2 Level Tracking below Steam Dome and Separators,

   tube side
   shell side
   downcomer,

   4.3 Flow Reversal (upwind differencing for V_α or $V_h < 0$).
   Investigation and correction of instability problem (may need a new numerical scheme),

   4.4 Separator Model,

   4.5 Condensation for primary side,

   4.6 Auxiliary Feed Water Injection,

   4.7 Correction of Preheater Location ("rewiring of code"),

   4.8 Cross-mixing in S.G. without Preheater Divider,

5. Parallel U-Tube Flow Instability

   (Cross-sectional area in primary side varies with time to account for stalled U-tubes during low-flow natural circulation),

6. U.S. UTSG Geometries and Conditions

   6.1 Add necessary control systems for three vendors,

7. OTSG Geometries

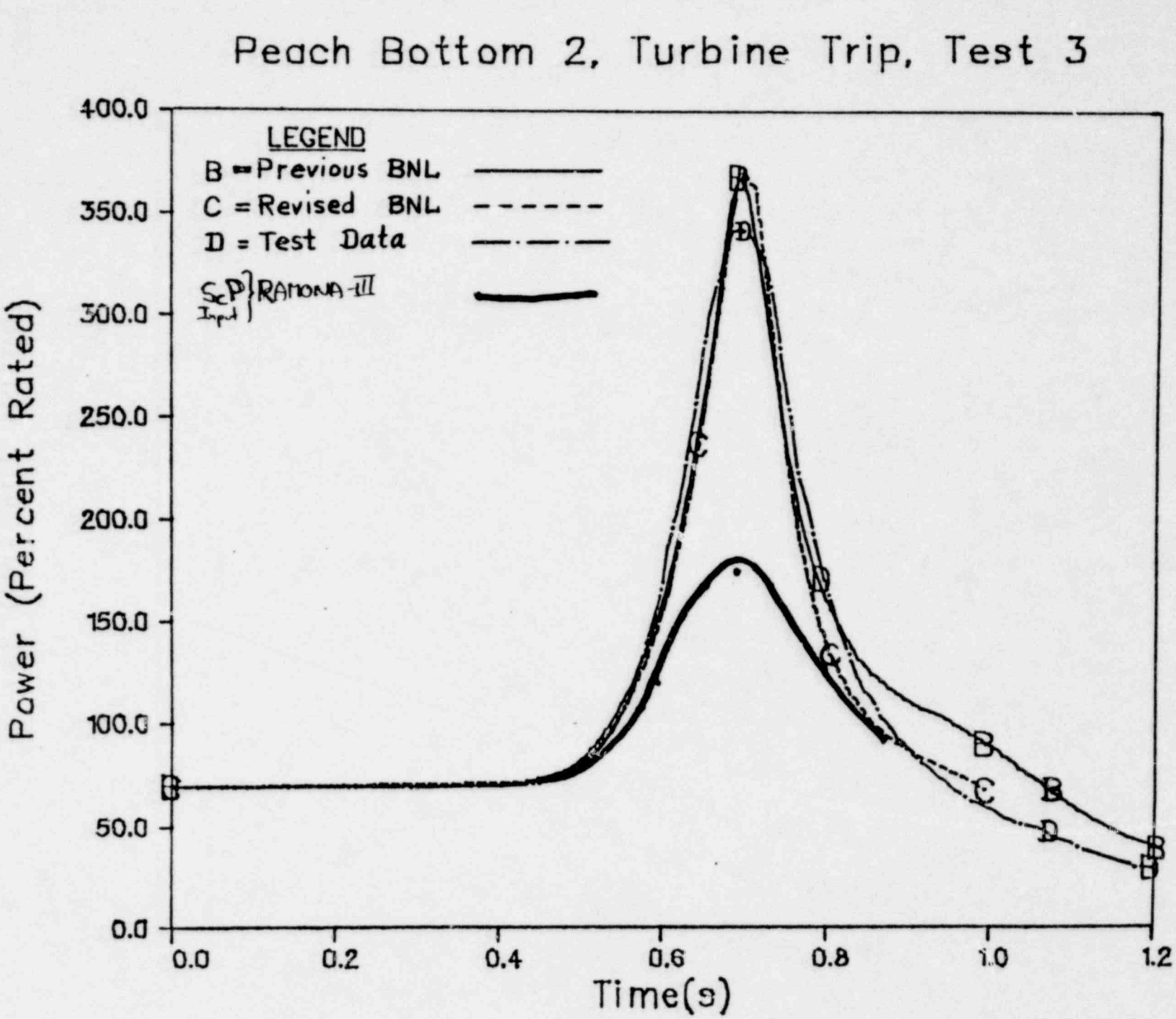
7.1 "Rewire" code for OTSG with and without aspirator,

7.2 Auxiliary Feedwater Injection into super-heated steam,

7.3 Add necessary B&W control systems.

ENCLOSURE 5

Comparison of Power Variation
in Peach Bottom Turbine Trip Test III
using two BNL models, test data
and RAMONA-III code


Peach Bottom 2, Turbine Trip, Test 3
LEGEND
B = Previous BNL
C = Revised BNL
D = Test Data
SCP Input } RAMONA-III
Power (Percent Rated)
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Time(s)