Enclosure 2

SAI-186-029-29

TECHNICAL EVALUATION REPORT

IMPPOVEMENTS IN TRAINING AND REQUALIFICATION PROGRAMS AS REQUIRED BY TMI ACTION ITEMS I.A.2.1 AND II.B.4

for the

Crystal River Unit 3

(Docket 50-302)

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I. INTRODUCTION

Science Applications, Inc. (SAI), as technical assistance contractor to the U.S. Nuclear Regulatory Commission, has evaluated the response by Florida Power Corporation for Crystal River Unit 3 (Docket 50-302) to certain requirements contained in post-TMI Action Items I.A.2.1, Immediate Upgrading of Reactor Operator and Senior Reactor Operator Training and Qualification, and II.B.4, Training for Mitigating Core Damage. These requirements were set forth in NUREG-0660 (Reference 1) and were subsequently clarified in NUREG-0737 (Reference 2).*

The purpose of the evaluation was to determine whether the licensee's operator training and requalification programs satisfy the requirements. The evaluation pertains to Technical Assignment Control (TAC) System numbers 44151 (NUREG-0737, I.A.2.1.4) and 44501 (NUREG-0737, II.B.4.1). As delineated below, the evaluation covers only some aspects of item I.A.2.1.4.

The detailed evaluation of the licensee's submittals is presented in Section IV; the conclusions are in Section V.

II. SCOPE AND CONTENT OF THE EVALUATION

A. I.A.2.1: Immediate Upgrading of RO and SRO Training and Qualifications

The clarification of TMI Action Item I.A.2.1 in NUREG-0737 incorporates a letter and four enclosures, dated March 28, 1980, from Harold R. Denton, Director, Office of Nuclear Reactor Regulation, USNRC, to all power reactor applicants and licensees, concerning qualifications of reactor operators (hereafter referred to as Denton's letter). This letter and enclosures imposes a number of training requirements on power reactor licensees. This evaluation specifically addressed a subset of the requirements stated in Enclosure 1 of Denton's letter, namely: Item A.2.c, which relates to operator training requirements; item A.2.e, which concerns instructor requalification; and Section C, which addresses operator requalification. Some of these requirements are elaborated in Enclosures 2, 3, and 4 of Denton's letter. The training requirements under evaluation are summarized in Figure 1. The elaborations of these requirements in Enclosures 2, 3, and 4 of Denton's letter are shown respectively in Figures 2, 3, and 4.

As noted in Figure 1, Enclosures 2 and 3 indicate minimum requirements concerning course content in their respective areas. In addition, the Operator Licensing Branch in NRC has taken the position (Reference 3) that

*Enclosure 1 of NUREG-0737 and NRC's Technical Assistance Control System distinguish four sub-actions within I.A.2.1 and two sub-actions within II.B.4. These subdivisions are not carried forward to the actual presentation of the requirements in Enclosure 3 of NUREG-0737. If they had been, the items of concern here would be contained in I.A.2.1.4 and II.B.4.1.

Figure 1. Training Requirements from TMI Action Item I.A.2.1*

Program Element	NRC Requirements**
OPERATIONS [illegible] TRAINING	Enclosure 1, Item A.2.c(1) Training programs shall be modified, as necessary, to provide training in heat transfer, fluid flow and thermodynamics. (Enclosure 2 provides guidelines for the minimum content of such training.)
	Enclosure 1, Item A.2.c(2) Training programs shall be modified, as necessary to provide training in the use of installed plant systems to control or mitigate an accident in which the core is severely damaged. (Enclosure 3 provides guidelines for the minimum content of such training.)
	Enclosure 1, Item A.2.c.(3) Training programs shall be modified, as necessary, to provide increased emphasis on reactor and plant transients
[illegible] REQUALIFICATION	Enclosure 1, Item C.1.a Each licensee shall be required to participate in appropriate requalification programs to assure that at a minimum, each operator reviews his performance with regard to current operating history, procedures, and changes to procedures and administrative limitations.
REQUALIFICATION	Enclosure 1, Item C.1 Content of the licensed operator requalification programs shall be modified to include instruction in heat transfer, fluid flow, thermodynamics, and mitigation of accidents involving a degraded core. (Enclosures 2 and 3 provide guidelines for the minimum content of such training.)
	Enclosure 1, Item C.2 The criteria for requiring a licensed individual to participate in accelerated requalification shall be modified to be consistent with the new passing grade for licensees of 80% overall and 70% with category.
	Enclosure 1, Item C.3 Programs should be modified to require the control manipulations listed in Enclosure 4. Normal control manipulations, such as plant or reactor startups, must be performed. Control manipulations during abnormal or emergency operations must be walked through with, and evaluated by, a member of the training staff at a minimum. An appropriate simulator may be used to satisfy the requirements for control manipulations.

*The requirements shown are a subset of those contained in Item I.A.2.1.
**References to Enclosures are to Denton's letter of March 28, 1980, which is contained in the clarification of Item I.A.2.1 in NUREG-0737.

Figure 2. Enclosure 2 from Denton's Letter

TRAINING IN HEAT TRANSFER, FLUID FLOW AND THERMODYNAMICS

1. Basic Properties of Fluids and Matter.

This section should cover a basic introduction to matter and its properties. This section should include such concepts as temperature measurements and effects, density and its effects, specific weight, buoyancy, viscosity and other properties of fluids. A working knowledge of steam tables should also be included. Energy movement should be discussed including such fundamentals as heat exchange, specific heat, latent heat of vaporization and sensible heat.

2. Fluid Statics.

This section should cover the pressure, temperature and volume effects on fluids. Example of these parametric changes should be illustrated by the instructor and related calculations should be performed by the students and discussed in the training sessions. Causes and effects of pressure and temperature changes in the various components and systems should be discussed in the training sessions. Causes and effects of pressure and temperature changes in the various components and systems should be discussed as applicable to the facility with particular emphasis on safety significant features. The characteristics of force and pressure, pressure in liquids at rest, principles of hydraulics, saturation pressure and temperature and subcooling should also be included.

3. Fluid Dynamics.

This section should cover the flow of fluids and such concepts as Bernoulli's principle, energy in moving fluids, flow measure theory and devices and pressure losses due to friction and orificing. Other concepts and terms to be discussed in this section are NPSH, carry over, carry under, kinetic energy, head-loss relationships and two phase flow fundamentals. Practical applications relating to the reactor coolant system and steam generators should also be included.

4. Heat Transfer by Conduction, Convection and Radiation.

This section should cover the fundamentals of heat transfer by conduction. This section should include discussions of such concepts and terms as specific heat, heat flux and atomic action. Heat transfer characteristics of fuel rods and heat exchangers should be included in this section.

This section should cover the fundamentals of heat transfer by convection. Natural and forced circulation should be discussed as applicable to the various systems at the facility. The convection current patterns created by expanding fluids in a confined area should be included in this section. Heat transport and fluid flow reductions or stoppage should be discussed due to steam and or noncondensible gas formation during normal and accident conditions.

This section should cover the fundamentals of heat transfer by thermal radiation in the form of radiant energy. The electromagnetic energy emitted by a body as a result of its temperature should be discussed and illustrated by the use of equations and sample calculations. Comparisons should be made of a black body absorber and a white body emitter.

5. Change of Phase - Boiling.

This section should include descriptions of the state of matter, their inherent characteristics and thermodynamic properties such as enthalpy and entropy. Calculations should be performed involving steam quality and void fraction properties. The types of boiling should be discussed as applicable to the facility during normal evolutions and accident conditions.

6. Burnout and Flow Instability.

This section should cover descriptions and mechanisms for calculating such terms as critical flux, critical power, DNB ratio and hot channel factors. This section should also include instructions for preventing and monitoring for clad or fuel damage and flow instabilities. Sample calculations should be illustrated by the instructor and calculations should be performed by the students and discussed in the training sessions. Methods and procedures for using the plant computer to determine quantitative values of various factors during plant operation and plant heat balance determinations should also be covered in this section.

7. Reactor Heat Transfer Limits.

This section should include a discussion of heat transfer limits by examining fuel rod and reactor design and limitations. The basis for the limits should be covered in this section along with recommended methods to ensure that limits are not approached or exceeded. This section should cover discussions of peaking factors, radial and axial power distributions and changes of these factors due to the influence of other variables such as moderator temperature, xenon and control rod position.

Figure 3. Enclosure 3 from Denton's Letter

TRAINING CRITERIA FOR MITIGATING CORE DAMAGE

A. Incore Instrumentation

1. Use of fixed or movable incore detectors to determine extent of core damage and geometry changes.

2. Use of thermocouples in determining peak temperatures, methods for extended range readings, methods for direct readings at terminal junctions.

3. Methods for calling up (printing) incore data from the plant computer.

B. Excore Nuclear Instrumentation (NIS)

1. Use of NIS for determination of void formation, void location basis for NIS response as a function of core temperatures and density changes.

C. Vital Instrumentation

1. Instrumentation response in an accident environment, failure sequence, time to failure, method of failure, indication of reliability (actual vs indicated level).

2. Alternative methods for measuring flows, pressures, levels, and temperatures.

   a. Determination of pressurizer level if all level transmitters fail.

   b. Determination of letdown flow with a clogged filter, flow flow ,,,

   c. Determination of other Reactor Coolant System parameters if the primary method of measurement has failed.

D. Primary Chemistry

1. Expected chemistry results with severe core damage, consequences of transferring small quantities of liquid outside containment, importance of using leak tight systems.

2. Expected isotopic breakdown for core damage, for clad damage.

3. Corrosion effects of extended immersion in primary water; time to failure.

E. Radiation Monitoring

1. Response of Process and Area Monitors to severe damages, behavior of detectors when saturated, method for detecting radiation readings by direct measurement at detector output (overranged detector), expected accuracy of detectors at different locations, use of detectors to determine extent of core damage.

2. Methods of determining dose rate inside containment from measurements taken outside containment.

F. Gas Generation

1. Methods of H_2 generation during an accident, other sources of gas (ie, N_2); techniques for venting or disposal of non-condensibles.

2. H_2 flammability and explosive limit, sources of O_2 in containment or Reactor Coolant System.

Figure 4. Control Manipulations Listed in Enclosure 4.

CONTROL MANIPULATIONS

*1. Plant or reactor startups to include a range that reactivity feedback from nuclear heat addition is noticeable and heatup rate is established.

2. Plant shutdown.

*3. Manual control of steam generators and/or feedwater during startup and shutdown.

4. Boration and or dilution during power operation.

*5. Any significant (greater than 10%) power changes in manual rod control or recirculation flow.

6. Any reactor power change of 10% or greater where load change is performed with load limit control or where flux, temperature, or speed control is on manual (for HTGR).

*7. Loss of coolant including:

1. significant PWR steam generator leak

2. inside and outside primary containment

3. large and small, including leak-rate determination

4. saturated Reactor Coolant response (PWR).

8. Loss of instrument air (if simulated plant specific).

9. Loss of electrical power (and of degraded power sources).

*10. Loss of core coolant flow natural circulation.

11. Loss of condenser vacuum.

12. Loss of service water if required for safety.

13. Loss of shutdown cooling.

14. Loss of component cooling system or cooling to an individual component.

15. Loss of normal feedwater or normal feedwater system failure.

*16. Loss of all feedwater (normal and emergency).

17. Loss of protective system channel.

18. Mispositioned control rod or rods (or rod drops).

19. Inability to drive control rods.

20. Conditions requiring use of emergency boration or standby liquid control system.

21. Fuel cladding failure or high activity in reactor coolant or offgas.

22. Turbine or generator trip.

23. Malfunction of automatic control system(s) which affect reactivity.

24. Malfunction of reactor coolant pressure/volume control system.

25. Reactor trip.

26. Main steam line break (inside or outside containment).

27. Nuclear instrumentation failure(s).

* Starred items to be performed annually, all others biennially.

the training in mitigating core damage and related subjects should consist of at least 80 contact hours* in both the initial training and the requalification programs. The NRC considers thermodynamics, fluid flow and heat transfer to be related subjects, so the 80-hour requirement applies to the combined subject areas of Enclosures 2 and 3. The 80 contact hour criterion is not intended to be applied rigidly; rather, its purpose is to provide greater assurance of adequate course content when the licensee's training courses are not described in detail.

Since the licensees generally have their own unique course outlines, adequacy of response to these requirements necessarily depends only on whether it is at a level of detail comparable to that specified in the enclosures (and consistent with the 80 contact hour requirement) and whether it can reasonably be concluded from the licensee's description of his training material that the items in the enclosures are covered.

The Institute of Nuclear Power Operations (INPO) has developed its own guidelines for training in the subject areas of Enclosures 2 and 3. These guidelines, given in References 4 and 5, were developed in response to the same requirements and are more than adequate, i.e., training programs based specifically on the complete INPO documents are expected to satisfy all the requirements pertaining to training material which are addressed in this evaluation.

The licensee's response concerning increased emphasis on transients is considered by SAI to be acceptable if it makes explicit reference to increased emphasis on transients and gives some indication of the nature of the increase, or, if it addresses both normal and abnormal transients (without necessarily indicating an increase in emphasis) and the requalification program satisfies the requirements for control manipulations, Enclosure 1, Item C.3. The latter requirement calls for all the manipulations listed in Enclosure 4 (Figure 4 in this report) to be performed, at the frequency indicated, unless they are specifically not applicable to the licensee's type of reactor(s). Some of these manipulations may be performed on a simulator. Personnel with senior licenses may be credited with these activities if they direct or evaluate control manipulations as they are performed by others. Although these manipulations are acceptable for meeting the reactivity control manipulations required by Appendix A paragraph 3.a of 10 CFR 55, the requirements of Enclosure 4 are more demanding. Enclosure 4 requires about 32 specific manipulations over a two-year cycle while 10 CFR 55 Appendix A requires only 10 manipulations over a two-year cycle.

B. II.B.4: Training for Mitigating Core Damage

Item II.B.4 in NUREG-0737 requires that "shift technical advisors and operating personnel from the plant manager through the operations chain to the licensed operators" receive training on the use of installed systems to control or mitigate accidents in which the core is severely damaged.

*A contact hour is a one-hour period in which the course instructor is present or available for instructing or assisting students; lectures, seminars, discussions, problem-solving sessions, and examinations are considered contact periods. This definition is taken from Reference 4.

Enclosure 3 of Denton's letter provides guidance on the content of this training. "Plant Manager" is here taken to mean the highest ranking manager at the plant site.

For licensed personnel, this training would be redundant in that it is also required, by I.A.2.1, in the operator requalification program. However, II.B.4 applies also to operations personnel who are not licensed and are not candidates for licenses. This may include one or more of the highest levels of management at the plant. These non-licensed personnel are not explicitly required to have training in heat transfer, fluid flow and thermodynamics and are therefore not obligated for the full 80 contact hours of training in mitigating core damage and related subjects.

Some non-operating personnel, notably managers and technicians in instrumentation and control, health physics and chemistry departments, are supposed to receive those portions of the training which are commensurate with their responsibilities. Since this imposes no additional demands on the program itself, we do not address it in this evaluation. It would be appropriate for resident inspectors to verify that non-operating personnel receive the proper training.

* * * * *

The required implementation dates for all items have passed. Hence, this evaluation did not address the dates of implementation. Moreover, the evaluation does not cover training program modifications that might have been made for other reasons subsequent to the response to Denton's letter.

III. LICENSEE SUBMITTALS

The licensee (FPC) has submitted to NRC a number of items (letters and various attachments) which explain their training and requalification programs. These submittals, made in response to Denton's letter, form the information base for this evaluation. For the Crystal River Unit 3 there were 3 submittals with attachments, for a total of 5 items, which are listed below.

1. Letter from J.A. Hancock, Assistant Vice President, Nuclear Operations, Florida Power Corp., to P.F. Collins, Chief of Operator Licensing Branch, NRC. September 15, 1980. (2pp). (re: Response to NRC letter dated March 28, 1980).

2. Letter from P.Y. Baynard, Manager of Nuclear Support Services, Florida Power Corp., to D.G. Eisenhut, Director of Division of Licensing, NRC. December 31, 1980. (1 pg, with enclosures. NRC Acc. No: 8101050285. (re: Transmittal, status of implementation and submittal schedules for the training programs).

3. Enclosure 2 to ltr. dated 12/31/80. (2 pp, attached to item 2). (re: Proposed topics covered in the Training Program for Mitigating Core Damage).

4. Letter from D.G. Mardis, Acting Manager of Nuclear Licensing, FLORIDA Power Corp., to J.F. Stolz, Chief of Operating Reactors Branch #4, Division of Licensing, NRC. May 5, 1982.(3 pp, with enclosure: item 6). NRC Acc No: 8205110624.(re: Response to NRC's RAI dated April 1, 1982).

5. "Course Outline, Degraded Core Training". Undated. (32 pp, attached to item 5).

IV. EVALUATION

SAI's evaluation of the training programs at Florida Power Corporation's Crystal River Unit 2 is presented below. Section A addresses TMI Action Item I.A.2.1 and presents the assessment organized in the manner of Figure 1. Section B addresses TMI Action Item II.B.4.

A. TMI Action Item I.A.2.1: Upgrading of Reactor Operator and Senior Reactor Operator Training and Requalification Programs.

Enclosure 1, Item A.2.c(1)

The basic requirements are that the training programs given to reactor operator and senior reactor operator candidates cover the subjects of heat transfer, fluid flow and thermodynamics at the level of detail specified in Enclosure 2 of Denton's letter.

In submittal item 1, the licensee stated that these requirements were being incorporated in their training programs. No additional details were provided with that submittal. Later, in submittal item 4, the licensee stated that the material taught on heat transfer, fluid flow and thermodynamics is comparable to the requirements of Enclosure 2 of Denton's letter. This meets the NRC requirements for operator training in these technical areas.

Enclosure 1, Item A.2.c(2)

The requirements are that the training programs for reactor and senior reactor operator candidates cover the subject of accident mitigation at the level of detail specified in Enclosure 3 of Denton's letter (see Figure 3 of this report).

The licensee stated in submittal item 1 that they were preparing an accident mitigation course along the INPO guidelines. In submittal item 2, the licensee stated that they had developed a training program for mitigating core damage and they provided an outline of the topics covered in phase one of their program. In submittal item 5, the licensee provided a more detailed outline of its training program. SAI has reviewed both

outlines and, while titles do not directly correspond with that of Denton's Enclosure 3, it appears that the necessary material is covered by the program. This is in agreement with the licensee's assertion stated in submittal item 4.

The licensee stated in submittal item 4 that the training program involved 56 hours in the areas of heat transfer, fluid flow, thermodynamics and accident mitigation. This does not meet the NRC criterion of 80 contact hours for these subjects.

Enclosure 1, Item A.2.c(3)

The requirement is that there be an increased emphasis in the training program on dealing with reactor transients.

In submittal item 1, FPC stated the training program involved an increased emphasis on reactor and plant transients and also stated that this program element would be continually upgraded. This part of the FPC training program complies with the NRC requirements.

Enclosure 1, Item A.2.e

The requirement is that instructors for reactor operator training programs be enrolled in appropriate requalification programs to assure they are cognizant of current operating history, problems and changes to procedures and administrative limitations.

In submittal item 1, FPC stated that licensed nuclear operations instructors and supervisors are enrolled in the operator requalification program. In submittal item 4, the licensee specifically stated that the instructor requalification program does address current operating history, problems and changes in procedures and administrative limits. This program for licensed instructors meets the NRC requirements.

Enclosure 1, Item C.1

The primary requirement is that the requalification programs have instruction in the areas of heat transfer, fluid flow, thermodynamics and accident mitigation. The level of detail required in the requalification program is that of Enclosures 2 and 3 of Denton's letter. In addition, these instructions must involve an adequate number of contact hours.

The same submittal items which provided information relative to items I.A.2.c(1) and I.A.2.c(2) above (submittal items 1, 2 and 4) contained information about the heat transfer, fluid flow, thermodynamics and accident mitigation aspsects of the operator requalification program. These program elements are judged to meet the NRC requirements.

Also as discussed in item I.A.2.c(2) the time devoted to the program elements of heat transfer, fluid flow, thermodynamics and accident mitigation is 56 contact hours. This does not meet the NRC criterion of 80 contact hours for these subjects.

Enclosure 1, Item C.2

The requirement for licensed operators to participate in the accelerated requalification program must be based on passing scores of 80% overall, 70% in each category.

In submittal item 4, the licensee stated that the requalification program calls for accelerated requalification if the overall score is less than 80% and if the score in any category is less than 70%. This meets the NRC requirement.

Enclosure 1, Item C.3

TMI Action Item I.A.2.1 calls for the licensed operator requalification program to include performance of control manipulations involving both normal and abnormal situations. The specific manipulations required and their performance frequency are identified in Enclosure 4 of the Denton letter (see Figure 4 of this report).

In submittal item 4, FPC stated that the operator requalification program does call for control manipulations as specified in Enclosure 4 of Denton's letter. This meets the NRC requirement for control manipulations as a part of operator requalification.

B. II.B.4 Training for Mitigating Core Damage

Item II.B.4 requires that training for mitigating core damage, as indicated in Enclosure 3 of Denton's letter, be given to shift technical advisors and operating personnel from the plant manager to the licensed operators. This includes both licensed and non-licensed personnel.

The requirement for training licensed personnel is partially met as a result of the licensee's actions discussed under Action Item I.A.2.1. The training program covers the required material (Enclosure 3 of Denton's letter) but 80 contact hours are not involved in the instruction of accident mitigation and related subjects such as heat transfer, fluid flow and thermodynamics. The licensee stated in submittal item 4 that 56 contact hours are involved for these subjects.

The requirement for training non-licensed operating personnel and shift technical advisors is met at Crystal River Unit 3. This conclusion is based on information provided in submittal item 4 which listed the titles of personnel trained and information provided in reference 7 which relates these titles to an organization structure.

V. CONCLUSIONS

SAI has reviewed the submittals of Florida Power Corporation about their training and requalification program relative to TMI Action Plan Item I.A.2.1 and II.B.4 and made evaluations on the content of these programs. SAI has found that FPC meets the requirements of TMI Action Item I.A.2.1 with the exception of not having 80 contact hours devoted to the subjects of heat transfer, fluid flow, thermodynamics and accident mitigation during each of the initial training and requalification programs

The requirements for TMI Action Item II.B.4 are met with the exception that 80 contact hours are not involved with the accident mitigation training of licensed personnel. The training of non-licensed personnel and shift technical advisors meets the NRC requirements.

V. REFERENCES

1. "NRC Action Plan Developed as a Result of the TMI-2 Accident." NUREG-0660, United States Nuclear Regulatory Commission. May 1980.

2. "Clarification of TMI Action Plan Requirements," NUREG-0737, United States Nuclear Regulatory Commission. November 1980.

3. The NRC requirement for 80 contact hours is an Operator Licensing Branch technical position. It was included with the acceptance criteria provided by NRC to SAI for use in the present evaluation. See letter, Harley Silver, Technical Assistance Program Management Group, Division of Licensing, USNRC to Bryce Johnson, Program Manager, Science Applications, Inc., Subject: Contract No. NRC-03-82-096, Final Work Assignment 2, December 23, 1981.

4. "Guidelines for Heat Transfer, Fluid Flow and Thermodynamics Instruction," STG-02, The Institute of Nuclear Power Operations. December 12, 1980.

5. "Guidelines for Training to Recognize and Mitigate the Consequences of Core Damage," STG-01, The Institute of Nuclear Power Operations. January 15, 1981.

6. I & E Report No.: 50-302/81-15, Office of Inspection & Enforcement, NRC. Approved by V.L. Brownlee, Acting Chief, Reactor Projects Section 2B, Division of Resident & Reactor Project Inspection, September 24, 1981.(No. of pages, unknown). NRC Acc No: 8112310317. (re: Verification of the implementation of the training programs required by NUREG-0737, Items I.A.2.1(4), & II.B.4.2A).

7. Letter dated January 19, 1982, from David G. Mardis, Florida Power Corporation to Harold R. Denton, U.S. NRC, Technical Specification Change Request No. 67, Rev. 1.