

SAI-186-029-06

TECHNICAL EVALUATION REPORT
IMPROVEMENTS IN TRAINING AND
REQUALIFICATION PROGRAMS AS REQUIRED BY
TMI ACTION ITEMS I.A.2.1 AND II.B.4

for the
Indian Point 2 Plant
(Docket 50-247)

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Prepared By:

Science Applications, Inc.
1710 Goodridge Drive
McLean, Virginia 22102

Prepared for:

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

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Science Applications, Inc.

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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 Consolidated Edison Co. of New York for the Indian Point 2 Plant (Docket 50-247) 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 xxxxx (NUREG-0737, I.A.2.1.4) and xxxxx (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 PERSONNEL TRAINING	<p>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.)</p> <p>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.)</p> <p>Enclosure 1, Item A.2.c.(3) Training programs shall be modified, as necessary to provide increased emphasis on reactor and plant transients.</p>
INSTRUCTOR REQUALIFICATION	<p>Enclosure 1, Item A.2.e Instructors shall be enrolled in appropriate requalification programs to assure they are cognizant of current operating history, problems, and changes to procedures and administrative limitations.</p>
PERSONNEL REQUALIFICATION	<p>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.)</p> <p>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 issuance of a license: 80% overall and 70% each category.</p> <p>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.</p>

*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 on 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 noncondensable 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 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 (low 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 H₂ generation during an accident; other sources of gas (Xe, Kr); techniques for venting or disposal of non-condensibles.
2. H₂ flammability and explosive limit; sources of O₂ 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 leaks
 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/or 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 (Consolidated Edison Co. of New York) 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 Indian Point 2 plant, there were 3 submittals with attachments, for a total of 9 items, which are listed below.

1. Letter from P. Zarakas, Vice President, Consolidated Edison Co. of New York, to H.R. Denton, Director of Office of Nuclear Reactor Regulation, NRC. September 19, 1980. (1 pg, with enclosures: items 2 through 6). NRC Acc. No: 8009250266. (re: Response to NRC letter dated March 28, 1980).
2. "Heat Transfer". undated. (2 pp, attached to item 1). (re: Outline for Heat Transfer Course).
3. "Fluid Mechanics". undated. (2 pp, attached to item 1). (re: Outline for Fluid Mechanics Course).

4. "Thermodynamics". undated. (2 pp, attached to item 1). (re: Outline for Thermodynamics Course).
5. "Indian Point Station, Training Manual, Section 8, Operations Training". Approved by Chief Operations Engineer, and Nuclear Training Director, July 28, 1980. (22 pp, attached to item 1).
6. "Mitigating Reactor Core Damage". Undated. (2 pp, attached to item 1). (re: Training Outline).
7. Letter from J.D. O'Toole, Assistant Vice President, Consolidated Edison Co. of New York, to D.G. Eisenhut, Director of Division of Licensing, NRC. February 26, 1981. (2 pp, with enclosure: item 8). NRC Acc No: 8103030722.
8. "Appendix B, Training Program for Mitigating Reactor Core Damage", Consolidated Edison Co. of New York, Indian Point Unit No. 2. February, 1981. (1 pg, attached to item 7).
9. Letter from J.D. O'Toole, Vice President, Consolidated Edison Co. of New York, to S.A. Varga, Chief of Operating Reactors Branch #1, Division of Licensing, NRC. April 30, 1982. (1 pg, with enclosure). (re: Response to NRC's RAI dated March 26, 1982).
10. Attachment A, Responses to NRC Questions Concerning Operator Training (2 pp, no date, attached to item 9).

IV. EVALUATION

SAI's evaluation of the training programs at Consolidated Edison Co. of New York's Indian Point Station Unit No. 2 are 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. I.A.2.1: Immediate Upgrading of Reactor Operator and Senior Reactor Operator Training and Qualification.

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.

The licensee's submittal of September 19, 1980 contained a copy of the operations training manual (submittal item 5) which addresses initial operator training. This training program calls for instruction in the areas of heat transfer, fluid flow and thermodynamics. Details as to the content of these instructions is found in submittal items 2, 3, and 4 which are course outlines. Comparing the content of these course outlines with the details of Denton's Enclosure 2 shows that the training program for Indian Point 2 meets this requirement.

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 training program for Indian Point 2 is described in submittal item 5. This training program calls for instruction on the topic of mitigation of core damage techniques. Details are found in submittal item 6. When the content of this submittal item was compared to the requirements of Denton's Enclosure 3 it was judged that the training program for Indian Point 2 complies with the requirements.

In submittal item 10, the licensee stated that the training program involved 80 contact hours in the areas of heat transfer, fluid flow, thermodynamics and accident mitigation. This meets the criterion imposed by the NRC staff.

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 10, the licensee affirmed that there was an increased emphasis on transients at Indian Point 2 and that this increased emphasis included both accident and nonaccident transients. This aspect of the Indian Point 2 training program meets the NRC requirement.

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.

The licensee's submittal item 1 stated the instructors are licensed operators and as such are retrained according to normal Indian Point 2 procedures. The retraining program described in submittal item 5 states that the program should include a review of changes in facility design, procedures and technical specifications. It is SAI's judgment that the Indian Point 2 training program meets the requirements relative to instructor requalification.

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 technical content of the requalification program in the areas of heat transfer, fluid flow, thermodynamics and accident mitigation is found in submittal items 2, 3, 4 and 6. As stated in the previous paragraphs for the evaluation of items A.2.c.(1) and A.2.c.(2), the program outlined by these submittal items meets the requirements defined by Enclosures 2 and 3 from Denton's letter.

In submittal item 10, the licensee affirmed that material on the subjects of heat transfer, fluid flow, thermodynamics and accident mitigation involve 80 contact hours. This meets the NRC criterion.

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 5, the Indian Point training program states that an operator who receives less than an 80% score on each of the technical areas shall be enrolled in an accelerated requalification program. This part of the Indian Point 2 training programs exceeds NRC requirements.

Enclosure 1, Item C.3

TMI Action Item I.A.2.1 calls for the licensed operator requalification program to include performance of 27 specific control manipulations involving both normal and abnormal situations.

Submittal item 5 listed control manipulations which were part of the simulator training for the requalification program. The manipulations in the requalification program are the same as in Enclosure 4 and on this basis SAI has concluded that the program complies with the requirements defined in Enclosure 4 of Denton's letter.

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 training of the licensed personnel is in accordance with the requirements of Action Item II.B.4. This requirement was met when the licensee instituted the training and requalification programs discussed for Action Item I.A.2.1.

The training of non-licensed operating personnel and shift technical advisors also has been evaluated. In submittal item 10, the licensee stated that accident mitigation training is given to operating personnel from the plant manager to the licensed operators and also to the shift technical advisors. The specific titles of people trained are: General Manager Nuclear Power Generation, Chief Operations Engineer, Senior Watch Supervisor, Senior Reactor Operators, Reactor Operators and Shift Technical Advisors. When these positions are examined using the facility organization chart (Figure 6.2-2 in the plant technical specifications) it can be seen that the senior on-site manager (Vice President Nuclear Power) is not given the accident mitigation training. This particular aspect of the training program does not appear to be in compliance with the NRC requirements. SAI believes that Consolidated Edison Co. of New York does not meet the requirement of TMI Action Item II.B.4 in that the plant manager (interpreted to be the senior on-site manager i.e., the Vice President Nuclear Power in the case of Indian Point 2), is not given accident mitigation training.

V. CONCLUSIONS

SAI has examined the training and requalification programs at Indian Point 2 Plant for the establishment and content of material as required by TMI Action Items I.A.2.1 and II.B.4.

Based on the evaluation of the previous section, it is SAI's conclusion that the training and requalification programs for the Indian Point Unit No. 2 meet the requirements of TMI Action Item I.A.2.1.

Relative to TMI Action Item II.B.4 there is one case where the requirements are not met. This case is the training of the plant manager in the use of installed plant systems to mitigate accidents. We interpret "plant manager" as identified in the enclosures to be the senior on-site manager who in this case is the Vice President Nuclear Power.

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.