John D. O'Toole
Vice President

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4 Irving Place, New York, NY 10003
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August 15, 1984

Re: Indian Point Unit No. 2
Docket No. 50-247

Mr. Darrell G. Eisenhut, Director
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Eisenhut:

Attached, please find Con Edison's Safety Analysis Report for the Safety Assessment System/Safety Parameter Display System. This fulfills our commitment listed in our response to NUREG-0737, Supplement 1 dated April 15, 1983 and later revised by our letter of March 12, 1984.

Should you or your staff have any questions, do not hesitate to call us.

Very truly yours,

John D. O'Toole

attach.
cc: Senior Resident Inspector
U. S. Nuclear Regulatory Commission
P. O. Box 38
Buchanan, New York 10511

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ATTACHMENT

Safety Assessment System/Safety Parameter Display System

Safety Analysis Report

Consolidated Edison Company of New York, Inc.
Indian Point Unit No. 2
Docket No. 50-247
August, 1984

1.0 INTRODUCTION AND SUMMARY

The Safety Assessment System/Safety Parameter Display System (SAS/SPDS) is part of our Emergency Response Capability being implemented in accordance with our response to NUREG-0737, Supplement 1 dated April 15, 1983. The Critical Safety Functions (CSFs), which is a part of the SAS system were selected to be consistent with the Westinghouse Owners' Group (WOG) Emergency Response Guidelines (ERGs) from which plant specific Emergency Operating Procedures (EOPs) are being developed. The SAS/SPDS displays have been designed by personnel with plant operating experience and evaluated against human factors design criteria. These displays use color-coding and pattern-recognition techniques to indicate off-normal values, and are validated and updated on an essentially real-time basis. The data displayed by the SAS/SPDS is validated by comparing redundant sensors, checking the value against reasonable limits, calculating rates of change, and/or checking temperature-versus-pressure curves. Invalid data are rejected by the SAS/SPDS logic.

The purpose of the SAS/SPDS is to assist control room personnel in evaluating the safety status of the plant. Functionally, the requirements are:

- o Provide a continuous indication of plant parameters or derived variables, representative of the safety status of the plant;
- o Aid the operator in the rapid detection of abnormal operating conditions;
- o Concentrate in one location, a minimum set of parameters to allow timely status assessment;
- o Incorporate human-factors considerations for simplicity and pattern-recognition;
- o Identify and delete faulty data; and
- o Display information during steady-state and transient conditions.

The minimum set of SAS/SPDS parameters from which the safety status of the plant is assessed was not specified by NUREG-0696. However, it did define important plant functions which should be encompassed by the SAS/SPDS parameters. These functions are reactivity control, reactor core cooling and heat removal from the primary system, reactor coolant system integrity, radioactivity control, and containment integrity, which are the same as the WOG-ERG CSFs.

Signal inputs to the SAS/SPDS have been evaluated for quality and validation. A verification and validation program will be conducted in accordance with our response to NUREG-0737, Supplement 1 and our letter of March 12, 1984.

The SAS/SPDS is part of our Emergency Response Capabilities and complements the upgraded EOPs. The basic set of parameters needed for emergency operations is integral to the EOPs and is the key element toward the selection of the SAS/SPDS parameters. Since our upgraded EOPs are supported by the ERGs and their background safety analysis, that analysis also supports the SAS/SPDS design.

Our plan for implementing the upgraded EOPs is contained in our submittal of the procedures generation package transmitted to the NRC on June 4, 1984. Basically, the WOG-LP Revision 1 ERGs will be converted into plant specific EOPs and will be used by Indian Point Unit No. 2.

The ERGs are composed of:

- Optimal Recovery Guidelines and Emergency Contingencies; and

- Critical Safety Function Status Trees (CSFSTs) and Function Restoration Guidelines.

The Optimal Recovery Guidelines provide guidance for the operator to recover the plant from nominal design basis faulted and upset conditions. The Function Restoration Guidelines, when used with the CSFSTs, provide a systematic means for addressing any challenge to plant critical safety functions.

The structure of the CSFSTs has been chosen to be compatible with the existing basis for operator training, since the status trees provide an explicit tool to re-emphasize the necessity for the operator to be always aware of the state of his plant safety functions. An additional advantage derived from the introduction of the status tree concept directly into the procedures structures is that the operator is provided with a performance aid, to reinforce his training and assist his memory, particularly during transient or emergency conditions.

The CSFSTs are displayed on our SAS/SPDS. As a complement to the EOPs, the SAS/SPDS performs the same functions and is compatible. Thus the critical safety functions integral to the ERGs (and thus our upgraded EOPs) form the basis of parameters selection for the SAS/SPDS.

2.0 DESIGN DESCRIPTION

The principal purpose of the SAS/SPDS is to aid the control room personnel during transient and emergency conditions in determining the safety status of the plant and in assessing whether abnormal conditions warrant corrective action by operators to avoid a degraded core.

Although the SAS/SPDS is not safety-grade, it is designed to be a highly reliable system. Design availability encompasses the following minimal functional capabilities:

1) The ability to monitor and display the status of all critical safety functions; and

2) The ability to determine the value of all parameters which are used to support emergency operations.

Three SAS/SPDS cathode ray tubes (CRTs) will be installed in the control room and located on the following basis:

1) CRT No. 1 is dedicated to the Reactor Operators. Available on this CRT are the 21 primary SAS/SPDS displays, the 6 Critical Safety Function Status Trees and summary display which will provide the Reactor Operators the safety status of the plant. A functional keyboard is provided on the Flight Panel so that any display can be called-up with just one key stroke;

2) CRT No. 2 is to be used by the Senior Reactor Operator or the Nuclear Plant Operator. This CRT, located in the console opposite the Accident Assessment Panel is used for monitoring the status of the major plant systems' conditions during accident or normal operation. Available on this CRT are the SAS/SPDS primary displays, the CSFSTs displays as well as other Plant Computer type displays (trends, logs, groups...); and

3) CRT No. 3 is to be used by the Senior Watch Supervisor (SWS) or the Shift Technical Advisor (STA). Available on this CRT are the SAS/SPDS primary displays, the CSFSTs displays and the trends, logs, groups,... displays. This CRT will provide the SWS and the STA the required information to monitor the safety status of the plant and the effectiveness of mitigating actions taken during an accident condition.

The SAS/SPDS is a useful tool in diagnosing plant symptoms, selecting the appropriate recovery techniques and maintaining Critical Safety Functions. A general discussion on symptom oriented emergency operation response is provided for information purposes in Enclosure 1.

3.0 SAS/SPDS PARAMETERS

The following list provides the parameter inputs to the SAS/SPDS. These parameters utilize Reactor Protection System/Engineering

Safety Features analog and digital inputs. In addition, these parameters encompass post-TMI accident monitoring instrumentation installed at Indian Point Unit No. 2. The basis for the parameter selection as discussed earlier is integral to the background analysis of the WOG-LP-Rev. 1 ERGs which we are adopting as IP2 upgraded EOPs. Thus, the safety analysis basis for the SAS/SPDS parameters is the same as our upgraded EOPs.

A. Reactivity Control

1. Intermediate Range Power Level
2. Source Range Power Level
3. Power Range Power Level
4. Reactor Trip Demand Signals (Trains A&B)
5. Reactor Trip Actuation Signal
6. Safety Injection Actuation Signal
7. Source Range High Voltage Status
8. Intermediate Range Startup Rate.

B. Reactor Core Cooling Control

1. Core Exit Thermocouples
2. Reactor Coolant System Subcooling Margin
3. Reactor Vessel Level Indication System
4. Reactor Coolant Pump Status
5. Reactor Coolant System Pressure
6. Reactor Coolant System Hot & Cold Leg Temperature
7. Safety Injection Actuation Signal
8. Refueling Water Storage Tank Level

C. Heat Sink Control

1. Steam Generator Narrow Range Water Level
2. Steam Generator Wide Range Water Level
3. Steam Generator Auxiliary Feedwater Flow
4. Steam Generator Pressure

5. Steam Generator Main Feedwater Flow

6. Steam Generator Steamline Flow

7. Steamline Isolation Signal

8. Feedwater Isolation Signal

9. Main Condenser Pressure

10. Condensate Storage Tank Level

11. Residual Heat Removal System Flow

12. Recirculation Pump Status

13. Residual Heat Removal System Heat Exchanger Inlet Temperature

14. Residual Heat Removal System Heat Exchanger Outlet Temperature

15. Circulating Water Pump Status

D. <u>Reactor Coolant System Integrity Control</u>

1. Pressurizer Pressure

2. Pressurizer Level

3. Pressurizer Relief Tank Pressure

4. Pressurizer PORV Position

5. Pressurizer Safety Valve Position

6. Air Ejector Radiation

7. Steam Generator Blowdown Radiation

8. Containment Humidity

9. Containment Pressure

10. Containment Radiation

11. Containment Water Level

12. Reactor Coolant System Cooldown Rate

    a) Cold Leg Temperature
    b) Reactor Coolant System Pressure

13. Main Steamline Radiation

14. Reactor Head Vent Valve Position

E. Containment Integrity Control

1. Containment Pressure

2. Containment Hydrogen Concentration

3. Containment Sump Level

4. Containment Humidity

5. Containment Temperature

6. Containment Radiation

7. Containment Isolation Phase A

8. Containment Isolation Phase B

9. Containment Ventilation Isolation

10. Stack Effluent Radiation

F. Reactor Coolant System Inventory Control

1. Pressurizer Level

2. Reactor Vessel Level

3. Reactor Vessel Head Vent Valve Position

4. Reactor Coolant System Subcooling Margin

5. Containment Hydrogen Concentration

4.0 CONCLUSIONS

The SAS/SPDS for IP2 is designed to aid the operators in diagnosing and responding to plant accidents and transients. The SAS/SPDS provides a concise display of critical plant parameters on color-graphic terminals located in the control room. Human factors engineering principles have been incorporated into the basic system design, function and displays. The CSFSTs that are integral with our upgraded plant specific EOPs are monitored by the SAS/SPDS. The implementation plan is described in our response to NUREG-0737, Supplement 1 and our March 12, 1984 letter. Final SAS/SPDS implementation reflects implementation of the initiatives of the NUREG-0737, Supplement 1. In this manner, the system is integrated with respect to the overall operator ability to comprehend plant conditions and to respond to emergencies.

ENCLOSURE 1

This enclosure provides a general discussion of "symptom" oriented emergency operations response.

A fundamental goal of nuclear safety is the prevention of uncontrolled releases of radioactive materials from nuclear power plants. To accomplish this goal the concept of "defense in depth" is adopted by providing multiple barriers to prevent the release of the radioactive materials. The three primary barriers that are provided in every nuclear power plant are:

1. the fuel matrix and fuel clad
2. the reactor coolant system pressure boundary
3. containment

These are direct physical barriers to the transport of radioactive materials and together provide the required "defense in depth". The reactor coolant system pressure boundary blocks the transport of radionuclides that escape through the fuel rod barriers and those that are produced outside of the fuel rods themselves. The containment blocks the release of radionuclides that pass through the reactor coolant system pressure boundary and those few radionuclides that form outside the reactor coolant system. The containment also includes the boundaries of those systems that penetrate the containment. As long as the fuel rod, reactor coolant system pressure boundary and containment barriers are intact in a nuclear power plant, that plant poses no threat to the health and safety of the general public. The goal of nuclear power plant operation, in terms of nuclear safety, is assuring that as many as possible of the three primary barriers remain intact at all times and under all conditions and/or circumstances that may exist.

For each of the barriers there is a set of functions that must be performed on a continuing basis if the barrier is to remain intact or if its integrity is to be restored. The full set of functions that must be performed in order to fully safeguard the general public from possible consequences of nuclear power plant operation is the Critical Safety Functions. It should be noted here that there are a variety of methods available for identifying the components of a set of Critical Safety Functions and, as a result, the tabulations of Critical Safety Functions that are developed frequently appear to differ among themselves. In reality, the differences are usually primarily semantic. The actual physical processes that must occur if the three primary barriers are to be kept intact are the same, regardless of the method of analyzing the processes or of naming the functions. The only point of issue in comparing various sets of Critical Safety Functions having a commom scope is whether each of the sets is complete within that common scope.

For our particular purposes here we consider the fuel rod, reactor coolant system pressure boundary and containment barriers. We also limit the scope of application to a reactor that is intended to be shutdown in order to show that we have the "capability" to safely shutdown. That is, we excluded normal power operation from the scope of the set of safety functions we need to consider. A set of Critical Safety Functions that is sufficient for the fuel rod, reactor coolant system pressure boundary and containment barriers consists of:

1. Maintenance of Subcriticality
2. Maintenance of Core Cooling
3. Maintenance of Reactor Coolant System Integrity
4. Maintenance of a Heat Sink
5. Maintenance of Containment Integrity
6. Control of Reactor Coolant Inventory

The association of these Critical Safety Function with the three primary barriers take the form:

Barrier	Critical Safety Function
Fuel Matrix and Fuel Clad	Maintenance of Subcriticality (minimize energy release in the fuel) Maintenance of Core Cooling (providing adequate heat removal from the fuel) Control of Reactor Coolant Inventory (maintain enough coolant for effective heat removal)
Reactor Coolant System Pressure Boundary	Maintenance of a Heat Sink (provide adequate heat removal from the RCS) Maintenance of Reactor Coolant System Integrity (prevent overpressurization of the RCS) Control of Reactor Coolant Inventory (prevent flooding and loss of pressure control)
Containment	Maintenance of Containment Integrity (prevent overpressurization of containment vessel)

We note the difference in using the words "maintenance" and "control". For our purposes "control" means to stay within bounds and "maintenance" means to stay on one side.

The means provided for maintaining the Critical Safety Functions, and thereby the integrity of the barriers, vary with both the particular set of conditions that may exist and the likelihood that that set of conditions will exist. The design of the plant is such that under normal operating conditions all Critical Safety Functions in a full, complete set are continuously satisfied with ample margin. The NSSS control system, augmented by trained operator response to annunciator alarms and backed by the plant Technical Specifications, serve to insure that small departures from preferred operating conditions are rectified before any challenge to the Critical Safety Functions develop. Under other circumstances which are much less likely to occur and are usually contingent on equipment functional failures, the Reactor Protection System automatically acts to block potential challenges to the Critical Safety Functions and to reinforce the protection of the fuel rod and reactor coolant system pressure boundary barriers. Specifically, the protection system:

- stops nuclear power generation by initiating a reactor trip,

- stabilizes reactor coolant temperature, pressure and inventory by initiating a turbine trip, main feedwater isolation and steamline isolation, as appropriate,

- insures the availability of a secondary heat sink by starting auxiliary feedwater flow and enabling the condenser dump system, and

- prevents overpressurization in the primary and secondary systems by (passively) opening the pressurizer and steamline safety valves, if necessary.

Operator action is required only to insure that the automatic protection systems are functioning as intended and, depending on the actual cause of the reactor trip, to initiate recovery operations.

In those rare situations in which either a barrier has failed or an essential function is jeopardized or lost the Engineered Safeguards System is activated to insure that the Critical Safety Functions are maintained to protect the surviving barriers. The Engineered Safeguards System duplicates all of the safety functions provided by the Reactor Protection System and broadens the barriers protection processes by automatically.

- starting the emergency diesel generators

- initiating safety injection

- isolating all nonessential containment penetrations

- actuating containment spray, if appropriate

Concurrently, trained operator response is invoked through the Emergency Operating Procedures to verify that the automatic systems are functioning, to diagnose the event, to restore or replace lost essential functions, and, when appropriate, to restore the plant to operating conditions as expeditiously as possible.

For those extremely rare events that go beyond the design basis of the Engineered Safeguards System and the scope of the Emergency Operating

Procedures, plant operators monitor, maintain and, if necessary, restore the Critical Safety Functions so that the barriers to the transport and release of radioactive materials can be kept intact. From an operations point of view (i.e., performance goals), maintaining the Critical Safety Functions and protecting the barriers represents, in effect, a final line of defense against the release of radioactive materials to the environment.

Monitoring the Critical Safety Functions provide a convenient and effective means of displaying the status of a nuclear power plant in two ways:

1) general surveillance under all sets of unusual or abnormal conditions that can lead to or result from initiation of safety injection.

2) direct operator guidance in those rare events that go beyond the design of the Engineered Safeguards Systems and the Emergency Operating Procedures.

The "general surveillance" aspects of Critical Safety Function monitoring would be carried out routinely by control room personnel during the period following activation of the Engineered Safeguards System and continuing until the plant status is fully diagnosed and understood by the operating personnel. The "direct operator guidance" aspects of Critical Safety Function monitoring is expected to be applicable only in those very rare situations in which, the plant enters a domain where the Emergency Operating Procedures may not be reliable guides and available plant systems may have to be used to direct operator control to maintain the Critical Safety Functions and to protect the surviving barriers.