WESTINGHOUSE CLASS 3

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WESTINGHOUSE TECHNICAL SUPPORT COMPLEX

D. V. Gennaro

J. L. Little

W. L. Luce

W. F. Schaefer

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WESTINGHOUSE ELECTRIC CORPORATION
Nuclear Energy Systems
P. O. Box 355
Pittsburgh, Pennsylvania 15230

8006170360

ABSTRACT

Following the Three Mile Island incident, investigations and analyses by various government organizations have emphasized the man-machine interface and the need for improving the presentation of data to both operating and technical support personnel. Westinghouse has developed a Technical Support Complex (TSC) that addresses certain requirements made by the Nuclear Regulatory Commission for improved in-plant procedures and preparations to cope with emergencies.

This report provides the functional and technical descriptions of the Westinghouse TSC that will enable, in normal as well as abnormal operation, the collection, processing, display, and transmission of plant status information. These data are provided to aid the plant operator and technical support personnel in limiting the consequences of abnormal events. The TSC reflects the results of an intensive Westinghouse study of the plant from the perspective of the recommendations given by the NRC Lessons Learned Task Force. The concepts and implementation methods discussed in this report are the results of the Westinghouse study and provide the basis for potential longer-term requirements in this area.

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1.0 INTRODUCTION

Westinghouse has developed a Technical Support Complex (TSC) capable of providing pertinent plant information to operating and technical support personnel. The TSC addresses the NRC's requirements for the following:

1. Onsite Technical Support Center (OTSC)

   The OTSC (described in detail in Section 2.0) provides key plant information in a location separate from the control room to support post-accident recovery management.

2. Bypassed and Inoperable Status Indication (BISI)

   The BISI (described in detail in Section 3.0) provides the operator and technical support personnel with a clear indication of the availability of plant safety systems (i.e., engineered safety features).

3. Plant Safety Status Display (PSSD)

   The PSSD (described in detail in Section 4.0) provides the operator and technical support personnel with a succinct account of the plant status as it pertains to plant safety.

An integrated approach to these requirements is taken in the Westinghouse TSC design. The TSC provides an efficient flow of information to allow effective decision making. The system structure and architecture provide the flexibility to adapt to meet future long-term NRC requirements in the area of man-machine interface design. The TSC design offers the capability to incorporate operator-oriented displays, human-engineered to improve operator response during off-normal and emergency situations.

2.0 ONSITE TECHNICAL SUPPORT CENTER

2.1 PURPOSE

The Onsite Technical Support Center (OTSC) serves as the focal point for post-accident recovery management. As such, it must have the capability to access, display, and transmit pertinent plant status information independent of actions in the control room. The major functions for which the OTSC provides a direction or support role include the following:

1. Ensuring that the plant is in a safe and stable shutdown condition following an incident.

2. Directing plant post-accident recovery operations.

3. Maintaining radioactivity control boundaries not originally compromised by the incident.

4. Maintaining onsite and offsite radiation exposures within acceptable levels.

5. Confining and recovering post-accident contaminants for safe removal to offsite storage locations.

2.2 DESIGN BASIS

Baseline functional requirements were defined for the OTSC in order to properly perform the above defined functions. These requirements are as follows:

1. The personnel in the OTSC must have access to real time information defining the current status of critical plant systems and functions.

2. The OTSC must have the capability to store historical pre-event and post-event data in order to enable a diagnosis and evaluation of the event to determine the extent of any possible plant system damage.

3. The OTSC must have the capability to access and display plant parameters independent of actions in the control room.

4. The interface of the OTSC equipment with existing plant instrumentation must not result in any degradation of the plant protection system, control room, or other plant functions.

5. Parameters to the extent possible should be from the same source that is used for control room indications and must be capable of being continuously displayed or indicated upon demand.

6. The OTSC must have the capability of interfacing with communications equipment for the offsite transmission of pertinent plant data.

7. The method of information presentation must provide a human engineered design with the flexibility of being user modified to meet needs as conditions may dictate.

2.3 INPUT DEFINITION

In order to define the information which must be available in the OTSC, a generic study of critical plant systems and key safety functions (as listed in Table 2-1) was conducted. This study resulted in a list of parameters for generic two, three, and four loop plants as shown in Table 2-2. This list will be revised on a plant specific basis. Table 2-3 lists the basis for input selection. Redundancy and diversity of process indications are utilized to satisfy concerns associated with unavailable signals due to sensor failures.

2.4 MAN-MACHINE INTERFACE

The man-machine interface for the OTSC is accomplished by the use of interactive graphic color cathode ray tube (CRT) displays. However, in order to provide an effective man-machine interface, it is neccesary to consider the utilization of the OTSC from an integrated viewpoint of both the workspace environment and operational organization in addition to the presentation of information.

2.4.1 WORKSPACE ARRANGEMENT

In order to human engineer the workspace arrangement of the OTSC, it is first necessary to specify the goals of the OTSC and personnel requirements. This includes definition of the tasks to be performed as well as the number, skills level, and organization of the people manning the OTSC.

On the basis of the OTSC's functional requirements and the emergency response plans of Westinghouse and various utilities, Westinghouse has developed the following guidelines for the workspace design:

1. The OTSC will function as a technical focal point for post-accident recovery management including:

    a. Evaluation of the cause(s), trend(s), and status of the accident,

    b. Determination of recovery strategies and recommendations for control room action, and

    c. Communication of plant status to offsite locations.

2. The emergency response team (ERT) that will man the OTSC consists of a team leader as well as experts in the various systems and components of the plant.

3. It is assumed that the team leader has a strong technical background. He is responsible for the coordination of efforts in the OTSC.

4. Because the nature of the emergency situation and the exact number and specialties of the experts called in can not be completely anticipated, the team leader must organize the available resources according to each particular situation.

5. Because the exact tasks facing the ERT can change and because the team composition may vary both with a particular emergency and on a plant specific basis, the primary criterion for workspace design should be flexibility of use.

6. The workspace layout should be designed to accommodate analysts and support personnel for such tasks as communications coordination and plant documentation retrieval.

7. Distances within the OTSC should provide visual access to the command station while allowing sufficient space to minimize noise and traffic congestion.

The preceding guidelines were used to develop a conceptual OTSC facility layout, as shown in Figure 2-1. Other design considerations developed for the OTSC workspace are as follows:

1. What each individual must be able to see:

    a. within the work area,

    b. beyond the work area,

    c. other people, and

    d. other equipment.

2. What each individual must be able to hear:

    a. oral communications,

b. plant page system, and

c. telephone - general communications.

3. What each individual must reach and manipulate:

a. OTSC equipment controls, and

b. equipment/devices.

4. What clearances and workplace accommodations are needed for:

a. seating and/or standing space,

b. access for maintenance,

c. control and display groupings and clearances,

d. work surfaces,

e. storage, and

f. special clothing or life support devices.

A conceptual OTSC layout for a single unit plant can be arranged as is shown in Figure 2-1.

1. Each work station consists of a table with a CRT and keyboard mounted on a sliding housing so that it can be moved along the length of the table and rotated 360 degrees. The table size must accommodate the dimensions of the CRT/keyboard and a maximum of six seated personnel. All CRTs can be locked in position to avoid accidental motion.

2. The OTSC command station for each unit consists of two work station tables in an "L" arrangement, each with a movable CRT/keyboard. One CRT/keyboard is dedicated to the PSSD display; the second is a general purpose display.

3. The satellite stations are arranged around the OTSC command station at a distance to allow visual access while still providing sufficient room to minimize noise and allow traffic to flow.

4. Adjacent to the command station CRTs are videocopiers and a printer to provide hard copy of CRT displays.

5. The specifications of the communications station are left open depending upon the exact equipment available.

6. Distances between the various parts of the OTSC should be chosen to provide enough room for smooth traffic flow.

7. Plant drawings, procedures, and design information should be accessible to personnel at all work stations.

Applications of this design approach to twin unit plants could be either in the form of totally separate facilities or an application which utilizes transferable satellite stations and unit dedicated command stations.

The following additional recommendations are also provided:

1. The acoustical properties of the room should be designed to minimize noise levels to facilitate verbal communications.

2. Ambient lighting should be designed to avoid glare caused by: a) overhead room lighting, b) light from windows (if any), and c) reflected surface light.

2.4.2 OTSC OPERATOR INTERFACE

The ability of the OTSC to be an effective tool in post-accident recovery management is a function of the inputs provided and the ability to present information in a meaningful and organized manner. As stated previously, the man-machine interface is through the use of interactive graphic color CRT displays. The interface functions in the OTSC consist of displays and console functions.

The display types available for OTSC personnel use consist of graphic and alphanumeric displays which are both preformatted and user constructible. Examples of the types of displays available are shown in Figures 2-2, 2-3, and 2-4. Figure 2-2 is an example of a preformatted system status display, gathering important system and loop parameters onto a single page of display. Figure 2-3 shows more detailed information on individual parameters such as information on sensor status, current value, and high and low limits. Figure 2-4 is an example of a graphic trend display showing a time history of related parameters. Highlighting techniques for indicating parameters or conditions of interest utilize both color and achromatic means.

By providing a combination of both preformatted and user constructible displays the OTSC personnel are provided with prearranged quickly accessible system information and the flexibility to permit the tailoring of information presentation to meet specific needs as conditions dictate. The specific content of preformatted displays will be determined by analyzing post-accident data requirements in terms of event evaluation, the safety status of the plant, and long-term recovery planning. Displays will also be designed to reflect plant specific design details.

Display access is provided both by dedicated functional console pushbuttons and standard keyboard entries. Dedicated keys provide access to the most frequently used displays or functions. For other functions access can be either direct by entering short codes or by utilizing an instruction function to determine the identification code for a display if it is unknown.

Other types of information is available through the console keyboard. These consist of functions such as point review, logs, post-trip historical data review, and offsite data transmission.

The point review functions enable the console operator to review plant sensor information. The types of review functions available are:

1. Values of individual points.

2. Points removed from scan.

3. Points removed from limit checking.

4. Points failed under quality checking routines.

5. Points whose scan frequencies have been changed from the normal scan frequencies.

There are log functions available to the OTSC personnel which can be displayed on CRTs with periodic updates or output onto a hard copy device such as a line printer. These functions can be preprogrammed and automatically initiated or specified and initiated by console operator input.

The post-trip review function provides the capability to review historical data to aid in an event evaluation. This function continuously stores in memory an updated table of preassigned sensor values for a predefined period. Upon the occurrence of a disturbance (e.g., plant trip) the system continues to store data for a defined time period. After this period, the entire data record can be reviewed by the OTSC personnel on CRTs and/or output to hard copy devices for permanent record storage purposes.

The offsite data transmission function enables OTSC personnel to transmit plant data to offsite locations via owner supplied communications systems. The OTSC operator can initiate transmission of data either on a "one-shot" or periodic basis. The transmitted data can be arranged into four edited versions for the specific needs of separate offsite communications receivers such as the NRC.

TABLE 2-1

CRITICAL PLANT SYSTEMS/FUNCTIONS

Reactivity Control

Primary System Inventory

Core Heat Removal Capabilities

Availability and Capacity of Heat Sinks

Containment Integrity

Primary System Pressure and Temperature

Availability and Capacity of Alternate Water Sources

Availability and Operability of Critical Support Systems

Radioactivity Control

TABLE 2-2

ONSITE TECHNICAL SUPPORT CENTER PARAMETERS

Variable	Number of Signals	Range	Units	Minimum Scanning Period

(b,c

TABLE 2-2 (Continued)

ONSITE TECHNICAL SUPPORT CENTER PARAMETERS

Variable	Number of Signals	Range	Units	Minimum Scanning Period

(b,c)

TABLE 2-2 (Continued)

ONSITE TECHNICAL SUPPORT CENTER PARAMETERS

Variable	Number of Signals	Range	Units	Minimum Scanning Period

(b,c

TABLE 2-2 (Continued)

ONSITE TECHNICAL SUPPORT CENTER PARAMETERS

Variable	Number of Signals	Range	Units	Minimum Scanning Period

(b,c)

TABLE 2-2 (Continued)

ONSITE TECHNICAL SUPPORT CENTER PARAMETERS

Variable	Number of Signals	Range	Units	Minimum Scanning Period

[ ] (b,c)

TABLE 2-3

TSC INSTRUMENT BASIS

PARAMETER	INITIAL EVENT DIAGNOSIS*	BASIS	(b,c)

5251A

TABLE 2-3 (Continued)

TSC INSTRUMENT BASIS

PARAMETER	INITIAL EVENT DIAGNOSIS*	BASIS	(b,c)

5251A

TABLE 2-3 (Continued)

TSC INSTRUMENT BASIS

PARAMETER	INITIAL EVENT DIAGNOSIS*	BASIS	(b,c)

5251A

TABLE 2-3 (Continued)

TSC INSTRUMENT BASIS

PARAMETER	INITIAL EVENT DIAGNOSIS*	BASIS	(b,c)

TABLE 2-3 (Continued)

TSC INSTRUMENT BASIS

PARAMETER	INITIAL EVENT DIAGNOSIS*	BASIS	(b,c)

5251A

TABLE 2-3 (Continued)

TSC INSTRUMENT BASIS

PARAMETER	INITIAL EVENT DIAGNOSIS*	BASIS	(b,c)

5251A

TABLE 2-3 (Continued)

TSC INSTRUMENT BASIS

PARAMETER	INITIAL EVENT DIAGNOSIS*	BASIS	(b,c)

TABLE 2-3 (Continued)

TSC INSTRUMENT BASIS

PARAMETER	INITIAL EVENT DIAGNOSIS*	BASIS	(b,c)

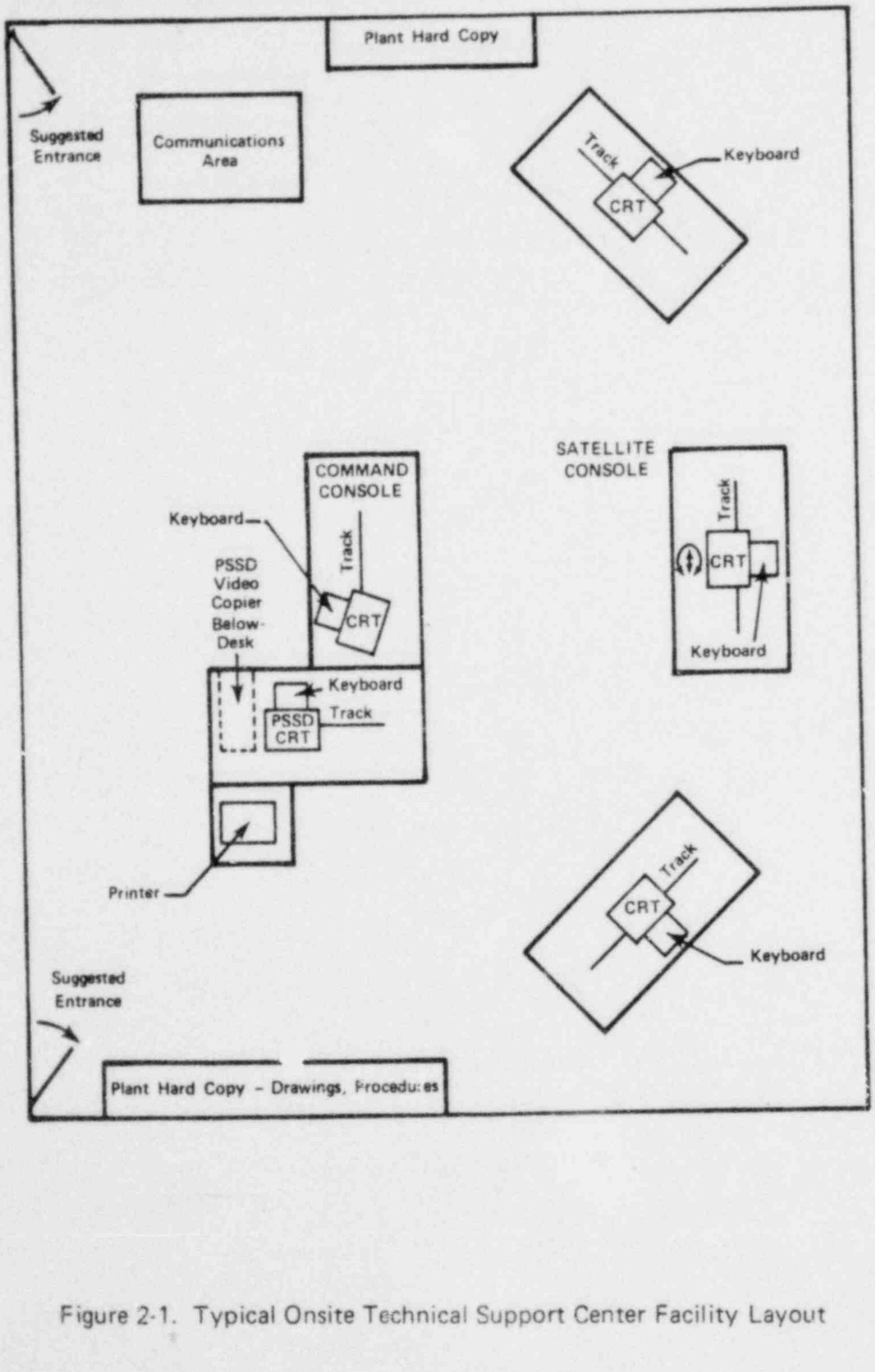

Figure 2-1. Typical Onsite Technical Support Center Facility Layout

Systems Status - Reactor Coolant System				
	Loop 1	Loop 2	Loop 3	Loop 4
T average (°F)	595.2	595.2	595.2	595.2
Overpower △T (%PWR)	110.0	110.0	110.0	110.0
Overtemp. △T (%PWR)	110.0	110.0	110.0	110.0
Cold leg temp. (narrow range) (°F)	559.8	559.8	559.8	559.8
Hot leg temp. (narrow range))°F)	624.0	624.0	624.0	624.0
Reactor coolant flow (%)	100.0	100.0	100.0	100.0
Reactor coolant pressure - WR (PSIG)	2250.0	2250.0	2250.0	2250.0
Pressurizer pressure (PSIA)	2250.0			
Pressurizer vapor temp. (°F)	563.8			
Pressurizer liquid temp. (°F)	565.2			
Pressurizer relief tank pressure (PSIG)	1.5			
Pressurizer relief tank level (%)	77.6			
Pressurizer relief tank temp. (°F)	110.3			
Pressurizer safety relief temp. (°F)	120.0			

Figure 2-2. System Status Display at Onsite Technical Support Center (Example)

Parameter Summary					
Point	Description	Value	Range	Units	Status
TO400	RCS Loop 1 Hot Leg T	593.4	0:700	DEGF	Normal
TO406	RCS Loop 1 Cold Leg T	547.2	0:700	DEGF	Normal
PO480	RCS Pressure	2234.1	0:3000	PSIG	Normal
LO421	Stm Gen 2 Narrow Range Level	39.1	0:100	PC	Low
PO549	Steamline Pressure	893.0	0:1100	PSIG	Normal
LO103	RWST Level	100.0	0:100	PC	Normal
LO114	Boric Acid Tank Level	98.8	0:100	PC	Normal
LO119	Condensate Storage Tank Level	56.4	0:100	PC	Normal
LO947	Containment Bldg. Water Level	3.3	0:100	PC	High

Figure 2-3. Parameter Information Display at Onsite Technical Support Center (Example)

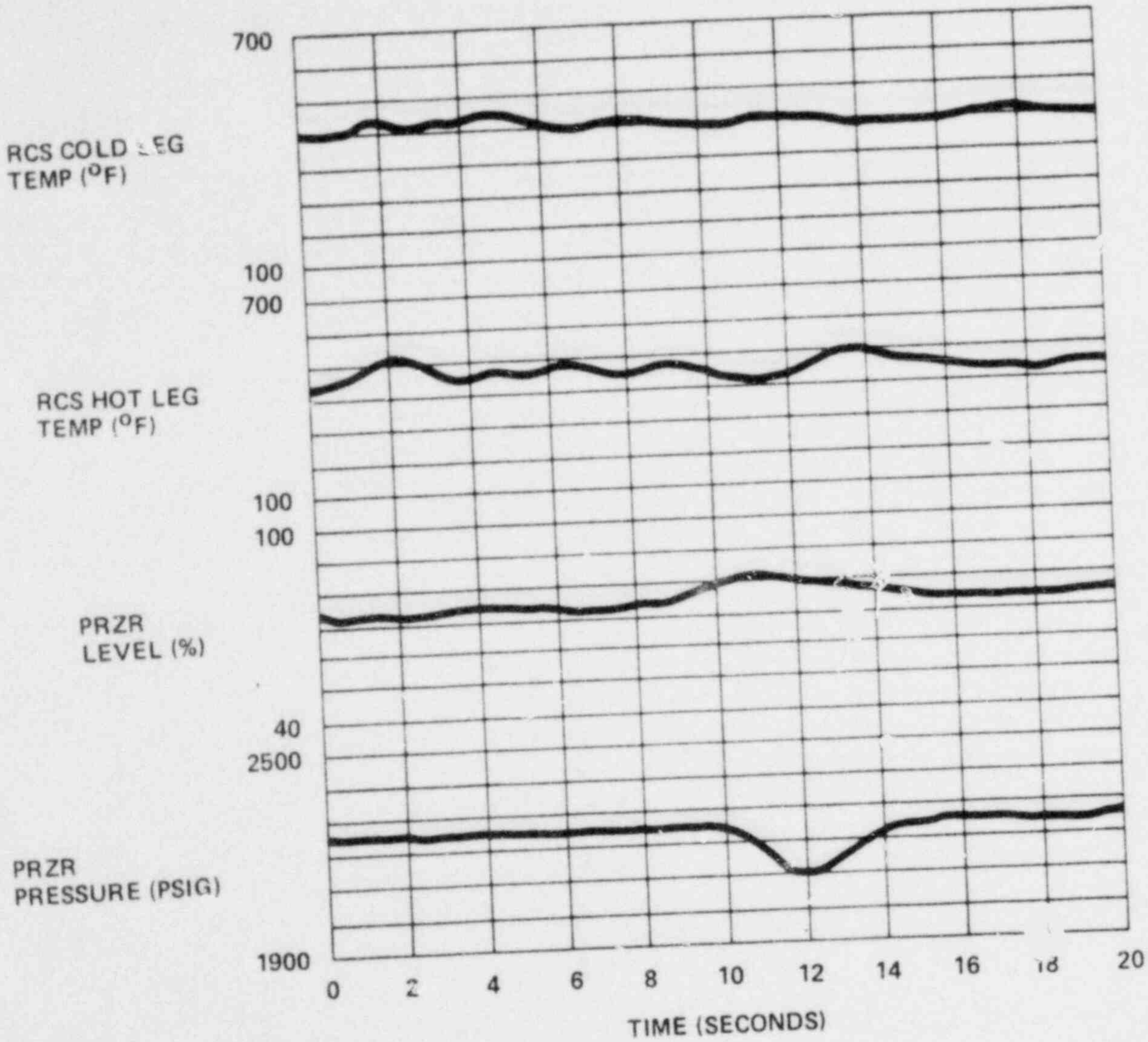

Figure 2-4. Graphic Display at Onsite Technical Support Center (Example)

3.0 BYPASSED AND INOPERABLE STATUS INDICATION FOR PLANT SAFETY SYSTEMS

3.1 PURPOSE

The purpose of the Bypassed and Inoperable Status Indication (BISI) system is to provide the control room operator with a continuous systems level indication of a bypassed or inoperable condition for the systems comprising the engineered safety features. The system considers the actual status of individual components including systems level bypasses and control room operator entered inputs for components removed from service.

3.2 INPUT DETERMINATION

Bypassed and inoperable status indication is provided for the systems comprising the engineered safety features and their critical support systems. These systems are identified in Table 3-1. This table also identifies the types of components for which monitoring is required, the approximate number of each type of component, and the type of status information needed. This list is generic in nature and will be revised to meet individual plant specific designs.

In the evaluation of system inputs, the components in each system are considered in the light of being in a proper state to perform or support the operation of a safety function. The systems level bypass functions that must also be considered are listed in Table 3-2. In addition to automatically monitored inputs, the system also considers the effect of component or system out of service inputs manually entered by the control room operator.

3.3 MAN-MACHINE INTERFACE

The interface between the operator and this system is provided by redundant CRT displays and keyboard consoles located in the control room. Personnel located in the Onsite Technical Support Center will also be able to access the same information. The BISI utilizes a structured display hierarchy for the operator interface. The display hierarchy is shown in Figure 3-1.

The primary display, an example of which is shown in Figure 3-2, contains the following information for each of the systems comprising the engineered safety features:

1. Bypassed or inoperable status indication for each affected subsystem on either a systems level and/or train level basis.

2. Identification of whether the condition is due to the inoperable status of a component or auxiliary support such as cooling water, power supply, etc.

Other levels of displays such as shown in Figure 3-3 provide supporting information on individual components within each subsystem and support
(a,c,f) system. [

]

Whenever the status of a system becomes inoperable or bypassed, the
(a,c,f) [

]

[(a,c.f)

]

TABLE 3-1

BYPASSED AND INOPERABLE STATUS INDICATION -
COMPONENT INPUTS

(b,c)

System	Components	Typical Number	Status
Emergency core cooling	Valves		Open/Shut
	Pumps		Operable
	Process (level,pressure)		High/Low, etc.
Auxiliary feedwater	Valves		Open/Shut
	Pumps		Operable
	Process		High/Low, etc.
Containment spray	Valves		Open/Shut
	Pumps		Operable
	Process		High/Low, etc.
Containment isolation	Valves		Open/Shut
Auxiliary power system	Breakers		Open/Closed/Out
	Generators		Operable
	Voltages		High/Low
Containment ventilation	Valves		Open/Shut
	Motors		Operable
Containment hydrogen recombiners	Valves		Open/Shut
	Motors		Operable
Component cooling	Valves		Open/Shut
	Pumps		Operable
Service water	Valves		Open/Shut
	Pumps		Operable

TABLE 3-2

BYPASSED AND INOPERABLE STATUS INDICATION -
SYSTEM LEVEL BYPASS FUNCTIONS

Safety injection

- Low pressurizer pressure
- Low steamline pressure
- Manual reset

Steamline isolation

Steam dump interlock

Steam generator blowdown isolation

(a,c,f

Figure 3-1. Display Structure – Bypassed and Inoperable Status Indication (a,c,f) [ ]

Figure 3-2. Primary Display – Bypassed and Inoperable Status Indication

(a,c,f)

Figure 3-3. Secondary Display – Bypassed and Inoperable Status Information

4.0 PLANT SAFETY STATUS DISPLAY

4.1 PURPOSE

The function of the Plant Safety Status Display (PSSD) is to present a succinct account of the overall plant safety status to the control room operator (or supervisor). The entire data base should be available to the operator arranged in a format that will enhance his response to events and the diagnoses of the cause of the event. Because the PSSD serves as an important interface between the plant process and the operator, the information presentation should be defined in terms of parameters and logic supportive of defined operating procedures for dealing with abnormal events.

4.2 INPUT DETERMINATION

In order to determine the required operational modes for the PSSD [(b,c,e)

].

Because of the fact that [(b,c,e)

], the PSSD incorporates [(b,c,e)

]

(b,c,e) [

] The parameters available for

(b,c,e) [

(b,c,e)] The role for which the PSSD provides [

] is as follows:

(b,c,e) [

]

[(b,c,e)

]

By addressing [(b,c,e)

]

[(b,c,e)

]

In defining the inputs for the PSSD, [ ] as (b,c,e)
follows:

[(b,c,e)

]

In response to the [(b,c,e)

]

(b,c,e) In order to satisfy the [

]

4.3 MAN-MACHINE INTERFACE

The PSSD system will process the defined input data set of plant parameters at [ ] and generate displays for redundant PSSD
(a,b,c)
(a,c) dedicated CRTs located in the control room. [
]

In order to achieve an effective man-machine interface, the display system must be designed to provide a logical and human engineered display structure and selection process in a manner which supports defined roles in which the operator is expected to perform during an abnormal occurrence.

(b,c) The role of the control room operator in [
]
depicted in Figure 4-1. The display system structure should be defined
(b,c) such that it [
] are defined as follows:

(t,c) [

]

[(b,c)

]

The display structure shown in Figure 4-2 [(a,c,f)

]

(a,c,f) [

]

A major problem associated with the man-machine interface is the

(a,c,f) [

] Figure

(a,c,f) 4-3 is an illustration of the display. [

]

(a,c,f) Figures 4-4 and 4-5 are preliminary versions of [ ] for two sample events: Primary to Secondary Coolant System Leak and Primary Coolant System Leak to Containment. The parameters chosen for the displays were chosen to

(a,c,f) [ ]

(a,c,f) [

]

The information at [(a,c,f

].

TABLE 4-1

PLANT SAFETY STATUS DISPLAY - SAFETY
GOALS - TERMINATE MODE TRANSIENTS

),c,e)

TABLE 4-2

PLANT SAFETY STATUS DISPLAY - SAFETY
GOALS - MITIGATE MODE TRANSIENTS

(b,c,

TABLE 4-2 (Continued)

PLANT SAFETY STATUS DISPLAY - SAFETY GOALS - MITIGATE MODE TRANSIENTS

),c,e)

[ ]

TABLE 4-3

PLANT SAFETY STATUS DISPLAY TERMINATE MODE PARAMETERS

(b,c,e

TABLE 4-4

PLANT SAFETY STATUS DISPLAY - MITIGATE MODE PARAMETERS

e) [ ]

[ ](a,c)

Figure 4-1. Operator Response Model

(a,c,f)

Figure 4-2. Display Structure of Plant Status Display (a,c,f

Figure 4-3. Sample Display – Plant Safety Status Display

(a,c,f)

Figure 4-4. Sample Plant Safety Status Display – Terminate Mode – Primary to Secondary Coolant System Leak (SG Tube Leak)

(a,c,f)

Figure 4-5. Sample Plant Safety Status Display – Mitigate Mode – Primary Coolant System Leak to Containment

5.0 TECHNICAL SUPPORT COMPLEX

The Westinghouse Technical Support Complex (TSC) provides an integrated means of addressing NRC requirements by providing the previously discussed functions of the:

1. Onsite Technical Support Center (OTSC) described in Section 2.0.

2. Bypassed and Inoperable Status Indication (BISI) described in Section 3.0.

3. Plant Safety Status Display (PSSD) described in Section 4.0.

The Westinghouse TSC not only provides the capability for satisfying these requirements in the short-term but also provides a foundation upon which future improvements can be accommodated.

The integration is achieved by [ ] (a,c)

5.1 SYSTEM DESCRIPTION

The system configuration for the TSC is shown schematically in Figure 5-1. The system consists of [ ]. (a,c)

5.1.1 INPUT/OUTPUT SYSTEM

(a,c) The input/output system consists of [

]

5.1.2 PROCESSING SYSTEM

(a,c) [

]

5.1.3 SYSTEM PERIPHERALS

(a,c) Included in the TSC design is an [

]

5.1.4 ONSITE TECHNICAL SUPPORT CENTER EQUIPMENT

The equipment in the OTSC consists of the following for a typical single unit application.

[ ] (a,c)

As stated in Section 2.4.1, applications of the TSC design to a multi-unit plant OTSC could be either in the form of totally separate facilities or an application which utilizes transferable satellite stations and unit dedicated command stations. Each unit would have its own independent computer system.

5.1.5 CONTROL ROOM EQUIPMENT

The following equipment is located in the control room:

[ ] (a,c)

5.2 SYSTEM ARCHITECTURE

The Westinghouse TSC is designed using [ ] (a,c)

(a,c)

Figure 5-1. Technical Support Complex System Configuration

6.0 EVALUATION OF THE TECHNICAL SUPPORT COMPLEX

The Westinghouse Technical Support Complex (TSC) instrumentation is not a safety system and, therefore, is not Class 1E. However, the TSC is designed to provide a high degree of reliability. Isolation devices are provided to maintain physical independence and isolation with safety systems, and to ensure that a failure in the TSC will not degrade the plant's protection system. The isolation devices are Class 1E, meet the requirements of established criteria, and are consistent with existing Westinghouse designs. The TSC design is such that a failure of any subsystem within the TSC will not significantly degrade the overall TSC. The TSC instrumentation need not be seismically qualified since it is a non-safety system and is not required to mitigate Condition II, III, or IV events.

6.1 APPLICABLE CRITERIA

The design bases for the Westinghouse TSC, as described in Sections 2.0 through 5.0, include consideration of the following criteria (these criteria are also summarized in Table 6-1):

1. NUREG-0578, "TMI-2 Lessons Learned Task Force Status Report and Short-Term Recommendations," July, 1979.

    a. NRC letter, "Followup Actions from the NRC Staff Reviews Regarding the Three Mile Island Unit 2 Accident," dated September 13, September 27, and October 10, 1979.

    b. NRC letter, "Discussion of Lessons Learned Short-Term Requirements," dated October 30 and November 9, 1979.

2. NUREG-0585, "TMI-2 Lessons Learned Task Force Final Report," October, 1979.

3. NUREG-0660, "NRC Action Plan Developed as a Result of the TMI-2 Accident," May, 1980.

4. NRC letter, "NRC Nuclear Data Link (NDL)," dated March 12, 1980.

5. NRC letter, "Clarification of NRC Requirements for Emergency Response Facilities at Each Site," dated April 25, 1980.

6. Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems," May, 1973.

7. Regulatory Guide 1.97, Proposed Revision 2 (For Comment), "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident," December, 1979.

8. IEEE Standard 279-1971, "IEEE Standard: Criteria for Protection Systems for Nuclear Power Generating Stations."

9. 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants."

6.2 EVALUATION

The TSC instrumentation addresses the NRC criteria issued as a result of the Three Mile Island Unit 2 event. The criteria, as described in Section 6.1, are broad and general in nature, and are subject to interpretation. The following is an evaluation of the TSC instrumentation regarding these criteria.

6.2.1 NUREG-0578, "TMI-2 LESSONS LEARNED TASK FORCE STATUS REPORT AND SHORT-TERM RECOMMENDATIONS"

Item 2.2.2.b of NUREG-0578 and the subsequent NRC implementation and clarification letters provides the following NRC position for the Onsite Technical Support Center (OTSC):

"Each operating nuclear power plant shall maintain an onsite technical support center separate from and in close proximity to the control room that has the capability to display and transmit plant status to those individuals who are knowledgeable of and responsible for engineering and management support of reactor operations in the event of an accident. The center shall be habitable to the same degree as the control room for postulated accident conditions. The licensee shall revise his emergency plans as necessary to incorporate the role and location of the technical support center. Records that pertain to the as-built conditions and layout of structures, systems and components shall be readily available to personnel in the technical support center."

Appendix A to NUREG-0578 also includes the following discussion on the longer term needs of the OTSC:

"Over the long term, it will probably be useful to provide plant status monitoring and recording equipment in the onsite technical support center. The Task Force recommends that requirements in this regard be developed in conjunction with requirements concerning the kind and form of information to be transmitted to the NRC."

In addition, NRC letter entitled, "Discussion of Lessons Learned Short-Term Requirements," provides clarification of the OTSC requirements in the areas of location, physical size and staffing, activation, instrumentation, instrumentation power supply, technical data, data transmission, structural integrity, and habitability.

While certain aspects of the overall design of the OTSC are not included as part of the Westinghouse TSC (i.e., location, habitability, procedures for staffing, power supplies, structural integrity, etc.), nothing in the design of the Westinghouse TSC prevents or hinders a utility's full compliance with all requirements.

The requirements for technical data (key plant parameters) that must be available in the OTSC have not been specified by the NRC. An extensive review of critical plant systems and key safety concerns has resulted in the identification of the key plant parameters which Westinghouse considers to be necessary in the OTSC for post-accident recovery operations. These parameters (specified in Section 2.0) are generic and, therefore, are subject to some tailoring to reflect plant specific designs.

The OTSC has the capability to access and display plant parameters independent of actions in the control room. The interface of the OTSC instrumentation with existing plant instrumentation will not result in any degradation of the control room, protection systems, controls, or other plant functions.

The OTSC also includes an output interface for offsite data communication, although the offsite data communication equipment is not included as part of the Westinghouse TSC.

6.2.2 NUREG-0585, "TMI-2 LESSONS LEARNED TASK FORCE FINAL REPORT"

NUREG-0585 endorses the OTSC concept and provides two additional recommendtions (Recommendations 5.0 and 7.2) in the area of information displays. The following excerpts provide the NRC recommendations:

1. "The Task Force recommends that automatic status monitoring be required by a decision to backfit Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems," to plants not already required to meet it. Furthermore, the design to satisfy the objectives of the guide should be flexible and capable of accepting additional monitoring functions at a later date."

2. Each licensee should be required to define and adequately display in the control room a minimum set of plant parameters (in control terminology, a state vector) that defines the safety status of the

nuclear power plant. The minimum set of plant parameters should be annotated for sensor limits, process limits, and sensor status. The annotated set of plant parameters should be presented to the operator in real time by a reliable, single-failure-proof system located in the control room. The annotated set of plant parameters should also be available in real time in the onsite technical support center."

A Bypassed and Inoperable Status Indication (BISI) system is included as part of the Westinghouse TSC, as discussed in Section 3.0. The BISI provides the operator (in the control room), as well as the technical support personnel (in the OTSC) in the event of an emergency, a continuous systems level indication of a bypassed or inoperable status of the systems comprising the engineered safety features. The BISI design is in accordance with the recommendations of Regulatory Guide 1.47.

In addition to the BISI discussed above, a Plant Safety Status Display (PSSD) is also included as part of the Westinghouse TSC, as discussed in Section 4.0. The PSSD provides the operator or supervisor (in the control room), as well as the technical support personnel (in the OTSC) in the event of an emergency, a succinct account of the overall plant safety status. The PSSD presents an annotated set of plant parameters (specified in Section 4.0) to the operator in real time by a highly reliable system.

The interface of the BISI and PSSD instrumentation with existing plant instrumentation will not result in any degradation of the control room, protection systems, controls, or other plant functions.

6.2.3 NUREG-0660, "NRC ACTION PLAN DEVELOPED AS A RESULT OF THE TMI-2 ACCIDENT"

NUREG-0660 (Tasks III.A.1.2, I.D.2, and I.D.3) incorporates the NRC requirements for the OTSC, BISI, and PSSD described in Sections 6.2.1 and 6.2.2.

6.2.4 NRC LETTER, "NRC NUCLEAR DATA LINK (NDL)"

As discussed in detail in Sections 2.0 and 5.0, the OTSC includes an output interface for offsite data communication with the NRC, the Emergency Operations Facility (Near-Site), Westinghouse, or others as appropriate. The actual offsite data communication equipment is not included as part of the Westinghouse TSC.

6.2.5 NRC LETTER, "CLARIFICATION OF NRC REQUIREMENTS FOR EMERGENCY RESPONSE FACILITIES AT EACH SITE"

The evaluation of the OTSC, described in Section 6.2.1, includes consideration of the applicable NRC requirements contained in their April 25, 1980 letter to all power reactor licensees.

6.2.6 REGULATORY GUIDE 1.47, "BYPASSED AND INOPERABLE STATUS INDICATION FOR NUCLEAR POWER PLANT SAFETY SYSTEMS"

As discussed in Sections 3.0 and 6.2.2, the design of the BISI is in accordance with the recommendations of Regulatory Guide 1.47 and the requirements of Section 4.1.3 of IEEE Standard 279-1971 and Criterion XIV of Appendix B to 10 CFR Part 50 with respect to indicating the bypass or inoperable status of portions of the protection systems, systems actuated or controlled by the protection system, and auxiliary or supporting systems that must be operable for the protection system and the system it actuates to perform their safety-related functions.

6.2.7 REGULATORY GUIDE 1.97, "INSTRUMENTATION FOR LIGHT-WATER-COOLED NUCLEAR POWER PLANTS TO ASSESS PLANT AND ENVIRONS CONDITIONS DURING AND FOLLOWING AN ACCIDENT"

The post-accident instrumentation recommended in Regulatory Guide 1.97 and the instrumentation utilized in the Westinghouse Emergency Operating Guidelines were considered in the analysis to determine the plant parameters that should be monitored and displayed via the Westinghouse TSC.

6.2.8 IEEE STANDARD 279-1971, "IEEE STANDARD: CRITERIA FOR PROTECTION SYSTEMS FOR NUCLEAR GENERATING STATIONS"

The following evaluation of the TSC against the criteria of IEEE Standard 279-1971 is provided in order to further demonstrate that a failure of the TSC components or total system will not significantly affect the ability of plant safety systems to function as required, or cause plant conditions more severe than those for which the plant safety systems are designed.

6.2.8.1 General Functional Requirement

The Westinghouse TSC, which consists of the OTSC, BISI, and PSSD will provide the required information to operating and technical support personnel in order to cope with emergencies.

As previously stated the TSC functions are:

1. To provide key plant information in a location separate from the control room to support post-accident recovery management (OTSC).

2. To provide the operator and technical support personnel with a clear indication of the availability of plant safety systems such as the engineered safety features (BISI).

3. To provide the operator and technical support personnel with a succinct account of the plant status as it pertains to plant safety (PSSD).

6.2.8.2 Single Failure Criterion

The TSC instrumentation does not need to be designed to the single failure criterion since it does not perform a protective function. Its functions are to collect, condition, and make plant data available to operating and technical support personnel in the event of a plant emergency. However, as stated in the previous TSC technical descriptions

(Sections 2.0 through 5.0), reliability, operational considerations, and good engineering practices have dictated some level of redundancy within portions of the TSC. Therefore, redundant data processors and displays have been incorporated in some parts of the TSC. This will also permit flexibility in operation, functional expansion capabilities, testing, and maintenance of the TSC.

6.2.8.3 Quality of Components

The TSC instrumentation equipment is designed and procured to high quality standards. Although the TSC need not meet Class 1E requirements, the system does meet some of the criteria as discussed in the previous TSC technical descriptions.

6.2.8.4 Qualification

The TSC instrumentation is qualified to perform its functions based on the provisions of highly reliable equipment. Condition II, III, or IV accident environments are not applicable to the TSC instrumentation since those events are not part of its design bases.

6.2.8.5 Integrity

Common mode failure mechanisms such as credible fires, floods, or missiles will not destroy the independence between the TSC and the plant protection system. A failure of the TSC would not impair the protection system capability in any significant manner.

6.2.8.6 Independence

The TSC instrumentation is independent and physically separated from the protection system. TSC circuits are not run with any of the protection system channels or trains. Where Class 1E circuits provide inputs to TSC functions, isolation devices serve to prevent credible faults such as open circuits, or applied credible voltages in TSC circuits from being propagated to the Class 1E circuits. The isolation device is Class 1E. TSC circuitry can be run with other control signals without jeopardizing independence from the protection system.

6.2.8.7 <u>TSC and Protection System Interaction</u>

The purpose of the TSC is for data acquisition, processing, display and transmittal. It performs no protection or control function. The TSC does not operate to provide reactor protection actuations or to keep the plant within operation limits. The TSC is primarily a surveillance system which provides the control room operator and technical support personnel with plant status information. A TSC failure does not lead to an unanalyzed condition. A failure in the TSC can not degrade the protection system to prevent it from performing its protective function.

If protection system signals are used in the TSC, transmission of those signals to the TSC are through means of appropriate isolation devices, as described in Section 6.2.8.6.

6.2.8.8 <u>Derivation of Inputs</u>

Variables required to be monitored by the TSC are discussed in the technical descriptions provided in Sections 2.0 through 5.0.

Some of the variables monitored by the TSC are the same variables used by the protection system to initiate protection actions. There is no need to provide diversity in this regard between the TSC and the protection system.

6.2.8.9 <u>Sensor Checks</u>

Sensor checks are not applicable since the TSC uses existing plant instrumentation. The existing instrumentation is capable of being periodically checked. Where it is impractical to conduct such a check at power, the checks will be performed during scheduled outages. Cross checking of redundant sensors may provide appropriate verification of sensor operability.

6.2.8.10 Test and Calibration

Since the TSC is a surveillance system, periodic on-line testing (per Regulatory Guide 1.22) is not required.

6.2.8.11 Channel Bypass

Redundant circuitry is used within the TSC for availability considerations. There is no need for channel bypass considerations as in the protection systems (such as placing elements in a tripped condition), when redundant elements are removed from service for maintenance or testing.

6.2.8.12 Operating Bypass

The TSC has no operating requirements that necessitate automatic or manual bypass of a protective function.

6.2.8.13 Indication of Bypasses

Since the TSC provides no protective or control function, indication of the TSC being bypassed for test or maintenance need not be continuously indicated in the control room. Individual equipment that is bypassed for purposes of maintenance or test will be indicated at the equipment location.

However, the Westinghouse TSC provides a BISI system in accordance with the recommendations of Regulatory Guide 1.47 as discussed in Sections 3.0, 6.2.2, and 6.2.6.

6.2.8.14 Access to Means for Bypassing

The design permits the use of administrative controls for manually bypassing the TSC for periods of time during testing.

6.2.8.15 Multiple Setpoints

Setpoints or the necessary change of setpoints for restrictive purposes (e.g., plant trip), are not required by the TSC, since no protective function is provided.

6.2.8.16 Completion of Action Once Initiated

Completion of protective actions once initiated is not applicable to the TSC, since no protective actions are provided.

6.2.8.17 Manual Initiation

Manual initiation of protective actions (per Regulatory Guide 1.62) is not applicable to the TSC, since no protective actions are provided.

6.2.8.18 Access to Setpoints Adjustments, Calibration, and Test Points

Setpoint adjustments are not applicable in the TSC. Administrative control will be applied to module calibration adjustments and test points.

6.2.8.19 Identification of Protective Actions

Identification of protective actions is not applicable to the TSC, since no protective actions are provided.

6.2.8.20 Information Read-Out

The requirements for information read-out in the control room of the plant status from the protection system is not pre-empted by the TSC. The TSC is designed as an aid to the plant operator and technical support personnel to cope with emergencies.

6.2.8.21 System Repair

The TSC instrumentation is capable of timely repair upon detection of a failure. The dependence on redundancy within the TSC is considered only from the standpoint of availability since no reliance in placed upon the TSC for protective actions.

6.2.8.22 Identification

The TSC instrumentation and cables need not be identified, since it is not a protection system. However, precautions should be taken to preclude routing of such cables or location of such equipment with protection system channels or cabinets, so as to maintain physical separation between the TSC and the protection system.

6.2.9 10 CFR PART 50, APPENDIX B, "QUALITY ASSURANCE CRITERIA FOR NUCLEAR POWER PLANTS AND FUEL REPROCESSING PLANTS"

The TSC system design complies with the requirements of 10 CFR Part 50, Appendix B. Quality assurance programs are in accordance with Westinghouse Quality Control Standard-2 described in WCAP-8370, Revision 9-A, "Westinghouse Water Reactor Divisions Quality Assurance Plan". The design of the TSC hardware and software will be subjected to an independent review for the purposes of design verification.

6.3 EVALUATION SUMMARY

The Westinghouse TSC is a computer based surveillance system, capable of processing and evaluating a plant's operation and safety status. The primary function of the system is to convey information; the system does not initiate any protective actuations or control functions. The system is an aid to the plant operator and technical support personnel to cope with emergencies.

The TSC instrumentation is not required to meet Class 1E specifications, but is designed to be highly reliable for purposes of availability.

TABLE 6-1

POST-TMI ITEMS APPLICABLE TO WESTINGHOUSE TSC

(Based on NRC Action Plan - NUREG-0660)

Item	References	Implementation Dates	
		Operating Reactors	Plants Under Contruction
Onsite Technical Support Center (NUREG-0660, Task III.A.1.2)	• NUREG-0660 (Tasks I.D.1 and III.A.3.4) • NUREG-0578 (Item 2.2.2.b) • NRC letters dated - 9/13/79 - 9/27/79 - 10/10/79 - 10/30/79 - 11/9/79 - 3/12/80 - 4/25/80	Initial - 1/1/80 Upgrade - 1/1/81	Initial - Fuel Loading Upgrade - 1/1/81 or prior to licensing
Bypassed and Inoperable Status Indication (NUREG-0660, Task I.D.3)	• NUREG-0585 (Item 5.0) • Kemeny Report (Item D.3) • NUREG-0660 (Tasks I.C.6 and I.D.1) • R.G. 1.47	(No action at this time - subject to NRC evaluation)	(No action at this time - subject to NRC evaluation)
Plant Safety Status Display (NUREG-0660, Task I.D.2)	• NUREG-0585 (Item 7.2) • Kemeny Report (Item D.1) • NUREG-0660 (Task I.D.1)	Design - 1/81 Installation - 1/82	Design - 1/81 or 12 months prior to OL Installation - 1/82 or prior to OL

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