December 21, 1990

Project No. 675

Mr. Shelby T. Brewer, President
ABB Combustion Engineering Nuclear Power
1000 Prospect Hill Road
Post Office Box 500
Windsor, Connecticut 06095-0500

Dear Mr. Brewer:

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION ON CESSAR-DC, SYSTEM 80+

Enclosed is a partial request for additional information, based on the staff review of Chapters 7, 13, 18 and Appendix A of CESSAR-DC. There will be additional questions on these chapters as we continue our review. In this regard, we note that you have not yet provided complete responses to our previous requests for additional information dated December 23, 1988, January 19, and June 26, 1989, and January 24, 1990. Please respond to all of these requests within 90 days of receipt of this letter. Incomplete or untimely responses will result in delays in completion of the staff review.

The staff notes that you have indicated that you still have not provided a complete application for staff review. In addition, we understand that your next amendment to CESSAR-DC should be received by us in January 1991. You have stated that this amendment should virtually complete the CESSAR-DC except for minor revisions to respond to our requests for additional information during the course of our review. As we understand it, this upcoming amendment will provide major additions to Chapters 2, 3, 11, 12, and 16 and less significant additions to Chapters 5, 7, 8, 9, 10, and 15 and Appendix A. Since you have not given the staff a complete submittal for its review, a detailed schedule leading to potential certification of the CESSAR System 80+ is difficult to develop. Upon our receipt of responses to our previous requests for additional information, the January 1991 amendment and the completion of the response to this letter, we will be able to establish a review schedule that is more realistic.

Sincerely,

original signed by
Dennis M. Crutchfield, Director
Division of Advanced Reactors
and Special Projects
Office of Nuclear Reactor Regulation

Enclosure:
As stated

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Proj. #675

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

December 21, 1990

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Division of Advanced Reactors
and Special Projects
Office of Nuclear Reactor Regulation

Enclosure:
As stated

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ENCLOSURE

REQUEST FOR INFORMATION
INSTRUMENTATION AND CONTROL SYSTEMS BRANCH

Questions:

420.1 ,420.2, and 420.3 pertaining to Chapter 1 were issued on April 13, 1988 by letter from Guy Vissing (NRC) to A.E. Scherer (CE). The questions addressed the 60 year licensing, listing of Regulatory Guides, and the remote shutdown panel. Combustion Engineering (CE) responded to the three questions by letter dated July 13, 1988.

For the following questions the CESSAR Design Certification document for the System 80+ will be referred to as the DC.

As described in the Licensing Review Bases (LRB), CE has committed to supply a sufficient level of information to allow the staff to conclusively reach the required health and safety determination. The level of detail required to make that determination is currently under review by the staff and the Commission. Several of the following questions may be significantly different if the Commission direction provides for a different level of detail than currently described in the LRB.

420.4 (7) This question requests CE to provide design details so that the staff can evaluate the system/equipment design with respect to all appropriate regulations and standards. CE is requested to provide examples which address most of the Instrumentation and Control (I&C) equipment. The first example requested is the Core Protection Calculator. The staff is relatively familiar with this equipment and CE has a current complete design available from which an appropriate level of detail could be provided.

The second example requested is equipment which is in the CE scope but has not been completely designed, or selected and may not be finalized until after design certification. Possible examples could be the programmable logic controllers for the Emergency Safety Features Actuation System (ESFAS) or the Integrated Process Status Overview (IPSO) panel.

The third example requested is for equipment outside of the CE scope for which interface requirements are to be established. As identified in the DC (7.1.1.4.L), the Heating, Ventilation and Air Conditioning (HVAC) systems are to supplied by others. Since the HVAC is important as an I&C support system, the staff must make a determination that the design is acceptable and the necessary level of design detail (or requirements) is included or referenced in the DC.

420.5 (7) This question refers to the EPRI Utility Requirements Documents (URD), Chapter 10. In the LRB, CE provides a listing of the differences between the CE DC document and the EPRI RD. One area identified is the Advanced Control Complex. This question is a general question related to the many items listed in the EPRI RD for which the Plant Designer has a task to perform. Some of the tasks have been performed by CE already, such as the

basic system functional descriptions. Some of the tasks, such as use of simulators and selection of specific wireless communications frequency allocations, may not have been completed. This question requests CE to address the EPRI requirements in detail and provide a listing of the tasks that have been performed or will be performed prior to design certification and identify the tasks and the interface requirements which will not be completed until after design certification.

420.6 (7.1.2.10) The staff agrees that fiber-optic technology provides inherent electrical fault isolation. Though the independence and separation provided by the fiber-optics will satisfy the Regulatory Guide 1.75, the DC claims that the fiber-optic technology will ensure that no single credible event can propagate. Single credible events can include random bit errors or power supply loss which are not unique to fiber-optics but should still be addressed. This question requests CE to clarify that other features are required to make a system single failure proof or that the single failure that is being addressed is limited to electrical faults.

420.7 (7.1.2.16.C.1) This section states that systems are "generally" designed to fail safe for the conditions listed. Provide a list of systems or parts of systems which do not meet this philosophy.

420.8 (7.1.2.16.C.2) This section states that test modes are designed such that they do not prevent system actuation. Does this include automatic as well as manual actuation? Are operator actions required to reset from test mode to allow automatic signals to actuate safety equipment? List any exceptions. Are there any test modes during refueling outages which require systems to be locked out for equipment or personnel protection? Provide a detailed explanation of the test and maintenance philosophy for the I&C design with respect to minimizing the potential for human errors and spurious actions.

420.9 (7.1.2.16.D.1) If the non-Class 1E Data Processing System is used to monitor the critical safety system setpoints describe how the information is to be verified or validated.

420.10 (7.1.2.17.C) This section states that all bypasses are at the channel level. The staff understands this to mean that all intentional bypasses are input at the local coincidence logic processors. Is this correct? Can the process sensors, transmitters, fiber-optic links or initiation logic be bypassed individually. If an initiation circuit fails, is that circuit placed in trip or bypass?

420.11 (7.1.2.17.C, Figure 7.2-1) If Channel A is bypassed which sensor is bypassed, if any?

420.12 (7.1.2.21.2) For this section and several others the statement is made that a function is manually initiated. This question requests CE to clarify the intention of manual actions. These actions can range from touching an interactive display screen to physically turning valve stem wheels.

420.13 (7.1.2.22) As described in this section the amount of equipment common to automatic and manual initiation is to be minimized. Describe the equipment which is common. Are there any common hardware or software modules?

420.14 (7.1.2.25.A) The staff requests CE to avoid the use of the caveat "to the extent practicable" in this section or others. With the design certification format this would be a difficult item to verify during construction as to the original scope and intent of the requirement. The staff does not disagree with the statement about subcomponents but is simply attempting to understand the design more accurately and to minimize future disagreements. What is the intent of this caveat and how would it be standardized?

420.15 (7.1.2.32) Describe the software verification and validation to be used for the non-Class 1E systems.

420.16 (7.1.3) This section addresses stable and noise free power to the I&C equipment. Are any specific standards to be referenced? What are the requirements for electromagnetic and radio frequency interference?

420.17 (7.1.3.E) Describe the tests and/or analyses that will be used to demonstrate that failures in non-Class 1E will not degrade the Class 1E circuits.

420.18 (7.1.3.H) Describe the difference between "deliberately made inoperable" and bypassed. Would different operator actions or technical specifications be required?

420.19 (Figure 7.1-4) Provide a description or drawing which shows the extent of shared taps, lines, and reference legs. Provide justification for any sharing proposed in the design.

420.20 (Figure 7.1-4C) This drawing shows the Supplementary Protection System (SPS). Section 7.1.1.7 states that the SPS is being replaced with the Alternate Protection System (APS). By which name is the system to be named? Also, this drawing shows the system to be Class 1E while section 7.7.1.1.11 shows the APS to be a non-Class 1E system. Is the system 1E or non-1E?

420.21 (7.2.1.1) The second paragraph contains the statement that the fourth channel is provided as a spare and allows bypassing of one channel while maintaining a two-out-of-three system. Is CE's intention to license the plant as a two-out-of-four plant in which case a bypass would be a technical specification limiting condition for operation with a time limit or is the intent to obtain the design certification based on a two-out-of-three design that would allow indefinite bypass of the spare channel? How would this be evaluated in the PRA?

420.22 (7.2.1.1.3) The system described is a two-out-of-four system which can have one channel in bypass. This leaves a two-out-of-three configuration which allows any single failure and would still complete the logic. Provide a comparison of this design with Section 8.3.2.4 of the EPRI URD Chapter 10. This section of the EPRI document requires the reactor protection system to withstand two single failures and still perform its function. Bypass capability is not addressed. Provide a summary list of all I&C areas that differ from the EPRI URD.

420.23 (7.2.1.1.8) This section states that the design will assure that predictable common mode failures do not exist. The staff agrees with this design goal but is also concerned with unpredictable common mode failures. 7.2.1.1.8.E discusses a degree of functional diversity. 7.2.1.1.8.G states that the Reactor Protection System (RPS) and Engineered Safety Features (ESF) systems use different design types which eliminate hardware and software design common cause failures. This question requests an elaboration of this statement. The staff considers software design errors to be a credible fault and, therefore, all modules which share common software design are subject to common mode failure. The information to be provided by CE should specifically address the design features which either eliminate the potential for common mode failures between redundant channels of the safety systems or provide alternate, diverse means to accomplish the same task. One method that has been discussed is the non-safety systems which CE has stated are designed with diverse equipment from the safety equipment. If this option is considered, CE should address the possibility that the safety systems will not be utilized until the non-safety systems are already disabled and unable to provide a diverse method of providing a specific function. The staff notes that page A-102a A-47 "Safety Implications of Control Systems" of the DC states that non-safety grade control systems are not relied on to perform any safety functions.

420.24 (7.2.1.1.9) This section states that the automatic testing does not degrade the ability of the RPS to perform its intended function. Describe the verification and validation of the testing software. Is the automatic test feature qualified as Class 1E?

420.25 (7.3.1.1.6) CE is also requested to address in greater detail the design features that eliminate common mode software errors as a concern for the ESF I&C systems.

420.26 (7.4.1.1.9.3) The Safety Injection System (SIS) and Chemical and Volume Control System (CVCS) are diverse. Does this diversity include the I&C portions?

420.27 (Table 7.5-3) The Reactor Coolant System (RCS) Boron Concentration is shown with a range of 0-5000 ppm. RG 1.97 has a range of 0-6000 ppm for this parameter. Exceptions from RG 1.97 guidelines should be specifically noted and justified.

420.28 (7.7) Section 7.7.1 addresses the IPSO, Data Processing System (DPS), and Discrete Indication and Alarm System (DIAS) in the Advanced Control Complex. Section 7.7 is titled "Control Systems Not Required For Safety." This question requests CE to provide a drawing or listing which clearly delineates the safety grade and non-safety grade displays and controls in the main control room.

420.29 (Figure 7.7-6) Provide a description of the capabilities of the load dispatcher. Does this design include the capability of a remote load dispatcher to move control rods or otherwise directly affect plant operation?

420.30 (Appendix A, page A123d, I.D.4) This section of the Control Room Design Standards in the DC note that the control room should be designed only after a full analysis of the control tasks has been performed. This is similar to many of the EPRI requirements which require many designer tasks early in the design. Has this specific analysis been performed and is it available for review?

420.31 (7) Provide the verification and validation (V&V) plan that is being used for the development of the NUPLEX 80+.

420.32 (7) Provide the V&V plan that will be used for the ESF I&C systems. In particular address the verification and validation of commercially purchased components. Of specific interest to the staff is the method to be used by CE to qualify the distributed microprocessors (PLCs). For example, if a PLC is provided by a company which in turn used chips and instruction sets from a subvendor, describe the method by which the end user would be notified of an error in the original instruction set.

420.33 (7) Provide a description of the method used by CE to assure that the compilers, assemblers, debuggers, and other tools used by CE and software suppliers are reliable.

420.34 (7) Identify any design standards, other than those required by the NRC, that are used for this design.

420.35 (7) Describe the method to be used to measure or estimate the reliability/availability of the safety system I&C components and subsystems. Of particular interest to the staff is the reliability of microprocessors, software, Cathode Ray Tubes (CRTs), plasma displays, fiber-optic links and any other relatively new technology used in this design.

420.36 (7) Describe the organizational relationship and the degree of independence between the people doing the verification and validation work and the software development team. At what point in the organization do they share a common manager?

420.37 (7.2.1.3.8) Provide a defense-in-depth analysis. An acceptable methodology is described in NUREG-0493, "A Defense-in-Depth and Diversity Assesment of the RESAR-414 Integrated Protection System," March 1979.

420.38 (7.2.2.3.2) Identify the specific sensors which will be shared between safety and non-safety systems and justify the design philosophy.

420.39 (Table 7.2-5) Describe the analysis done to ensure that erroneous data cannot prevent a Departure from Nuclear Boiling Ratio (DNBR) or power density trip.

420.40 (7.2.1.1.7.2) The Control Element Assembly (CEA) positions are monitored by two diverse methods. Describe the diversity for the equipment from the reed switches/rod drive position to the position displays and associated calculators.

420.41 (7.3.2.4) The Failure Modes and Effects Anaylsis (FMEA) provided in Table 7.2-5 does not adequately address failure modes other than total failure such as loss of power. Address system stall, lockup, runaway, degraded power supplies (voltage, frequency), power fluctuations, timing errors, etc.. For example, data communication modules can send incorrect data as well as simply failing to send any data at all.

420.42 (7.1.2.17) Describe the self-diagnostic features of the system. Describe which diagnostics are run on-line, in background or in maintenance (bypassed) mode. Describe the actions taken when an on-line diagnostic system detects an error.

420.43 (7) Describe the data bus used in the multiplexors. Provide enough detail to demonstrate that the multiplexors are not a single failure point. The previous question concerning common mode software errors will also be considered in the staff evaluation of the multiplexors.

420.44 (7) Are watchdog timers provided in the microprocessors? Describe the reset cycle and actions on timeout.

420.45 (7) Describe the provisions that have been put in place to assure that commercial equipment dedicated for Class 1E use is free of viruses.

420.46 (7.1.1.7) This section describes the description of the difference between the System 80+ and the Palo Verde design. In addition to the few system level functional differences listed, this section (and ESF) should be expanded to note the very significant differences in the design.

420.47 (7.3.1.1) Provide the protocol, configuration, and modes for the communication networks.

420.48 (7) Describe the fiber-optic and multiplexor arrangement in enough detail to show that the independence criteria are not violated.

420.49 (7) Does the DC for this design allow for, or intend to utilize, expert or artificial intelligence systems in the safety or non-safety systems?

420.50 (7) Do the safety systems require any rotating memory devices to perform their function?

420.51 (7.3.1) Explain the "normal control" function of the ESF-Component Control System (CCS). Provide a more detailed explanation of the redundancy controller function. What happens if the redundancy controller malfunctions?

420.52 (Figure 7.2-12) Provide a detailed version of this diagram that shows individual power supplies, microprocessors, and connections. The staff understands that the details may change between this review and plant construction. As part of the "level of detail" discussions which are currently taking place, it would be helpful if CE could provide their opinion, using the drawings as examples, of what should be "locked" into the design certification and what can be changed.

420.53 (Figure 7.2-11) It is unclear to the staff how the data flow through the functional blocks shown will actually be accomplished. Provide a more detailed figure.

420.54 (7) Describe the trade-offs between analog and digital systems and describe the reasons why CE considers the new microprocessor based design to be an improvement over previous designs.

420.55 (7) Describe the time frame for when preliminary experimentation ends and design under controlled formal and documented verification and validation begins for the design. Describe the time frame for the point in the design when simulators are available. The EPRI Requirements Document requires the use of dynamic simulators in the design process.

420.56 (7.7.1.1.11) Describe the diversity of the APS. Does this diversity include diverse sensors, processors, and power supplies? Address the detailed guidance provided with the ATWS Rule, 10CFR50.62 Statement of Considerations.

420.57 (7) It is not clear to the staff how the sensor trarsmitter outputs will be transferred to the Remote Shutdown Panel when required. Presumably the calibration data updates in the plant protection system would be disconnected during the transfer. Provide a more detailed description of the transfer from the main control room to the remote panel.

420.58 (non-docketed backup material review) As part of the staff's review to date there have been meetings with the licensee and material presented and discussed which has not been placed on the docket. These questions are labeled as "review" questions. In Volume 1 of the backup documentation that was available for the staff to review there was a description of the priority 1 and 2 alarms which are processed and displayed independently by the DIAS and DPS systems which also cross check each other. How is independence and isolation maintained.

420.59 (Review) A description of the touch screen discrete indicators was presented. Does the operator need to select different screens to see the RG 1.97 Cat 1 variables?

420.60 (Review) The DPS is described in the manuals available to the staff as having a RS-232 datalink available and that bi-directional communication is supported. Describe any area in which non-safety systems provide information to safety systems.

PROJECT

100.1 What plans does CE have for addressing the National Environmental Policy Act, including potential severe accident mitigation design alternatives?

REQUEST FOR ADDITIONAL INFORMATION
COMBUSTION ENGINEERING SYSTEM 80+
HUMAN FACTORS BRANCH

INTRODUCTION

Chapter 13, Section 13.2, "Training" and Section 13.5, "Plant Procedures" and Chapter 18, "Human Factors" are currently under review by the Human Factors Assessment Branch (LHFB) staff. The following documents were included as part of the review of supporting documentation for Chapter 18.

- SD-791-01 Control Complex Information Systems
- DP-791-01 Layout of Control Panel Indication and Controls
- TE-790-01 Verification Analysis Report-Section C, Suitability Analysis
- SD640 Component Control System, System Description

The results of the initial review of Chapter 18 and the supporting documentation indicates that the content of Chapter 18 provides little data to support the human engineering decisions that drove the design of the man-machine interfaces. Similar deficiencies were noted in Chapter 13, Sections 13.2 and 13.5. No information was provided regarding the content and format of procedures and training. Such information is critical to the completion of a thorough technical review of Chapters 13 and 18.

The staff interprets the requirements of 10 CFR 52.47(a)(1)(ii) to specify that the standardized C-E design include standardized training and procedures. While it will be necessary for certain aspects of training and procedures to be site-specific (e.g., site geography and security), training and procedures related to those standardized portions of the design should be standardized and, therefore, remain consistent across sites.

The staff also believes that control room design/development tests and evaluations may necessitate a fully operational control room prototype to determine if the performance objectives of the plant can be met given the equipment design, software design, procedures, training, and organization of the staff complement. Mock-ups may be used during the design of the control room to establish proof of concept and to evaluate design strategies. The fully operational control room prototype, however, should be equal in fidelity and completeness to that of a first article of production. The software component of the control room should be mature enough to be considered final and under a configuration control program. Interaction with simulated systems outside the control room should be sufficiently developed to run scenarios for normal, abnormal and emergency operations and to test individual and crew performances.

The staff intends to seek the guidance of the Commission on its interpretations for standard plant design requirements in the area of procedures, training and control room design.

The following request for additional information (RAI) identifies specific concerns with Combustion Engineering's approach to human factors and its application on the System 80+ control room design. This additional information is necessary for the staff to continue the review of Chapters 13 and 18 of the CESSAR-DC documentation.

Page	Para	Question #	SYSTEMS ENGINEERING QUESTIONS
		620.1	Provide a detailed human factors program plan which includes a scope of work, the organization of the human factors group and their reporting structure, a description of the human engineering and system analysis studies to be performed, the standards and guidelines that will be generated as a result of human factors efforts, a schedule of major human engineering milestones and technical reviews with anticipated levels of human engineering support, and an outline of the human factors test and evaluation plan.
		620.2	Describe the human engineering studies that led to the selection of the flat panel programmable displays used on the control boards. Describe how they meet the operator and instrumentation requirements identified in the task analysis, as well as the maintainability, and reliability requirement established for control room instrumentation. Also address how they contribute to the goal of redundancy and diversity. Include relevant findings from task analyses and product evaluations.
		620.3	Describe the technical and administrative methods used by C-E's human factors specialists to track the evolution of the design and to influence the design process. Describe the documentation control system that is in place to ensure that the evolution of the man-machine interface elements of the design have been documented and provide an auditable documentation trail. How are the results of studies, design decisions and trade-offs documented?
		620.4	How many human factors specialists are currently dedicated on a full-time basis, to the System 80+ design? Into how many hours of face-to-face contact time does this translate with the NSSS and BOP engineering and design staffs per week?
		620.5	Chapter 18 Section 17.7.1.1.2 describes the use of 11 colors; TE 790-01 paragraph 3.1.2, point 1, identifies another two colors; and SD640 paragraph 6.1.4.1 identifies two more colors. There is no clear and concise presentation of the information coding scheme used in the System 80+ control room. Provide a matrix of all the information coding methods and their meanings used in the control room. This would include, at a minimum, the colors, the symbols, changes to alpha-numeric or symbols such as case or size, any patterns, position/location/denotation of data that would convey information, flash, flash rate, figure-background changes, reverse video, color changes (include contrast ratios), changes in intensity, etc., or any combinations thereof that are used on software driven and hardwired displays that provide some kind of quantitative or qualitative information to operators or maintenance personnel.

Page	Para	Question #	TRAINING AND PROCEDURES QUESTIONS

The information provided in Sections 13.2, "Training," and 13.5, "Procedures," of the CESSAR-DC indicate that these areas are not in the CESSAR scope and, therefore, there will be no effort to standardize these areas across sites. The final development of training and procedures for the C-E System 80+ will be the responsibility of each individual applicant referencing the C-E design. The staff finds this position to be inconsistent with the requirements of 10 CFR 52. It is the staff's position that in accordance with 10 CFR 52, standardization of the plant design should be the basis for development of standardized training and procedures.

For example, if a system requires a specific flow rate for optimal operation, standardized training and procedures related to the system can be developed based on the task analysis. The details related to how that flow rate is achieved need not be in the training. However, information related to why that flow is required and the consequences if that flow cannot be attained and maintained should be provided and procedures should be developed to reflect this information. Where procedural development requires specific detailed information on non-standardized equipment (e.g., maintenance procedures), it is not expected that procedures would be developed until the non-standard equipment is designated. In order to address this issue, the following specific concerns should be considered.

Section 13.2 "Training" Questions

The information provided in Section 13.2 indicates that information concerning the site-specific operator training program is within the referencing applicant's scope and shall be provided in the site specific Safety Analysis Report (SAR). Since this is not consistent with the staff's position on standardization, the following should be addressed.

620.6 Describe the standardized training materials (e.g., content, format, and development process) being provided to the purchasers of the C-E System 80+ for those aspects within the CESSAR design scope.

620.7 Describe the guidance that will be provided to purchasers of the C-E System 80+ to ensure consistent adaptation of the standardized training materials to site-specific training materials.

620.8 Given the advanced technology of the C-E System 80+ what are the specific skills, knowledge, abilities, and aptitudes based on the task analysis, that will be provided to purchasers to assist in the development of site-specific personnel selection criteria.

Page	Para	Question #	Section 13.5 "Procedures" Questions
			The information provided in Section 13.5 indicates that information concerning the site-specific operator plant procedures is within the referencing applicant's scope and shall be provided in the site-specific SAR. Since this is not consistent with the staff's position on standardization, the following should be addressed.
		620.9	Describe the standardized normal, abnormal, and emergency operating procedures C-E will provide to the purchasers of the C-E System 80+.
		620.10	Describe the standardized procedural development guidelines to be provided to referencing applicants for those normal, abnormal, and emergency operating procedures (e.g., writer's guide, verification, and validation guide, procedural maintenance guide). Describe the interface information that will be provided to ensure that site-specific procedures will be consistent with the standardized procedures?
		620.11	Does System 80+ use advanced and intelligent operator aids based on expert systems or other artificial intelligence (AI) technologies? If so, describe the following: a. The extent and dependence on intelligent operator aids necessary to achieve the single operator design goal. b. The specific operator aids that are planned and the technology on which they are based. c. The methods of knowledge engineering that will be used. d. The approach to be taken to develop operator confidence in the systems to assure that they will be appropriately utilized. e. The methods to be used for the verification and validation of the performance of intelligent operator aids.

Page	Para	Question #	DETAILED QUESTIONS FROM CHAPTER 18.0 HUMAN FACTORS ENGINEERING
18-1	18.1	620.12	How will C-E demonstrate that the System 80+ design objectives of improving operator performance, reducing maintenance time, and improving reliability are met?
18.1-1	18.1	620.13	How does C-E plan to demonstrate that "improved plant comprehension" has been achieved over the reference design for: a. improved alarm presentation and handling b. continued plant operation with loss of 1 or 2 diverse information display systems c. integration of normal and accident monitoring displays d. improved usability of the information presentation methods used to reduce required operator information processing requirements
18.1-1	18.1	620.14	What is the projected reliability of the controls and displays in the control room?
18.1-1	18.1	620.15	Describe the human engineering analyses and the findings of the analyses that supported the decision to use CRT's and flat panel displays as the primary sources of operator information and hardwired instrumentation as the back-up instrumentation.
18.2-1	18.2-1	620.16	How was the task analysis used by those responsible for the individual panel designs? On what basis was the allocation of tasks made to specific pieces of equipment?
18.2-2	18.2.1	620.17	How was the adequacy of the information supplied to the operator to perform the tasks determined for the following: a. Type of data b. Amount of Data c. Usability of Data d. Compatibility with other forms of information/data supplied in the plant at local control stations, on specific pieces of equipment, etc.
18.2-2	18.2.2	620.18	Who is on the initial design team and who is on the review team? Are they the same people or are the teams composed of different people?
Table	18.2-2	620.19	Human engineering is not included under Design Process Activities. Under Primary Responsibilities a human factors specialist is also not included. Please explain the scope, responsibility, and reporting structure of the human engineering function in the System 80+ program.

Page	Para	Question #	
18.3-1	18.3(A)	620.20	Identify the human engineering principles established for Nuplex 80. What analyses were used to identify the areas requiring improvement. What "specific improvements" were added?
18.3-1	18.3(D)	620.21	How was the potential for human error identified, reduced, and documented in "Reduce the potential for human error that could affect safety or availability."
18.3-1	18.3(E)	620.22	How was the reduction of operator information processing identified, reduced, and documented in "Reduce the operator's information processing while meeting all of his information needs."
18.3-1	18.1(F)	620.23	How will C-E demonstrate that improvements in the reliability of the man-machine interface have been achieved, as noted in the statement, "Improve the reliability of the man-machine interface through redundancy, segmentation, and diversity"? Does the term man-machine interface refer to the reliability of the hardware or a reduction in human error?
18.3-2	18.3.2(B)	620.24	Describe the workload analysis for one and three person operation of the controlling workspace. Describe how the task loading and work loads change.
18.3-2	18.3.2(B)	620.25	Describe the basis for the design goal of one person control of operations between hot standby and full power. Were separate task analyses performed for one and three person operations? How does the allocation of tasks among the staff change in the control room for one person, three person and a full six person shift?
18.3-2	18.3.2(C)	620.26	How does the Nuplex 80+ configuration minimize required access to the controlling spaces? A desk/barrier does not appear to reduce the requirement for maintenance personnel access to control room equipment and face-to-face communications with the operating staff.
18.3.2	18.3.2(D)	620.27	Describe the duties and responsibilities of the control room supervisor and describe the tasks expected to be performed at the CRS console in the control room. Which tasks will be performed in the supervisors office? Who will be the primary operators of the CRT's on the Control Room Supervisor's console and what displays are they expected to use or access?
18.3-2	18.3.2(F)	620.28	Explain how the control room design addresses the issues of habitability and the storage requirements for working documentation, procedures, supplies and personal effects. Describe the process used to establish the requirements for areas that support the control room such as the Technical Support Center, shift supervisor's office, etc.

Page	Para	Question #	
18.3-3	18.3.3(D)	620.29	How was "sufficient instrumentation" identified for the Remote Shutdown Panel? Describe the human engineering efforts or studies which contributed to the design of the Remote Shutdown Panel and the "convenience controls" distributed at equipment locations.
18.3-3	18.3.3(E)	620.30	Describe the human engineering test and evaluation methodologies that have been, or will be, used. How does the human engineering test and evaluation program fold into the System 80+ verification and validation program?
18.3-3	18.3.4(A)	620.31	The System 80+ control room design currently includes several types of control and display instrumentation. Some of it is new to control room applications, some is not. This paragraph states, "The man-machine interface is based on accepted human engineering methods, principles and criteria such as those presented in NUREG-0700." Identify the principle human engineering source documents used in the development of the man-machine interfaces, such as: a. Identify which elements of the man-machine interface were developed based on existing human engineering documentation. Identify the documentation. b. Identify which elements of the man-machine interface required the development of additional human engineering guidance. Identify the guidance. c. Describe the means C-E will use to ensure (1) that the man-machine interface aspects of the new technology will be compatible with that of the established technologies, (2) that the new man-machine interfaces will meet the requirements of the tasks, as defined by the human engineering studies, and (3) that the differences as well as the similarities among the man-machine interface devices enhance operator and maintainer performance.
18.3-3	18.3.4(C)	620.32	In the context of being presented as a design basis for Nuplex 80+ this paragraph states, "The number of physical display devices and the quantity of data presented to the operator is reduced compared to control rooms for existing plants." Provide the human engineering studies C-E has done to determine the benefits and drawbacks of reducing the number of display devices and quantity of data presented to the operator. Include specifically the studies which determined the optimal levels of re-

Page	Para	Question #	
18.3-3	18.3.4(C)	620.32 (Cont'd)	duction of display devices and data. Include the results of human engineering studies which were used to support the quantity of data presented to the operator, any consolidation of instrumentation, and any changes in the modes of displaying data to the operator in the Nuplex 80+ control room.
18.3-3	18.3.4(D)	620.34	What studies did C-E perform to determine the amount and type of "operator information overload?" Provide the quantitative and qualitative results of the investigations. Describe the baseline control room in which the studies were performed and the parameters that were measured or assessed. Were the studies replicated on the C-E System 80+ control room design? What thresholds were established for acceptable and unacceptable levels of operator cognitive loading? How does the System 80+ control room design specifically address each of the parameters assessed by the studies?
18.3-3	18.3.4(E)	620.35	This paragraph states, "The effectiveness of modern man-machine interface devices will be demonstrated through the use of prototypes and HFE evaluations." Does this refer to demonstrating the software and hardware attributes of the instrumentation? Or does it refer to human factors and human performance evaluations of (1) the device (as a stand-alone instrument) and (2) in the context of the System 80+ control room environment. When in the design process are the HFE evaluations scheduled to occur? Describe in detail the HFE evaluations that will be performed. Provide a basis for the criteria that will be used to determine a device's effectiveness (as a stand-alone instrument) from the human performance perspective. Also provide the assessment methodology that will be used to determine the suitability of a device for incorporation into the System 80+ control room design.
18.3-4	18.3.4(F)	620.35	This paragraph states, "Under degraded conditions, operators will continue to have access to all required information. Equipment failures impacting automated data processing and presentation features are accommodated by increased operator surveillance." What constitutes a degraded condition? Is it the loss of one computer driven display, one electrical bus (potentially affecting many instruments) or all digitally driven equipment?

Page	Para	Question #	
18.3-4	18.3.4(F)	620.35 (Cont'd)	How does increased surveillance on the part of the operator compensate for the loss of technical data? Are the data and the synthesized information normally available through the computer database available from other sources? Where will the alternate sources of information be located? From the human performance perspective, how will "increased surveillance" compensate for loss of the computer? Will operators be required to perform calculations, adjustments, or operations (manual, cognitive, decision-making, etc.) that would normally be done by the computer? Describe the impact on operator and crew performance in the control room, at the Technical Support Center and at the Emergency Operations Facility.
18.3-4	18.3.4(K)	620.36	This paragraph states that, "A standard set of display and access convention is applied consistently for all information presentation methods." Provide the human engineering document that identifies and discusses the standardized display and access conventions for all the information presentation methods. Do the standards apply to vendor supplied equipment and "off the shelf" hardware and/or software?
18.3-4	18.3.4(L)	620.37	This paragraph states that, "Critical functions established for both safety and power production serve as a primary basis for information and alarm presentation." What is the definition of the term "critical function?" How were "critical functions" identified? Was a critical task analysis performed on critical operator and maintainer tasks in the control room and to what level of detail were the critical task analyses performed? If a critical task analysis was not performed, explain why. How were the contributions of the human engineering task analysis and the critical task analysis integrated into the development of information and alarm presentations?
18.4-3	18.4.3	620.38	This paragraph says, "Operating staff targets for Nuplex 80+ were established to accommodate a variety of staffing assignments during both normal and emergency operations." How many extra people are expected to be in the control room and the Technical Support Center during an emergency? Provide the analysis that identifies and describes the duties, responsibilities, and capabilities of the additional personnel and the space, equipment, and information they will require. Describe how the current configurations of the control room and Technical Support Center meet the requirements and support the duties to be performed.