EXAMINATION REPORT

Docket No: 50-285 License No: DPR-40

Licensee: Omaha Public Power District
1623 Harney
Omaha, NE 68012

Examinations administered at Fort Calhoun Station (FCS)

Chief Examiner: Stephen L. McCrory, Examiner 7/31/84
Date

Approved by: R. A. Cooley, Section Chief 8/1/84
Date

Summary

Examinations conducted on June 5-7, 1984.

Written and oral examinations were administered to three Reactor Operator candidates. All three candidates failed these examinations.

FCS EXAMINATION REPORT

Report Details

1. Examination Results

SRO Candidates				RO Candidates			
Total	Pass	Fail	%	Total	Pass	Fail	%
0				3	0	3	0

2. Examiner

S. L. McCrory, Chief Examiner, NRC

3. Examination Report

This Examination Report is composed of the sections listed below.

A. Examination Review Meeting Comment Resolution

B. Exit Meeting Minutes

C. Generic Comments

D. Examination Master Copy (SRO/RO Questions and Answers)

Performance results for individual candidates are not included in this report because, as noted in the transmittal letter attached, examination reports are placed in NRC's Public Document Room as a matter of course.

A. Examination Review Meeting Comment Resolution

In general, editorial comments or changes made during the exam, the exam review, or subsequent grading reviews are not addressed by this resolution section. This section reflects resolution of substantive comments made during the exam review. The modifications discussed below are included in the master exam key which is provided elsewhere in this report as are all other changes mentioned above but not discussed herein. The following personnel were present for the exam review:

NRC	UTILITY
S. L. McCrory	J. F. Gass
	F. E. Swihel
	A. W. Richard
	L. T. Kirsch

FCS EXAMINATION REPORT

COMMENTS

(1) 1.3 The candidates may make reference to the Reactor Vessel head metal temperature.

Resp. High Reactor Vessel head metal temperatures are the chief contributors to the formation of voids in the head when in natural circulation. However, head temperature alone is inadequate to describe the mechanics of void behavior during repressurization because it is possible to repressurize above the saturation temperature of the head region without immediate void collapse.

(2) 1.7 The candidates may base their answer on the slightly positive MTC observed during startup after refueling.

Resp. ACCEPT - The key was modified to accept this answer if the refueling startup assumption was stated.

(3) 2.1 The candidates may make reference to the Emergency Diesel starting and the sequencing on of safeguards loads.

Resp. REJECT - The question clearly states that NO AC power is available.

The candidates may note that pneumatic valves will go to their accident (fail) positions as air pressure drops.

Resp. The specific response of the pneumatic valves is beyond the scope of the question and was treated as a neutral issue.

(4) 2.4 The specific numbers from the curve are 1388 psi for HPSI and 188 psi for LPSI.

Resp. ACCEPT - Key modified.

(5) 2.6 The Gas Stripper is generally not functional and should not be part of the required flow path.

Resp. ACCEPT - Key modified.

The candidates may indicate the following flow path: Evaporator Distillate - Monitor Tanks - Overboard Evaporator Bottoms - Concentrate Tanks - Drums.

Resp. REJECT - This flow path is not the one described in the system description for liquid releases.

Candidates may substitute relief valve CH-208 for RC pump seal leakage.

Resp. ACCEPT - Key modified

(6) 2.7 Flow path should be changed to read: Vent fans (VA-3A/3B/7C/7D) - Plenum - containment atmosphere

Resp. ACCEPT - Key modified

(7) 2.8 The candidates may indicate that the diesel minimum run time is 7 days because the fuel oil transfer pumps have automatic start capability.

Resp. A review of T.S. 2.7 and 3.7 indicate that the operability of the diesel generator is not dependent on the auotmatic function of the fuel oil transfer pumps, relying rather on the 5 hr minimum time afforded by the day tank to allow for operator action. The key was modified to accept 7 days as full credit ONLY if the automatic function of the FOTP was stated as an assumption.

(8) 3.1 The Iodine monitor actually monitors the the plant stack rather than the containment ventilation discharge duct.

Resp. ACCEPT - Key modified

The condensate return monitor monitors liquid flow.

Resp. ACCEPT - Key modified

The candidates may list monitors by number rather than by name.

Resp. ACCEPT - Key modified to indicate number designators.

(9) 3.4 The proportional counters were replaced with wide range fission chambers during the latest refueling outage.

Resp. ACCEPT - Key modified

(10) 3.7 The temperature error signal to the Steam Dump and Bypass system should be T_{avg} - $T_{no\ load}$ (532°F) vice T_{avg} - T_{ref}.

Resp. ACCEPT - Key modified

(11) 3.12 The trip setpoint of the Thermal Margin / Low Pressure trip is variable with the minimum value being 1750 psia. A trip may initiate above the minimum setpoint.

Resp. The setpoint value of the TM/LP trip is not required for a full credit answer and was not considered in the grading.

(12) 4.5 The functional name of the "B-10 Cutout Switch" was changed to the "Extended Range Cutout Switch" when the proportional counters were replaced with wide range fission chambers. Additionally, the operation or nonoperation of this switch as a part of the immediate actions is less significant than the other actions required and should be weighted less when grading.

Resp. ACCEPT - Key modified and point value redistributed.

B. Exit Meeting Summary

At the conclusion of the examination period, the examiner met with representatives of the plant staff to discuss the results of the examinations. The following personnel were present for the exit interviews:

NRC	UTILITY
S. McCrory	G. Gates
L. Yandell, SRI	J. Gass
	F. Swihel
	L. Kirsch
	A. Richard

During the oral examinations some generic weaknesses were observed. The discussion of these generic areas is summarized below.

1. All of the candidates demonstrated significantly below average understanding of both reactor and thermodynamic theory. They were frequently unable to recognize or discuss various theoretical concepts when approached in other than the standard manner of a stylized class room presentation.

2. All of the candidates demonstrated a tendency to "stop short" when reviewing both procedures and Technical Specifications to determine a course of action to handle a particular plant condition. This resulted in failure to find the appropriate procedural guidance to deal with an emergency condition or led to an inadequate or improper interpretation of T.S. concerning continuation of plant operation.

3. All of the candidates were unable to properly interpret the control room indications of the DC electrical buses to assess the status of the batteries.

4. Most of the candidates were not familiar with the anticipated indications observable in the control room when drawing a bubble in the pressurizer. Most stated that the first indication of bubble formation was a drop in indicated pressurizer level rather than a leveling off of pressurizer pressure. They did not realize that level detectors are well down from the top of the pressurizer.

The examiner reported that there were no clear passes of the oral examinations and that final evaluation would be made after a thorough review in the region office.

C. Generic Comments

During the grading of the exams, areas of generic weakness are identified based on the responses of the candidates to individual questions. The following generic weaknesses were identified as a result of the grading of the FCS exams.

1. All of the candidates did not realize that the change in Beta effective over core life has no effect on the stable negative period after a reactor trip. (1.2b)

2. The candidates were not able to demonstrate a clear understanding of the behavior of vessel head voids in the natural circulation condition. (1.3)

3. Most of the candidates did not demonstrate an understanding of how to use the plant data curves to calculate RCS temperature changes resulting from reactivity changes while at power. (1.9)

4. Most of the candidates demonstrated a lack of understanding of the operation of the battery chargers and their relation to the batteries and normal DC bus loading. (2.5)

5. All of the candidates appeared to be "locked in" on a single flow path for rad waste disposal/release. The term "release" implies admittance to the environment, whereas drumming indicates preparation for transfer or storage. (2.6b)

6. None of the candidates were able to describe a proper flow path for containment recirculation ventilation in the accident mode. Most did not even identify a significant number of the components in the flow path. (2.7)

7. None of the candidates were able to satisfactorily identify the CVCS components effected by Engineered Safeguard Actuation Signals when provided with a simplified drawing of the CVCS. (3.8)

8. None of the candidates were familiar with the OP 10 immediate actions for alarms indicating abnormal conditions in the RCS and safety related systems. (4.3)

9. Most of the candidates did not know the definition of a "spray cycle" nor the conditions which require that one be recorded. (4.10)

FCS EXAMINATION REPORT

These areas and the overall performance on both the written and oral examinations prompted a review of FCS examination performance for the past year. Table 1 summarizes examination performance from August '83 through June '84.

Table 1

LICENSING EXAMINATION PERFORMANCE SUMMARY

FORT CALHOUN STATION

EXAM DATE	SRO	pass	fail	%pass	RO	pass	fail	%pass
8/2-4/83	6	2	4	33	0			
11/30/83-12/1/83	6	3	3	50	1	1	0	100
6/6-7/84	0				3	0	3	0

From August 1983 through June 1984, a total of sixteen (16) examinations have been taken by FCS candidates. Only six (6) passes were achieved for an average pass ratio of 37.5%.

Twelve (12) of the sixteen (16) were initial examinations. Four (4) of these twelve (12) passed for an initial pass ratio of 33.3%.

Four (4) of the sixteen (16) were retakes from prior examinations up thorugh August 1983. Three (3) of these four (4) failed on the successive attempt for a pass ratio of 25%.

Eight (8) of the ten (10) failures failed the written examination and two (2) of these also failed oral examinations. The other two (2), one of whom was a retake, failed the oral examination only.

This information leads NRC to conclude that serious problems may exist in the FCS training program. NRC requests that the FCS training program be closely evaluated by licensee staff personnel to identify the principle factors contributing to the poor examination performance over the past year and that written response be provided to NRC within 60 days of receipt of this report. The response should identify the causes of poor examination performance and detail the proposed corrective action. The FCS training and requalification programs will be further evaluated by the NRC during the examination period of the week of November 4, 1984.

FCS EXAMINATION REPORT

D. FCS Examination Key

Date Administered: 6/5/84

Exam Type: Reactor Operator

Comments: Question 3.2 was deleted from the examination as being not applicable. The point value of the question was equally distributed among the remaining questions in category 3 by applying the factor 1.12 (28÷25) to the total points earned in the category. The relative weighting of the categories remained unchanged.

The following editorial or content changes were made during the administration of the written examination:

1. In question 2.4, the word "injection" was changed to "injecting".

2. In question 4.9, item 3 (Automatic Sequential Rod Control) was deleted.

FCS EXAMINATION KEY

1.1 If the temperature in the reference leg of one channel of pressurizer level indication increased, what would happen to indicated level for that channel? EXPLAIN

Answer:

The indicated level would increase because the density of the water in the reference leg decreases. This causes the differiential pressure across the level detector to decrease causing indicated level to read higher.

Reference: Std Thermo, FCS Sys Description I-4 (design)

Question value is 1 pt, 0.25 for "increase" and 0.75 for explanation.

FCS EXAMINATION KEY

1.2 A. Explain the change in B_{eff} over core life.

B. Explain how this change affects the "after trip" negative stable reactor period.

Answer:

A. B_{eff} decreases over core life as a result of the build up of Plutonium.

B. The stable period observed after a trip is unaffected by the change in B_{eff} because it is entirely dependent on the delayed neutron half live which is constant over core life.

Reference: CE Rx Theory, Std Rx Theory

Question value is 2 pts, 1pt for each part.

FCS EXAMINATION KEY

1.3 Explain why a steam void in the vessel head does not immediately collapse when the RCS is rapidly repressurized in the natural circulation condition.

Answer:

The steam void exists at saturation conditions prior to repressurization. As system pressure increases the void is compressed which reduces the surface area contact at the steam-water interface. In order for the steam to condense it must give up the latent heat of vaoprization. Since the heat transfer surface area has decreases the steam void is unable to transfer sufficient heat to condense and becomes superheated. Additionally, the head temperature remains high due to poor cooling mechanisms available in natural circualtion.

Reference: Std Thermo Theory and accident test analysis

Question value is 1.5 pts, 0.5 pt for compression discussion, 0.5 pt for inadequate heat transfer, and 0.5 pt general discussion.

FCS EXAMINATION KEY

1.4 The relative worth of a CEA is dependent on the neutron flux reaching it. List and explain four (4) factors or conditions which affect the flux reaching a particular CEA.

Answer: (any 4)

1. Temperature-- Neutrons travel longer distance at higher temperature, therefore, higher probability of capture.

2. Boron concentration-- As concentration goes up fewer neutrons reach the rods.

3. Fission product poisons-- as poision concentration increases fewer neutrons reach the rods.

4. Rod shadowing-- when adjacent rods are inserted, the existing rod sees a lower flux.

5. Radial position-- rods near the center of the core see higher flux than peripheral rods.

6. Axial position-- the farther a rod is inserted into the core the greater the flux it is exposed to.

Reference: Std reactor theory and core characteristics

Question value is 3 pts, 0.25 for factor/condition, and 0.5 for explanation

FCS EXAMINATION KEY

1.5 Answer TRUE or FALSE for each of the following:

A. Equilibrium Samarium is flux dependent.
B. It takes approximately 100 hours to reach equilibrium Xe from the Xe free condition.
C. It takes approximately 40 hours to reach equilibrium Xe following a transient.
D. Xenon is flux independent.
E. It takes 30-40 days to reach equilibrium Sm.

Answer:

A. FALSE
B. FALSE
C. TRUE
D. FALSE
E. TRUE

Reference: Std Rx Theory

Question value is 2 pts, 0.4 ea.

FCS EXAMINATION KEY

1.6 A. Figure 1.6 is a typical critical heat flux curve. Label each of the areas I-IV as to the heat transfer mechanism or boiling regime. Identify point A on the curve,

B. If the plant is initially operating at the conditions of point X and pressure is increased such that ALL boiling is suppressed, how and why will the DNBR change?

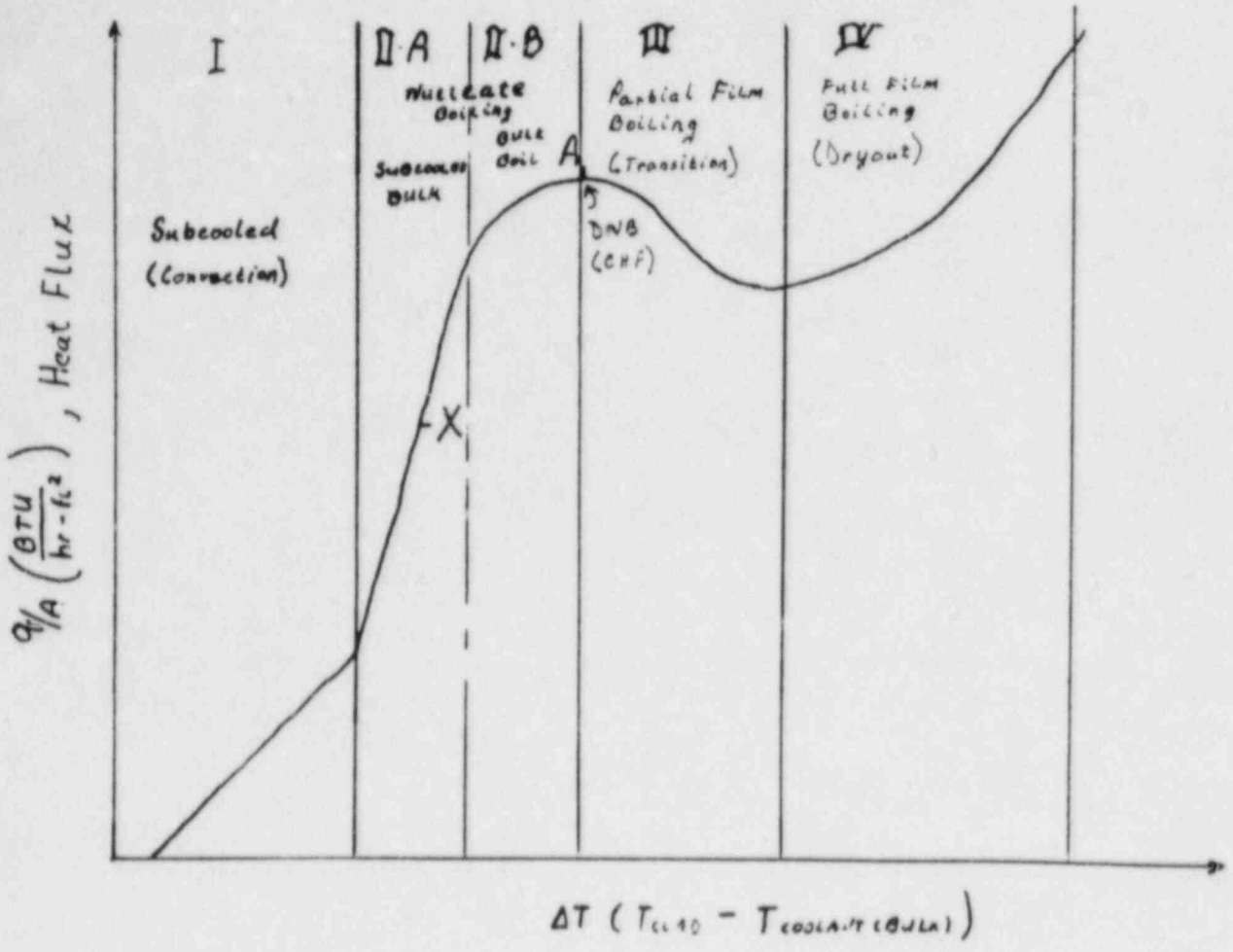
Answer:

A. I--subcooled (convection)
II-A--nucleate surface boiling, subcooled bulk
II-B--nucleate surface boiling, bulk boiling
III--partial film boiling (transition)
IV--full film boiling (dryout)
Point A--DNB (CHF)

B. The DNBR increases because the CHF limit was increased by raising system pressure. Actual heat flux remains unchanged. DNBR=CHF/AHF

Reference: Std heat transfer theory

Question value is 2.5 pts, part A. 0.3 ea, part B. 0.3pt for increase and 0.2pt ea for CHF and AHF.



Typical Departure from Nucleate Boiling Curve

Figure 1.6

FCS EXAMINATION KEY

1.7 During a reactor startup, will the actual critical position be HIGHER, LOWER, or the SAME AS the estimated critical position calculated before the following changes? EXPLAIN your choices. (Consider each change separately).

A. The operator starts using main steam to warm the turbine prior to reaching criticality.

B. Actual boron concentration was 30 ppm higher than the value used for figuring the ECP.

C. Startup was delayed 4 hours beyond the ECP time; a shutdown time of sixteen (16) hours was used for the ECP.

D. The pressurizer pressure setpoints are all lowered by 50 psi prior to criticality.

Answer:

A. LOWER - because the lowering of temperature will insert positive reactivity. (Will accept SAME if RCP heating is identified as being sufficient to over come heat loss for turbine warmup.) OR
HIGHER - MTC for startup following refueling is slightly positive. (Must state BOL assumption for full credit)

B. HIGHER - because the higher boron concentration inserts negative reactivity.

C. LOWER - bescause Xe decay will insert positive reactivity.

D. HIGHER - because lowering the pressure inserts negative reactivity. (Will SAME if the change is considered insignificant but recognized.)

Reference: CE Rx theory

Question value is 3 pts, 0.25 for HIGHER/LOWER, and 0.5 for explanation.

FCS EXAMINATION KEY

1.8 Figure 1.8 A-D represent the flow-head characteristics of a fluid system containing a centrifugal pump. For parts A through D below draw the new flow-head curves on figures 1.8 A-D respectively.

A. Power supply to the pump motor goes from 60 HZ to 63 HZ.
B. A venturi type flow detector is installed in downstream piping.
C. A second identical pump is installed in parallel with the existing pump.
D. A second identical pump is installed in series and the system is acid cleaned.

Answer: See figure 1.8 Key

Reference: Std centrifugal pump laws
CAMERON Hydraulic Data, Ingersall-Rand 1977, sect 1.

Question value is 2.5 pts, see key figure for point breakdown.

FCS EXAMINATION KEY

1.9 The plant is at 100% power, ARO, rod control in manual and the core age is 5000 MWD/T. With NO operator action, explain the effect of increasing the boron concentration by 10 ppm. Indicate the final plant parameters of temperature, pressure, and power. What is the final boron concentration (asssume ideal core)? (Use the cycle 8 data provided) Show all work for full credit.

Answer:

The net effect will be to decrease temperature. The final values of pressure and power will be the same as in the begining

From figure II.A.4 the incremental boron worth is 92.7ppm/1% the reactivity inserted = -10ppm/92.7ppm/1% = -0.108%=-0.00108

From figure II.C.4 the MTC =-1.62×10^{-4}/deg F= -0.000162/deg F

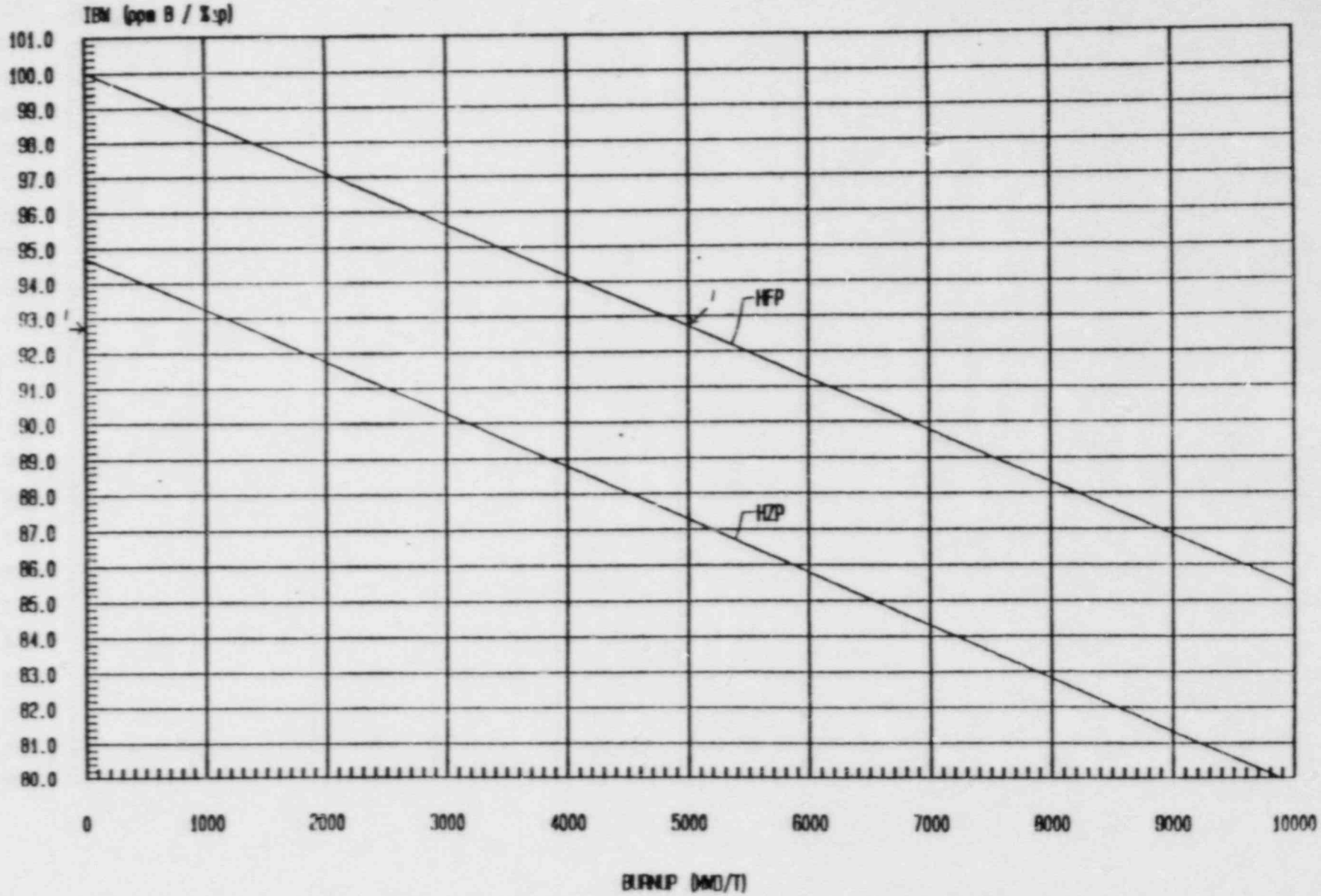
The change in temperature = -0.00108/-0.000162/deg F = 6.7°F
T_{avg} goes from 568 to 561.3

From figure II.A.1.b the initial boron concentration was about 390 ppm so that the final concentration is about 400 ppm (accept 400-410 ppm).

Reference: FCS TDB cycle 8 data, Std Rx theory

Question value is 3 pts, 0.4 ea for final temp, press, power, and boron; 0.35 ea for values (4) taken from figures or calculated.

CYCLE 8 INVERSE BORON WORTH VS. BURNUP

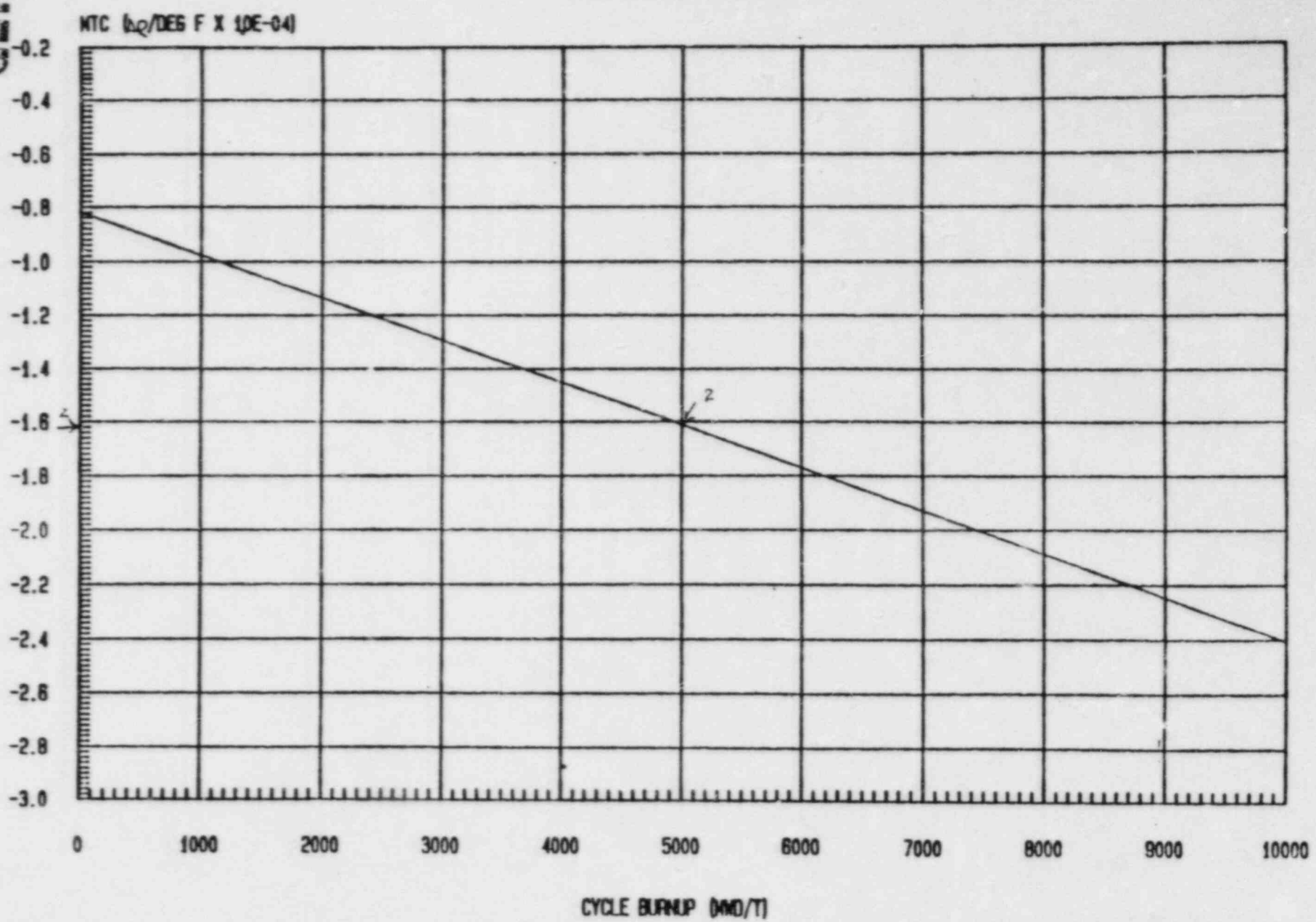


R8 3-30-83

II.A.4

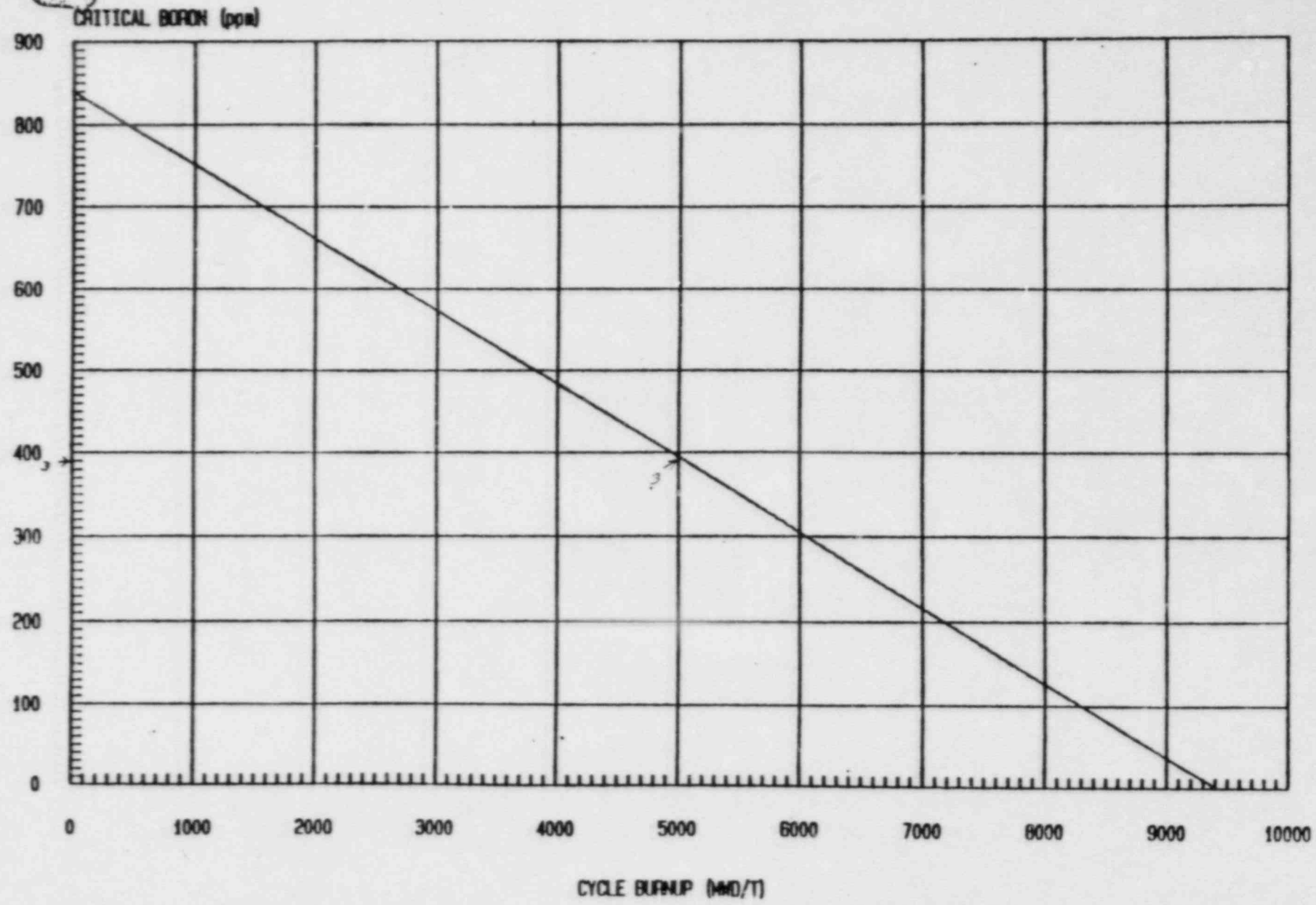
MOD. TEMP. COEFFICIENT VS. BURNUP

CYCLE 8 (ARO, HFP, EQ. XE)



CRITICAL BORON CONCENTRATION VS. BURNUP

CYCLE 8 (ARO, HFP, EQ. XE)



R10 3-30-83

II.A.1.b

FCS EXAMINATION KEY

1.10 While operating, an operator should be concerned about condensate depression .

A. Explain its effect on plant efficiency.

B. Explain its effect on the NPSH availible to the condensate pumps.

C. Explain the effects of changing condenser vacuum on condensate depression.

Answer:

A. As condensate depression increases it lowers plantefficiency because the heat removed has to be replaced by the reactor with no usable work out (or vice versa).

B. Decreasing condensate depression decreases the NPSH availible to the condensate pumps (or vice versa).

C. Increasing condenser vacuum decreases condensate depression (or vice versa).

Reference: Std Thermo Theory

Question value is 1.5 pts, 0.5 per part.

FCS EXAMINATION KEY

2.1 What plant system(s) is designed to assure core cooling during a loss of all electrical AC power? Explain your answer.

Answer:

AFW. DC required to start TDAFWP which then operates on SG steam and pneumatic valves (which fail to their accident positions).

Note: Operation of the diesel generators is not given credit since the question indicated that ALL AC power is lost.

Reference: FCS Sys Description III-4

Question value is 1.5 pts, 0.5 for system, and 0.25 pt ea for underlined items (4).

FCS EXAMINATION KEY

2.2 When and why is condensate sprayed into low pressure turbine exhaust areas of the main turbi e?

Answer:

On high temperature to prevent excessive thermal stresses on final stage blading.

Reference: FCS Sys Description III-1

Question value is 1.5 pts, 0.5 per underlined item.

FCS EXAMINATION KEY

2.3 Regarding the Shutdown Cooling System (SCS):

A. Describe how the shutdown cooling passes through the core during normal SCS operation.

B. What are the four (4) KEY system conditions (may be primary, SCS, or support) that must be met before normal shutdown cooling can be initiated?

Answer:

A. Shutdown cooling during normal operation is delivered (to the cold leg nozzles)(down the annulus,)(through the core,) and return to the SCS (from exit lines on the hot leg) of the reactor.

B. RCS pressure 265 psia
RCS temperature 300°F
CCW available and within temperature limits
At least one LPSI pump available.

Reference: FCS Sys Description I-8

Question value is 2 pts, part A. 1 pt, 0.25 per (), part B. 1 pt at 0.25 ea.

FCS EXAMINATION KEY

2.4 What is the maximum RCS pressure at which the Safety Injection System will inject water into the primary system? At what pressure are all subsystems injecting water?

Answer:
highest 1388 psig
all 188 psia

Reference: FCS Sys Description I-9

Question value is 1 pt, 0.5 ea.

FCS EXAMINATION KEY

2.5 What potential problem(s) may arise on a DC bus whose battery is disconnected during normal operation?

Answer:

The battery chargers need a reference voltage, usually provided by the battery, to maintain a steady bus voltage. If the battery is lost, the battery charger will maintain constant voltage only as long as the bus load does not change. If the bus load increases, the voltage will drop off and become unstable. Additionally, the battery chargers are only rated at a maximum capacity of 200 amps and would be unable to handle large load demands/transients placed on the bus.

Reference: FCS Sys Description II-1 pg 20

Question value is 2 pts, 0.5 per sentence. The underlined parts of the sentence are the key concepts.

FCS EXAMINATION KEY

2.6 A. List five (5) of six (6) systems which drain to the Reactor Coolant Drain Tank.

B. Describe the flow path of liquid from the RCDT which will ultimately be released as liquid waste. Assume full processing (except evaporation) is required.

Answer:

A. (any 5)
1. pressurizer quench tank drains
2. reactor coolant loop drains
3. CEDM leakage
4. safety injection system leakage
5. reactor coolant pump seal leakage (CH-208)
6. refueling pool drains

B. RCDT -- Waste Holdup tank -- treatment inlet header -- waste filters -- monitor tank -- (recirculate through ion exchangers) -- overboard header -- condenser circ water discharge.

Note: Describing the flow path through the drumming facility is not a credible part of the answer since this deals with solid waste and the question specifically addressed liquid waste release.

Reference: FCS Sys Description I-15.

Question value is 3.5 pts, part A. 0.25 ea, part B. 0.5 for flow path arrangement/sequence, 0.29 for each component (exclude RCDT and IX).

FCS EXAMINATION KEY

2.7 Describe the flow path of the containment air recirculation system (filtered) while operating in the accident mode. Briefly describe the main function of EACH component in the flow path.

Answer:

(containment atmosphere) -- (inlet face dampers) -- (baffle type) moisture separators -- (media type) mist eliminators -- HEPA filters -- charcoal filters -- cooling coils -- vent fans -- plenum -- (containment atmosphere)

Moisture separators -- first stage of moisture removal to protect the HEPA filters from damage and blockage ("blinding")

Mist eliminators -- second stage of moisture removal (for same reason)

HEPA filters -- high efficiency mechanical (particle) filters which help prevent clogging of the charcoal filters

Charcoal filters -- remove gases particularly radioactive iodine

Cooling coils -- condense moisture (post accident) to reduce contaiment pressure and cool air to maintain favorable environment for proper equipment operation and to allow containment entry.

Vent fans -- pull air through the filter and cooling train

Plenum -- provides a common discharge for the vent fans to enhance mixing of containment atmosphere.

Reference: FCS Sys Description I-17

Question value is 4 pts, 0.8 pt for flow path, 0.22 ea for components in flow path except () (8 items), 0.2 ea for function (8 items).

FCS EXAMINATION KEY

2.8 What is the minimum design operating time for each of the following components during a limiting design base accident without operator intervention?

A. SIRWT
B. Diesel Generator
C. Battery (1800 amp rate)
D. Emergency Feedwater Storage Tank

Answer:

A. 24 min (all pumps injecting) (FSAR)
B. 5 hr (T.S. 2.7) OR 7 days IF auto operation of the FO transfer pumps is stated.
C. 8 hr (S.D. II-2)
D. 8 hr (T.S. 2.5 basis)

References as indicated

Question value is 2 pts, 0.5 ea.

FCS EXAMINATION KEY

2.9 List the two occurrences which result in inadequate cooling by the Spent Fuel Pool Cooling System (SFPC) and explain what can be done to maintain SFP temperature within Technical Specification limits if cooling by the SFPC is inadequate.

Answer:

1. SFPC failure (any of the following may be counted as sytem failure: valve failure, piping rupture, pump faliure, or excessive heat exchanger leakage)

2. full core offload

Crosstie to SCS hx to increase cooling (not during normal plant ops)

Reference: FCS Sys Description I-13

Question value is 1.5 pts, 0.5 ea.

FCS EXAMINATION KEY

2.10 Explain why the deborating ion exchangers are installed in the Chemical and Volume Control System.

Answer:

At end of core life, boron concentration is reduced by using the ion exchangers to reduce the large volume of waste that would be generated by normal dilution since the normal critical boron concentration is very low.

Reference: FCS Sys Description I-5

Question value is 1.5 pts, critical elements are remove B at EOL, low B concentration, and reduce waste at 0.5 ea.

FCS EXAMINATION KEY

2.11 List three (3) systems/components which discharge into the vent header of the waste gas system. (DO NOT include components of the waste gas system itself.)

Answer: (any 3)

1. quench tank
2. reactor coolant drain tank
3. VCT
4. neutralization tank (not used)
5. waste holdup tanks
6. spent resin storage tank
7. aux building sump tank
8. waste evaporator
9. gas stripper

(The gas decay tanks and automatic gas analyser are part of the waste gas system.)

Reference: FCS Sys Description I-16

Question value is 1.5 pts, 0.5 ea.

FCS EXAMINATION KEY

3.1 List all the automatic control functions generated by the process radiation monitoring system. Include the type of radioactivity (particulate, gaseous, et.), the system monitoried, and the intended system responses to the control signal(valves ___ and ___ open/close, VIAS etc). For signals which generate an engineered safeguards actuation signal, it is necessary only to indicate the type of ESAS.

Answer:

system	activity form	control fcn
1. Containment Vent discharge duct (RMs 61, 62)	particulate/gaseous	initiate VIAS
2. Steam Generator blowdown mon (RMs 54A, 54B)	liquid	shuts blowdown isolation valves (HCV-1387A,B & HCV-1388A,B)
3. Containment stack (RMs 50, 51, 60)	gaseous/part iodine	initiate VIAS
4. Condenser off gas (RM 57)	gaseous	secure turbine extract steam to aux steam sys
5. Waste disposal (RM 55)	liquid	close RDWS liquid effluent overboard control valve
6. Waste disposal aux steam cond return (RM 59)	liquid (2 phase)	close RCV-059

Reference: FCS Sys Description II-9

Question value 3 pts, 0.5 per numbered response or about 0.15 per individual response.

FCS EXAMINATION KEY

3.2 Describe the operation of the Reactor Regulating System for automatic rod control. Include input siganls, intermediate signals, and output control signals.

Answer:

System input: turbine first stage pressure, Tavg, nuclear power and pressurizer pressure. The turbine first stage pressure is converted to a proportional power signal and a Tref signal. The Tref signal is compared to Tave to generate an error signal (temperature mismatch). The turbine power signal is compared to the nuclear power signal to generate a power mismatch (rate) compensating signal. Pressurizer pressure is compared to the pressure setpoint to generate a pressure (rate) compensating signal. These three signals are summed to produce a rod raise/lower signal.

Reference: FCS Sys Description II-4

Question value 3 pts, ten underlined responses at 0.3 ea

NOTE: THIS QUESTION WAS EVALUATED AS NOT APPLICABE DURING THE EXAM REVIEW AND WAS DELETED FROM THE EXAM.

FCS EXAMINATION KEY

3.3 List eight (8) functions of the CONDENSATE system.

Answer:

1. Deliver condensate to the suction of the feed pumps.
2. Increase and decrease water inventories in the feed and condensate systems.
3. Provide (and regulate) cooling water to:
   a. hydrogen coolers
   b. condensate cooler
   c. generator stator coolers
4. Provide makeup water to the emergency (aux) feedwater storage tank.
5. Provide water to the feed pump shaft seals during startup.
6. Collect heater drain tank pump discharge.
7. Provide turbine exhaust hood spraywater.
8. Deaerate condensate.
9. Provide cooling water to the steam packing exhauster.
10. Provide condensate pump seal water (fill, lube,& cool).
11. Act as a surge volume (condensers) to accomodate inventory changes due to plant load changes.
12. Provide means for chemical addition.

Reference: FCS Sys Description III-3

Question value is 2 pts, 0.25 per response. 3.a,b,c each count as separate responses for a total of 14 possible responses.

FCS EXAMINATION KEY

3.4 A. List the three (3) different channels of excore nuclear instrumentation.

B. For each channel, list the type of detectors, and the indicating range.

C. For each channel, list the protective, permissive, and control signals generated. (Setpoints are NOT required).

Answer:

A. Channel	B. Detector	Range	C. Signals
Wide rng log	Fission	10^{-8}--125%	Rate of pwr chg inhibit/trip
Pwr rng safty	UIC	0--200%	Rate trip block APD trip on Loss load trip Hi flux trip
Pwr rng cntrl	UIC	0--200%	Rx Reg (no longer used)

Reference: FCS Sys Description II-6

Question value is 3, part A. 0.3 ea (3 responses), part B. 0.15 ea (7 responses), part C. 0.175 ea (6 responses).

FCS EXAMINATION KEY

3.5 What are two (2) means of detecting reactor coolant leakage into the component cooling water system?

Answer:

1. Increase in surge tank level
2. High radiation on the pump discharge rad monitor.

Reference: FCS Sys Description I-7

Question value is 1 pt, 0.5 ea.

FCS EXAMINATION KEY

3.6 What signals are necessary to auto initiate containment spray? Include parameter setpoints and channel coincidence logic.

Answer:

Pressurizer pressure low 1600 psia 2/4 AND containment pressure high 5 psia 2/4.

Reference: FCS OP-5, Sys Description II-7

Question value is 1 pt, 0.5 per part

FCS EXAMINATION KEY

3.7 Describe the design response of the Steam Dump and Bypass Control system to each of the following events. Include control parameter setpoint values.

A. Turbine trip from 100% power.
B. Ten percent load rejection while at 30% power.
C. Turbine trip from 18% power.

Answer:

A. The dump and bypass valves will all quick open in less than3 seconds since the T_{avg}-$T_{no\ load}$ (532) error is greater than 30°F. When the temperature error is less than 29°F the valves will begin to modulate in the normal manner. The bypass valve will respond to the larger of the temperature or pressure error signals. As temperature error reaches 3°F the dump valves will shut while the bypass valve may remain open to establish no load SG pressure of 900 $\pm$ 5 psia.

B. Because SG pressure is near no load value below 35%, sufficient pressure error signal may be generated to open the bypass valve briefly to reduce pressure to 900 $\pm$ 5psia.

C. The bypass valve may open due to the pressure error signal but the dump valves will not open unless the temperature error reaches 8°F. Then they will open at the normal rate and close again when the temperature error is 3°F.

Reference:FCS Sys Description III-2, SAR sec 7, fig 7.4-6.

Question value is 3.5 pts, part A. 1.5 pts, part B. 1pt, part C. 1pt

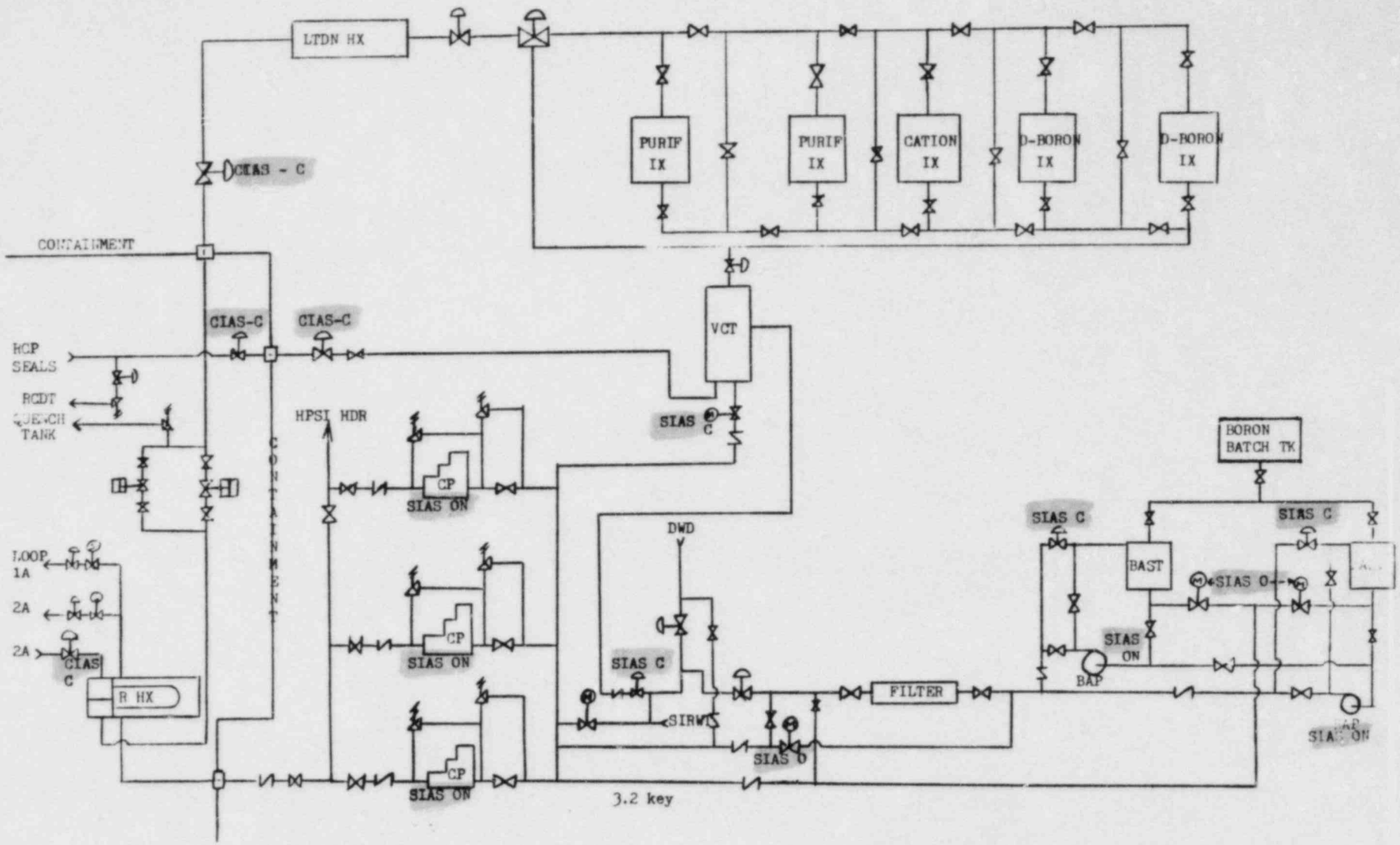
FCS EXAMINATION KEY

3.8 Figure 3.2 is a simplified drawing of the CVCS. On figure 3.2 indicate all components which receive Engineered Safeguard Actuation Signals . For each component, indicate the type of ESAS (CSAS, VIAS, etc.) and the final condition of the component (open-closed, on-off).

Answer: See drawing 3.2

Reference: FCS P&IDs E-23866-210-120,121 Sys Description II-7

Question value is 4 pts, 0.25 each item (16 items).


LTDN HX
PURIF IX
PURIF IX
CATION IX
D-BORON IX
D-BORON IX
CIAS - C
CONTAINMENT
CIAS-C
CIAS-C
VCT
RCP SEALS
RCDT QUENCH TANK
HPSI HDR
SIAS C
CP
SIAS ON
CP
SIAS ON
CP
SIAS ON
DWD
SIAS C
SIRW
SIAS O
FILTER
BORON BATCH TK
SIAS C
SIAS C
BAST
SIAS O
SIAS ON
BAP
SIAS ON
LOOP 1A
2A
2A
CIAS C
R HX
CONTAINMENT
3.2 key

FCS EXAMINATION KEY

3.9 Match each of the Enginered Safeguards Control System actuation signals with the monitored parameters which may initiate it:

1. Safety Injection Actuation Signal (SIAS)
2. Containment Isolation Actuation Signal (CIAS)
3. Containment Spray Actuation Signal (CSAS)
4. Ventilation Isolation Actuation Signal (VIAS)
5. Main Steam Isolation Signal (MSIS)
6. Recirculation Actuation Signal (RAS)

A. Hi Containment Radiation
B. SIRW Tank Level Lo
C. Hi Containment Pressure
D. Lo Pressurizer Pressure
E. Lo Steam Generator Pressure

Note: Parameters may be used more than once and Actuation Signals may respond to more than one parameter.

Answer:

1. C,D
2. C,D
3. C,D
4. A,C,D
5. E,C
6. B,C,D

OR

A. 4
B. 6
C. 1-6
D. 1-4, 6
E. 5

Reference: FCS Sys Description II-7

Question vlaue is 2 pts, 0.14 ea (14 responses).

FCS EXAMINATION KEY

3.10 List ten (10) signals to the turbine E.H.C. which will cause a turbine trip by de-energizing the master trip solenoid valve (setpoints not required)

Answer: (any 10)

1. overspeed
2. backup overspeed
3. low vacuum
4. excessive thrust brg wear
5. low brg oil pressure
6. high exhaust hood temp.
7. loss of stator cooling
8. main lube oil pump press. low
9. loss of both speed signals
10. high rotor vibration
11. high moisture separator level
12. low emergency trip system pressure
13. low hydraulic system pressure
14. loss of 24 VDC power supplies
15. loss of 125 VDC bus
16. reactor trip
17. generator field bkr trip
18. MSIVs shut

Reference: FCS Sys Description III-1

Question value is 2 pts, 0.2 ea.

FCS EXAMINATION KEY

3.11 List three (3) of the four (4) types of fire detectors used by the Fire Protection System, the basic property each is designed to respond to, and a typical area in which each would be employed.

Answer

PYR-A-LARM/Flame:	infrared flame	RCP chambers
Ionization:	combustion gases	vent ducting
Thermal:	hi temp or rate	turb oil tnk transformers
Photoelectric:	smoke	DG room

Reference: FCS Sys Description III-16

Question value is 1.5, 0.16 ea, 9 items required.

FCS EXAMINATION KEY

3.12 Describe the RCS response to the selected pressurizer pressure control channel failing high. Describe the event up to new steady state conditions or initiation of a reactor protective function whichever comes first. (Assume NO operator action)

Answer:

All (heaters will de-energize) and (the spray valves will go full open). Sprays will stay open and actual (pressure will decrease) until a (thermal margin/low pressure trip is initiated) at 1750 psia by the safety pressure channels.

Reference: FCS Sys Description I-4

Question value is 2 pts, 0.5 per ( ) area.

FCS EXAMINATION KEY

4.1 Which of the following are addressed by Technical Specifications? Write YES if the item is covered by Technical Specifications and NO if the item is not covered by Technical Specifications.

1. Steam Generator Level
2. Auxiliary Building Crane
3. Secondary Chemistry
4. Raw Water Pumps
5. Turbine Generator Throttle Valves
6. Pressurizer Quench Tank
7. Boric Acid Transfer Pumps
8. House Service Transformer
9. Reactor Coolant Drain Tank
10. Missouri River Level

Answer/Reference:

1. Yes (2.1.1)
2. Yes (2.11)
3. No
4. Yes (2.4)
5. No
6. No
7. Yes (2.2)
8. Yes (2.7)
9. No
10. Yes (2.16)

Reference: FCS Technical Specifications

Question value is 2.5, 0.25 ea.

FCS EXAMINATION KEY

4.2 Answer TRUE or FALSE for each of the following:

1. House Service Transformers TIA-3 and TIA-4 (4.16 kV) may both be inoperable for up to one week provided the operability of both diesel generators is demonstrated immediately, and the NRC is notified immediately and a report is submitted to the NRC as in Section 5.6 with an outline of the plans for restoration of off-site power.

2. One of the four a-c instrument buses may be inoperable for 8 hours provided the reactor protective and engineered safeguards systems instrument channels supplied by the remaining three busses are all operable.

3. Both unit auxiliary power transformers TIA-1 and TIA-2 (4.16 kV) may be inoperable for up to 24 hours provided the operability of both diesel generators is demonstrated immediately.

4. Each of the diesel generators may be inoperable for up to seven days during any month, provided the other diesed is started to verify operability, shutdown, and controls are left in the automatic mode and there are no inoperable engineered safeguards components associated with the operable diesel generator.

5. Either one of the DC Distribution Panels AI-41A and AI-41B may be inoperable for up to 24 hours.

Answers:

1. False
2. True
3. True
4. False
5. False

Reference: FCS Tech Spec 2.7

Question value is 2 pts, 0.4 ea.

FCS EXAMINATION KEY

4.3 List the specific immediate response required for EACH of the below listed annunciator alarms. Consider each alarm separately. (Plant is at full power)

1. CC Water from Coil VA-8B No Flow
2. Volume Control Tank Temp. Hi
3. Pressurizer Spray Valve PCV-103-1 Seal Failure
4. Quench Tank Temp. Hi
5. Reactor Coolant Pump RC-3A Vibration Hi
6. Reactor Regulating System Loop 1 and 2 T_{avg} Deviation
7. Low Flow Reactor Coolant Pre-Trip
8. Nuclear Instrument Channel Inoperative

Answer:

1 A. Check AC surge tank for loss of level.
B. If tank level has decreased substantially, close HCV-403B&D and HCV-403E&F. (Re-establish surge tank level.)
C. Check containment sump for increased level.

2. Make sure TCV-211-1 is closed and TCV-211-2 is in bypass (of Demin)

3. Select the other spray valve for control.

4. A. Check for level increase.
B. Check safety valves that relieve to the tank for leakers.

5. Enter containment to verify the alarm.

6. A. Check for dropped CEA.

7. A. Check flows on alternate channels on the same loop.
B. Terminate power increases.

8. A. Check high voltage light on N.I. panel lit.
B. If the safety channel failed go to 2/3 trip logic.
C. If control channel fails, trend ASI since power ratio recorder is lost.

Reference: FCS OP-10

Question value is 5 pts, 0.35 pt per number/lettered response (14 total).

FCS EXAMINATION KEY

4.4 After a reactor trip, pressurizer pressure and level and RCS temperature continue to decrease. List three (3) verifications or plant conditions to be checked and the conditional responses which may be necessary for each. (Example: Verify charging flow. If flow is less than 20 gpm, start the standby charging pump.)

Answer: (any 3)

1. Verify that both main feedwater regualting valves have "ramped" to 5% flow.
   If this has not occurred automatically, take manual control of the FWRVs and close as required.
   If valves do not respond to manual control, secure main feedwater pumps and/or close FWRV block valves HCV-1103 and 1104 (and reference EP-6).

2. Verify the steam dump and bypass system is controlling T_{avg} and steam generator pressure at the no load condition.
   If T_{avg} and steam pressure are dropping below their no load values, take manual control and attempt to close the dump and/or bypass valves.
   If this is not successful in terminating uncontrolled heat extraction, shut MSIVs (and reference EP-6).
   If T_{avg} and steam pressure have not been reduced to their no load values automatically, take manual control of the bypass and/or dump valves and open as required.
   If this is not possible, open the atmospheric dump valve (HCV-1040) as required.

3. Verify that pressurizer relief valves are seated, and RC-141/PCV-102-1 and/or RC-142/PCV-102-2 alarms are not actuated.
   Monitor pressurizer quench tank pressure, level and temperature and relief header temperatures.

4. If RCS pressure is below 2300 psia and the power operated relief valve(s) is not seated, attempt to close the PORV. Use the motor operated isolation valve if necessary.

5 If RCS pressure is below 2500 psia and the code safety(s) has not seated, borate for cold shutdown and initiate a controlled plant cooldown if the inventory loss is within the capability of the charging system.

Reference: FCS EP-1 pg 3

Question value is 3 pts, 1 pt ea. Divide equally over the number of subparts.

FCS EXAMINATION KEY

4.5 What immediate response(s) is required if, during reactor startup, criticality is achieved below the ECP-1.0% DELTA K/K position prior to continuing critical operations ?

Answer:

1. Make the reactor subcritical. (Drive rods in or borate)
2. Turn Extented Range cutout switches to "off".
3. Consult the Reactor Engineer (or his designated rep).
4. Verify boron concentration, time and T_{avg}.
5. Recalulate the ECP.

Reference: FCS OP-7 pg 6

Question value is 2 pts, 0.45 ea for items 1, 3-5, and 0.2 pt for item 2.

FCS EXAMINATION KEY

4.6 List four (4) ways that radioactive contaminants may enter the body and become an INTERNAL radiological health hazzard.

Answer: (any 4)

1. Inhalation (breathing in)
2. Oral ingestion (swallowing)
3. Open wounds or skin abrasions
4. Through the skin pores
5. Skin absorption (cellular osmosis)
   (Will accept "through the skin" as a single correct answer)

Reference: Std Rad Con Inforamation

Question value is 2 pts, 0.5 ea.

FCS EXAMINATION KEY

4.7 A. What are the normal administrative (daily, weekly, quarterly, and yearly) whole body radiation exposure limits at FCS?

B. List two (2) persons (by title or job function) who may authorize exceeding specified whole body exposure limits for radiation work permits.

Answer:

A.

Daily	100 mRem
Weekly	300 mRem
Quarterly	1250 mRem
Yearly	5000 mRem

B. Plant Manager
Supervisor-Chem and Rad Protection

Reference: FCS Rad Protection Man. pg VII-2-4

Question value is 3 pts, part A. 2 pts at 0.5 ea and part B. 1 pt at 0.5 ea.

FCS EXAMINATION KEY

4.8 A. List six (6) direct ALARMS that would immediately indicate a loss of Component Cooling Water. (DO NOT list temperature alarms from systems or components serviced by CCW. These are secondary symptoms. Redundant components will be counted as one.)

B. If CCW cannot be restored within ____(fill in time), what are your actions?

Answer: (any 6)

A. 1. CCW pump disch press lo
2. CCW disch header lo flow
3. CCW surge tank level hi-lo
4. CCW Pump trip
5. AC/RW interface valve secondary solenoid off normal
6. CCW from (containment air cooler) coils no flow
7. HPSI pump bearing cooler no flow
8. LPSI pump bearing cooler no flow
9. Spray pump bearing cooler no flow
10. CCW from (SIT) leakage cooler lo flow
11. CCW pump AC-3A/B/C standby start

B. 5 minutes
1. Manually trip reactor and verify shutdown
2. Ensure turbine tripped and all stop and intercept valves shut
3. Ensure generator breaker tripped
4. Stop all RCPs

Reference: FCS EP-8, OP-10 and Sys Description I-7

Question value is 4 pts, part A. 2 pts at 0.33 ea, and part B. 2 pts at 0.4 ea.

FCS EXAMINATION KEY

4.9 Arrange the list of items below in the order of occurence (initaite, reset, block, etc.) during a STARTUP from cold shutdown to hot full power. For EACH item indiacte the contolling parameter value/setpoint.

1. Zero Power Mode Bypass
2. Loss of load Bypass
3. Automatic Sequential Rod Control (deleted during the exam)
4. Steam Generator Low Pressure Trip Bypass
5. High Rate of Power Change Bypass
6. PPLS Block
7. APD Bypass
8. Wide Rang Log Channel Hi Volts Off

Answer:

1. (6) PPLS - pressurizer pressure 1700 psia
2. (4) Steam generator low pressure trip bypass - reset SG press 550 psia
3. (8) Wide range log channel hi volts off - SR indication 10^3 cps
4. (1) Zero power mode bypass - reset 10^{-4}% reactor power
5. (5) High rate of power change bypass - reset 10^{-4}% reactor power
6. (2) Loss of load bypass - reset 15% reactor power
7. (7) APD bypass - reset 15% reactor power

Note: Item pairs 4-5 and 6-7 may be reversed. (5-4 and 7-6)

Reference: FCS OPs 2,3, &7, OI-RC-3, and Sys Description II-4,5,6,&7

Question value is 3 pts, 1 pt for arrangement, 0.28 per parameter setpoint/value.

FCS EXAMINATION KEY

4.10 A. What is the definition of a "spray cycle" when discussing pressurizer operation?
B. What conditions require that a spray cycle be recorded?

Answer:

A. A "spray cycle" is the opening and closing of a spray valve (either main or auxiliary).
B. If a spray cycle occurs or is performed when the temperature difference between the pressurizer and the spray water is greater than 200°F, it must be recorded.

Reference: FCS OI-RC-7 pg 5

Question value is 1.5 pts , 0.75 per part.