

FCS EXAMINATION REPORT
Number: 50-285/OL-85-04

Docket No: 50-285

License No.: DPR-40

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

Examinations administered at Fort Calhoun Station

Chief Examiner:

S. L. McCrory
S. L. McCrory, Examiner

7/15/85
Date

Approved by:

R. A. Cooley
R. A. Cooley, Section Chief

7/16/85
Date

Summary

Examinations conducted on June 18, 1985.

Written and oral examinations were administered to two (2) Senior Reactor Operators and four (4) Reactor Operators. All candidates passed these examinations.

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PDR ADOCK 05000285
Q PDR

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Report Details

1. Examination Results

SRO Candidates

Total	Pass	Fail	%
2	2	0	100

RO Candidates

Total	Pass	Fail	%
4	4	0	100

2. Examiners

S.L. McCrory, Chief Examiner, NRC
J. Whittemore, 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. FCS Examination Key (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:

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NRC

S.L. McCrory
J. Whittemore

UTILITY

J. Fluehr
G. Pelnar
L.T. Kusek
F. Swihel

COMMENTS

- (1) 1.10C. Peak Xenon is reached approximately eight hours after a trip from 100% power. Therefore, the answer key should show a higher critical rod position at eight hours than at four hours.
Resp. **ACCEPT.** Key modified.
- (2) 1.11 Full credit should be given if the candidate states that discharge valves are throttled to prevent centrifugal pump runout. Runout implies high starting and running motor currents. Therefore, the current should not have to be mentioned to obtain full credit on this question.
Resp. This comment was submitted without supporting evidence. However, it was considered during the grading.
- (3) 2.2/
6.2 HVAC is also used to maintain the controlled area of the auxiliary building at a negative pressure and to reduce containment pressure following a loss of coolant accident. Both of these functions assist in controlling the release of radioactivity to the environment. We believe that these responses are both unique answers and should be added to the list in your answer key.
Resp. **ACCEPT.** Key modified.
- (4) 2.9 An additional fluid system cross connect is that between the plant air system and the instrument air system near the water plant.
Resp. **ACCEPT.** Key modified.
- (5) 3.9 Radioactive liquid waste effluent is monitored by both RM-055A and 055. Radiation monitors RM-050 and 051 may be used to monitor either the containment atmosphere or the ventilation discharge stack. These monitors are normally used for containment.
Resp. **ACCEPT.** Key modified.

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- (6) 3.11 Automatic turbine runback is no longer in use at Fort Calhoun Station. An additional acceptable answer to Item 4 should be "low steam generator pressure".
Resp. **ACCEPT.** Turbine runback was deleted from the list of required answers and the point value was redistributed over the remaining 9 items. Low SG pressure was accepted as an alternate to Item 4.
- (7) 4.1/ 7.1 This question asks the candidate the contents of Revision 20 to OP-4 issued on March 28, 1985. Candidates were trained on this revision of the procedure. However, it would be very difficult for them to recall the nature of that revision based only on the information provided in the question.
Resp. Based on the lack of direction or focus of the question wording, it was decided that this question would not be allowed to adversely influence a marginal grade such that a candidate would fail the category or the examination.
- (8) 7.11 This question consisted of several detailed Technical Specifications in which words or numbers were changed. The candidate was then asked to respond true or false to each. Operators are not expected to memorize Technical Specifications in minute detail. This question does not really test the type of Technical Specification knowledge an operator would be required to demonstrate while on the job.
Resp. NRC does not agree that detailed memorization is required to satisfactorily address this type of question. It is reasonable to expect that properly trained operators will be required to use the Technical Specifications for both actual and hypothetical situations often enough to become readily familiar with many of the more frequently encountered operational areas such as electrical distribution and electrical sources.
- (9) 8.7A Review of the jumper log is neither the responsibility of the Reactor Operator or the Shift Supervisor. Therefore, questions on this subject may be beyond the scope of a Senior Reactor Operator's license exam.
Resp. The Shift Supervisor has primary responsibility to ensure the proper use of the jumper logs and is required to review their status frequently. However

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he has neither the time or the ability to "validate" these logs. This is the primary objective of the monthly and prestartup reviews. Therefore, for the Shift Supervisor to have confidence in the validity of such dynamic documents as the jumper logs, he should be aware of the other review requirements.

B. Exit Meeting Summary

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

NRC

S. McCrory
J. Whittemore

UTILITY

J. Fluehr
F. Swihel
W. G. Gates
L. T. Kusek
J. Gass

Some areas of concern arose during the oral examinations which affected the operators' ability to respond competently to some routine and abnormal conditions.

- (1) The use of OP-10, Abnormal Condition Procedures, was unclear to both the candidates and the examiners. All of the candidates examined in this area (at least three of six) stated that while they were not required to memorize the immediate actions in OP-10, they were expected to take action on abnormal conditions (annunciators) without first referring to OP-10. Some felt that the use of OP-10 was almost entirely optional. During the exit, allusion was made that OP-10 was treated as a reference document which provided guidance if the operator chose to refer to it. A review of FCS Technical Specification 5.8, Reg Guide 1.33, and Standing Order G-7 established the requirements to have specific procedures addressing abnormal and alarm conditions and for strict compliance with such procedures. NRC is concerned about Fort Calhoun's treatment of this issue.
- (2) Candidates had difficulty finding specific procedures for response to instrument failures. Most of this guidance is found in OP-10 since almost all instrument failures will

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result in an alarm. However, because of the treatment of OP-10 as indicated in (1) above, the candidates responded marginally in this area.

- (3) While using an approved procedure to walk through a switch line-up on the 120 VAC instrument buses, it was discovered that the breaker identification numbers in the procedure did not match the ones on the control room reference diagrams. The examiner was told that the schematics used by maintenance and surveillance personnel had the correct number identifications. Failure to use a consistent number identification system on all documents which refer to the same component can lead to confusion and possibly an unsafe condition.
- (4) A transient scenario was structured such that the candidates were forced to cooldown the plant by natural circulation and conditions proceeded in such a way that a void formed in the vessel head. They were then told that the conditions which had caused the loss of the Reactor Coolant Pumps were corrected and that the pumps were available for restart. None of the candidates (four of six were asked) could find procedural guidance on the initial conditions to be established prior to starting a RCP with a void in the vessel head. In most cases, the candidates were unable to use their system and theoretical knowledge to identify the conditions needed to safely start a RCP with the vessel head voided. At the exit, it was confirmed that this type of guidance did not exist.

NRC requests that the licensee respond specifically to item B. (1) above to clarify the facility policy on the use of OP-10 and the expected response of the operators to individual alarms not a part of an overall emergency condition as identified in the emergency procedures. Please submit this response within 60 days of the date of this report.

Items (2) through (4) are provided as feedback on potential problem areas seen by the examiners and may be used at the discretion of the licensee.

C. Generic Comments

There were no significant weaknesses identified during the grading of the written examinations. Candidate performance on the written examination was substantially improved over the previous set of examinations.

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D. FCS EXAMINATION KEY

Date Administered: 6/18/85

Exam Type: Senior Reactor Operator and Reactor Operator

U.S. NUCLEAR REGULATORY COMMISSION
SENIOR REACTOR OPERATOR LICENSE EXAMINATION

Facility: Fort Calhoun Station

Reactor Type: CE-PWR

Date Administered: 6/18/85

Examiner: S.L. McCrory

Candidate: _____

INSTRUCTIONS TO CANDIDATE:

Use separate paper for the answers. Write answers on one side only. Staple question sheets on top of answer sheets. Points for each question are indicated in parentheses after the question. The passing grade requires at least 70% in each category and a final grade of at least 80%. Examination papers will be picked up six (6) hours after the examination starts.

<u>Category Value</u>	<u>% of Total</u>	<u>Candidate's Score</u>	<u>% of Category Value</u>	<u>Category</u>
_____	_____	_____	_____	5. Theory of Nuclear Power Plant Operations, Fluids, and Thermodynamics
_____	_____	_____	_____	6. Plant Systems Design, Control and Instrumentation
_____	_____	_____	_____	7. Procedures - Normal, Abnormal, Emergency, and Radiological Control
_____	_____	_____	_____	8. Administrative Procedures Conditions, and Limitations
_____	_____	_____	_____	TOTALS
Final Grade			_____ %	

All work done on this examination is my own. I have neither given nor received aid.

Candidate's Signature

FCS EXAMINATION KEY

5. THEORY OF NUCLEAR POWER PLANT OPERATIONS, FLUIDS, AND THERMODYNAMICS

- 5.1 The pressurizer is cooled down from normal operating temperature while maintaining saturation conditions and a constant actual level. If no adjustments are made to the level indication circuitry, how and why will indicated level vary as the pressurizer is cooled down. (1.5)

ANS:

The indicated level will go up. The indication is normally density compensated for normal operating temperature. Therefore, as the pressurizer is cooled the density of the water increases but the compensating signal is set for a lower density. As a result, the increased d/p in the level detector is converted to increased level.

REF:

FCS TDB III.1.a and SD I-4-39,41

KEY:

FLUID PZR IND DET

Question value is 1.5 pts, 0.5 for change in level indication change and 1 pt for explanation.

FCS EXAMINATION KEY

5.2 Calculate the time required for reactor vessel bulk water temperature to reach 212°F if the conditions below exist simultaneously. STATE ALL ASSUMPTIONS AND SHOW ALL WORK FOR FULL CREDIT. (3.0)

- A. The reactor has been shutdown for 100 hours after a 250 day run at 100% power.
- B. All means of removing heat from the vessel are lost.
- C. No circulation to the primary loops occurs.
- D. Reactor vessel water is initially at 112°F and well mixed.
- E. The reactor vessel head is de-tensioned but still sealed.

ANS:

ASSUMPTIONS:

- a. Vessel water volume = 2956 cu. ft. (+ 10%) (0.5)
- b. Decay heat load = 0.1 - 0.5% of rated thermal power (0.5)
- c. Rated thermal power = 1500 MW (0.5)
- d. Water density = 59.8 - 61.8 lbm/cu. ft. (0.25)
- e. 57,000 Btu/min = 1 MW (0.25)
- f. 1 Btu will raise 1 lbm water 1 degree F. (0.25)

SOLUTION:

- g. water mass = $a \times d = 159,092 - 200,949$ lbm (0.1)
- h. heat load = $c \times b \times e = 85,500 - 427,500$ Btu/min (0.1)
- i. heat required = $g \times f \times (\Delta T = 100) = 15,909,200 - 20,094,900$ Btu (0.1)
- j. time required = $i/h = 3.7 - 23.5$ min (0.45)

REF:

FCS SD-I-4, Rev 4 and TS pg 4, STD HT XFER

KEY:

COREOPS HTTRANS IPR

Question value is 3 pts broken down as indicated.

FCS EXAMINATION KEY

- 5.3 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. (3.0)

ANS: (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 poison 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.

REF:

Std reactor theory and core characteristics

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

FCS EXAMINATION KEY

- 5.4 A. What parameters are directly manipulated by the operator to control cooldown in natural circulation? (1.0)
- B. Describe and explain the major differences you would observe in the establishment of natural circulation in the following two (2) plant conditions:
1. Reactor trip caused by tripping all four (4) reactor coolant pumps simultaneously. (1.0)
 2. Reactor trip with reactor coolant pumps running for one (1) hour after the trip. Then all reactor coolant pumps are lost and no longer available for restart. (1.0)

ANS:

- A. Cooldown during natural circulation is controlled by the steam generator feed and steam rate. (As steam and feed flow is increased the rate of cooldown is increased.)
- B. 1. Decay heat represents 5%-7% of full power immediately following a reactor trip. With no flow, a large ΔT will exist across the core. This large thermal driving head will cause rapid development of natural circulation flow and a relatively high flow rate.
2. After one hour following a trip, decay heat represents 1%-3% of full power. Thus, the thermal driving head is relatively small which will prolong the time it takes to establish natural circulation flow and the final flow rate will be relatively small.

REF:

Basic Thermo

Question value is 3 pts, 1 pt for part A, and 1 pt each for parts 1 and 2 in B.

FCS EXAMINATION KEY

- 5.5 Briefly explain why you agree or disagree with the following statement. (1.5)

A 10° heatup with a +.3 delta K/K MTC will cause power to change as much, but in the opposite direction, as a 10° cooldown with a -.3 delta K/K MTC with initial power at 50%.

ANS:

Disagree. Power will increase in both cases, but will not increase as much during heatup because Doppler effects will aid in turning power.

REF:

STD CE CORE CHAR.

Question value is 1.5 pts, 0.5 for disagree, and 1 pt for explanation.

FCS EXAMINATION KEY

- 5.6 Reactor power increases by a factor of 10 in 110 seconds. What was the reactor period for this increase? Show calculations. (1.0)

- A. 10.9 sec
- B. 36.4 sec
- C. 47.8 sec
- D. 100 sec

ANS:

C

$$P_1/P_0 = 10 = e^{t/T} = e^{110/T}$$

$$\ln 10 = \ln e^{110/T}$$

$$2.302 = 110/T$$

$$T = 110/2.302 = 47.8$$

REF:

STD RX TH

Question value is 1 pt, 0.5 for C and 0.5 for correct formulation.

FCS EXAMINATION KEY

5.7 Beta is the fraction of all neutrons released by fission which are delayed: (2.0)

- A. When comparing the individual Betas for thermal fission of U₂₃₅, PU₂₃₉, and fast fission of U₂₃₈, which is largest?
- B. From BOL to EOL, does the average delayed neutron fraction INCREASE, DECREASE, or REMAIN THE SAME? Explain.
- C. Why is Beta_{eff} less than Beta?
- D. For equivalent positive reactivity additions to a critical reactor, will the SUR be larger or smaller at EOL compared to BOL?

ANS:

- A. U₂₃₈
- B. Decreases - Concentration of U₂₃₅ goes down while the concentration of PU₂₃₉ goes up.
- C. Decrease in thermal leakage is outweighed by the decrease in the fast fission factor. (The importance factor is LT 1)
- D. Larger.

REF:

STD CE CORE CHAR

Question value is 2 pts, 0.3 each for A and D, 0.7 each for B and C.

FCS EXAMINATION KEY

5.8 Answer TRUE or FALSE for each of the following: (2.0)

- 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.

ANS:

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

REF:

Std Rx Theory

Question value is 2 pts, 0.4 ea.

FCS EXAMINATION KEY

5.9 How does the departure from nucleate boiling ratio (DNBR) change (INCREASE, DECREASE, or REMAIN THE SAME) for each of the following events or conditions? The answer should consider only initial plant response prior to automatic action. Briefly explain each answer.

- A. Ejected CEA (1.0)
- B. Main Steam line break (1.0)
- C. Loss of coolant accident (1.0)
- D. Loss of cooling water to letdown heat exchanger (1.0)

ANS:

- A. Decrease - local power goes up
- B. Increase - overcooling lowers temperature
- C. Decrease - depressurization / reduced flow
- D. No effect - no change until letdown isolation on high temp.

REF:

Basic Thermo

Question value is 4 pts, 1 pt each (0.5 pt each for trend and explanation).

FCS EXAMINATION KEY

5.10 If after operating in natural circulation for 2 hours, an operator error causes a complete loss of natural circulation flow, how will the following parameters change (INCREASE, DECREASE, or REMAIN THE SAME)? Briefly explain your answer. (Assume no further operator action.) (3.0)

- A. Core Delta T
- B. Core thermocouple temperature
- C. Steam Generator Pressure

ANS:

- A. Increase as T_h goes up due to boiling in the core.
- B. Increase due to boiling in the core (and loss of heat removal).
- C. Decrease due to loss of heat transfer through the Steam Generators.

REF:

Basic Thermo and Heat Transfer

Question value is 3 pts 0.4 for change and 0.6 for explanation.

FCS EXAMINATION KEY

5.11 Explain the importance of delayed neutrons in light water reactor technology. (1.0)

ANS: They greatly extend average neutron generation time and allow stable control by increasing the reactor period.

REF: Nuclear Reactor Theory, Lamarsh, pg 420-21

Question value is 1 pt.

END OF CATEGORY 5

FCS EXAMINATION KEY

6. PLANT SYSTEMS DESIGN, CONTROL AND INSTRUMENTATION

- 6.1 Standing Order 0-30 lists 12 items which are considered safety related equipment for testing purposes. List eight of them. Duplicate or redundant components count as one item. (2.0)

ANS: (ANY 8)

1. LPSI pump(s)
2. HPSI pump(s)
3. Safety injection and Shutdown Cooling System valves, interlocks, or piping
4. Raw Water Pump(s)
5. CCW pump(s)
6. Containment Air Cooling and Filtering Unit(s)
7. Containment Air Cooling Unit(s)
8. Containment Spray pump(s)
9. Containment Cooling System valves, interlocks, or piping
10. Aux Feedwater pump(s)
11. Diesel Generator(s) and associated switchgear
12. Fire Pumps.

KEY WORD:
SURV

REF: FCS SO A-0-30, pg 1, Rev 3

Question value is 2 pts, 0.25 each.

FCS EXAMINATION KEY

6.2 What are four (4) ways that the Heating, Ventilating and Air Conditioning system helps control the spread or release of radioactivity? (4.0)

ANS: (ANY 4)

1. Ensuring that air flow inside the building is from areas of lower activity to areas of higher activity.
2. Providing sufficient air flow to ensure that legal radioactivity limits are met at points where ventilating air leaves the building.
3. Reducing possible radioactivity release to the atmosphere through HEPA filters.
4. Providing charcoal filtration of effluent air from the safety injection pump rooms, spent regenerant tank room, TSC, and spent fuel area to entrap Iodine.
5. Providing for remote isolation of rooms where larger releases of radioactivity may occur.
6. Maintains a negative pressure on the containment and aux buildings.
7. Limits pressure in containment by condensing moisture on a LOCA or steam leak.

KEY WORD

HVAC DESGN

REF:

FCS SD-I-6, pg 1, Rev 6

Question value is 4 pts, 1 pt each.

FCS EXAMINATION KEY

6.3 On figure ____ indicate the position or condition of each component shown for NORMAL mode of operation. (3.0)

ANS:

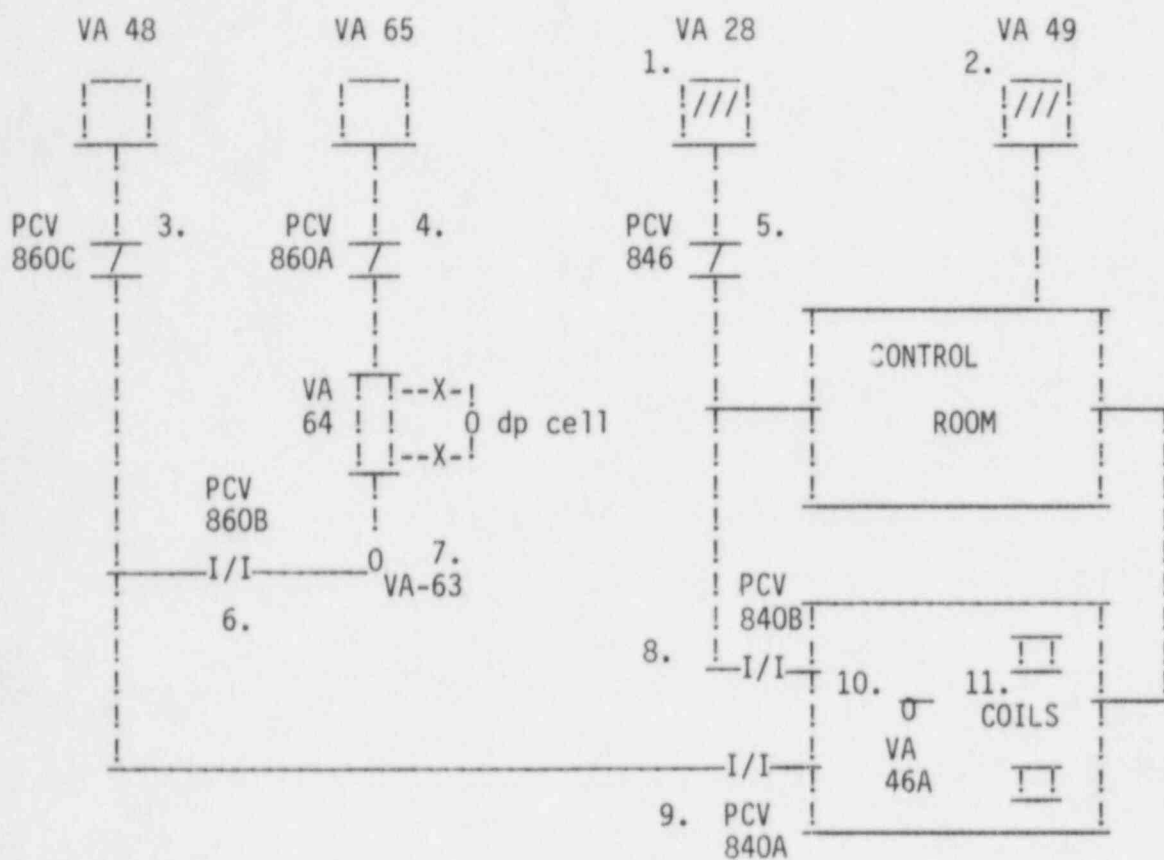
SEE FIGURE COMPONENT	_____	NORMAL	FILTERED MAKEUP	RECIRCULATION
VA 28		OFF	OFF	OFF
VA 49		ON	OFF	OFF
PCV 860C		OPEN	SHUT	SHUT
PCV 860A		SHUT	OPEN	SHUT
PCV 846		SHUT	SHUT	SHUT
PCV 860B		SHUT	OPEN	SHUT
VA 63		OFF	ON	OFF
PCV 840B		OPEN	OPEN	OPEN
PCV 840A		THROTTLED	THROTTLED	SHUT
VA 46A		ON	ON	ON
COILS		AUTO	AUTO	AUTO

KEY WORD:
HVAC PATH

REF: FCS SD-I-6 pgs 7-10, Rev 6

Question value is 3 pts, 0.27 each.

FCS EXAMINATION KEY



/// = fan

O or _O = blower

I/I or T = damper valve

FIGURE 2. _

FCS EXAMINATION KEY

6.4 What provides the backup to the Shutdown Cooling system if both
LPSI pumps fail? (1.0)

ANS: The containment spray pumps.

KEY WORD:
RHR AOP PUMP

REF: FCS SD-I-8, pg 2, Rev 1.

Question value is 1 pt.

FCS EXAMINATION KEY

- 6.5 A. How is the CCW surge tank protected against over pressure if the pressure control valve malfunctions? Where is the effluent collected in this case? (2.0)
- B. If the CCW system is to be drained for maintenance and is radioactively clean, what processing of the effluent is required prior to release into the Missouri River? (1.0)

ANS:

- A. The tank is protected by a relief valve (set at 50 psig). The effluent is collected in the radioactive waste disposal system.
- B. The effluent must be run through a Dechromating ion exchanger (to reduce the chromate concentration to LT 0.05 PPM).

KEY WORD

CCW AOP TANK VALVE IX

REF:

FCS SD-I-7, pgs 6, 7, Rev 3

Question value is 3 pts, 1 pt each.

FCS EXAMINATION KEY

6.6 List five (5) of the nine (9) interlocks which must be satisfied to operate the main disconnect switch, DS-T1, electrically. (2.5)

ANS: (ANY 5)

1. Key interlock switch satisfied (local operation only, Key in custody of Shift Supervisor)
2. 345K breakers 4 and 5 OPEN in Substation 3451.
3. Main Steam Stop Valves 1-4 SHUT.
4. 22 KV Bus - De-energized.
5. Generator field breaker - OPEN
6. 4.16 KV Breakers 1A11, 13, 22, 24 - OPEN (Kirk Key interlocks with breakers need not be operated for this operation).
7. Bus Cooling Unit - OFF
8. Operating Motor overload - CLOSED
9. 69 Permissive satisfied. (This switch operated by the MANUAL - ELECTRIC selector handle on the operator. The 69 Permissive is satisfied when the operator is lined for electrical operation.)

KEY WORD:

ELEDST NOP BKR

REF:

FCS SD-II-1, pgs 13 and 14, Rev 3

Question value is 2.5 pts, 0.5 each.

FCS EXAMINATION KEY

6.7 List three events/conditions which will cause the turbine auxiliary feed pump "trouble" alarm. (1.5)

ANS:

1. Turbine trip on high back pressure
2. DC auxiliary lube oil pump trip on overload
3. Loss of DC power

KEY WORD:

AFW IND

REF:

FCS SD-III-4, pg 11, Rev 5

Question value is 1.5 pts, 0.5 each.

FCS EXAMINATION KEY

- 6.8 Briefly describe the difference in how the discharge flow rate of the motor driven and turbine driven auxiliary feed pumps is controlled. (2.0)

ANS:

The motor driven aux feed pump is run at constant speed and the system backpressure regulates the discharge flow rate. Discharge flow control valves affect backpressure to control flow.

The turbine driven aux feed pump has a variable speed controller which senses both feed and steam header pressures to maintain the discharge of the turbine pump 40 psi above steam header pressure.

KEY WORD:,

AFW PUMP CNTRL

REF:

FCS SD-III-4, pgs 19 & 20, Rev 5

Question value is 2 pts, 1 pt each.

FCS EXAMINATION KEY

6.9 What conditions will cause one or more Raw Water Pumps to start automatically? (2.0)

ANS:

1. If the running pump trips, the pumps on the opposite bus will start in standby.
2. All four pumps will start when sequencing is actuated by:
PPLS
CPHS
SIAS

KEY WORD:

SWS PUMP CNTRL

REF:

FCS SD-II-1, pg 29, Rev 3, and SD-III-8, pg 9 & 21, Rev 3

Question value is 2 pts, 1 pt each. Give $\frac{1}{2}$ credit if one or more of the ESF signals are given without mentioning the sequencers. If sequencers only, are mentioned, give full credit.

FCS EXAMINATION KEY

6.10 What is the minimum design operating time for each of the following components during a limiting design basis accident without operator intervention? (2.0)

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

ANS:

- A. 24 min (all pumps injecting) (FSAR)
- B. 5 hr (T.S. 2.7) OR 7 days IF auto operation of the F0 transfer pumps is stated.
- C. 8 hr (S.D. II-2)
- D. 8 hr (T.S. 2.5 basis)

REF:

as indicated

Question value is 2 pts, 0.5 ea.

FCS EXAMINATION KEY

- 6.11 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) (2.0)

ANS:

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.

REF:

FCS Sys Description I-4

Question value is 2 pts, 0.5 per underlined area.

END OF CATEGORY 6

FCS EXAMINATION KEY

7. PROCEDURES - NORMAL, ABNORMAL, EMERGENCY,
AND RADIOLOGICAL CONTROL

7.1 Revision 20 to OP-4 (Load Changes, Normal Power Operations) was issued near the end of March 1985. What was the focus of this revision? (1.0)

ANS: Placed increased emphasis on achieving specified chemistry conditions in the Steam Generators prior to exceeding 30% power.

KEY WORD:
NOP JOB

REF: FCS OP-4, pgs 1 & 2, Revs 19 & 20

Question value is 1 pt, 0.5 for SG chemistry and 0.5 for 30% power.

FCS EXAMINATION KEY

7.2 What is the main function of OP-1? (1.0)

ANS:

To provide a master checklist of items that must be completed prior to plant startup and for trip recovery.

KEY WORD:

NOP

REF:

FCS OP-1, pg 1, Rev 21

Question value is 1 pt, 0.33 ea for checklist, startup, and trip recovery.

FCS EXAMINATION KEY

7.3 During plant startup from cold shutdown, the pressurizer temperature is 500°F and indicated level is 43%. Can heaters be energized to increase or maintain pressure without adjusting level? Explain. (2.0)

ANS:

No. The actual level is 39.5% (using figure III.1.a). The minimum level for heater operation is 41.5% which would be 49.5% indicated level at 500°F.

KEY WORD:

NOP IND

REF:

FCS OI-RC-3, pg 3, Rev 26 and TDB Fig. III.1.a, Rev 0

Question value is 2 pts, 0.5 for "No" and 1.5 for explanation.

FCS EXAMINATION KEY

7.4 Steps 5 and 6 of OP-3 read as follows: (1.0)

"5. Terminate 345 KV backfeed line up if required and ensure all four 4160 volt electrical busses are being supplied from the house service (161 KV) transformers."

"6. Reset the EHC and perform turbine chest/shell warming per OI-ST-2."

A footnote states that the sequence of these steps is important. Explain why.

ANS:

If the EHC is reset prior to opening PCB-4 and 5, the unit will "roll off". (Roll off - come off the turning gear and speed up to 1800 RPM)

KEY WORD:

NOP MNGEN

REF:

FCS OP-3, pg 3, Rev 18

Question value is 1 pt.

FCS EXAMINATION KEY

7.5 During plant startup, how is reactor power controlled between 1% and 10% power? (1.0)

ANS: By use of the steam dumps or bypass valves.

KEY WORD:
NOP

REF: FCS OP-3, Rev 18

Question value is 1 pt.

FCS EXAMINATION KEY

7.6 List the immediate actions when Emergency Boration, EP-9, is required. (1.5)

ANS:

1. Close demineralized water makeup control valve (FCV-269X) makeup stop valve (FCV-269).
2. Open boric acid pump discharge valve (HCV-268) and boric acid gravity feed stop valves (HCV-258 and 265).
3. Start boric acid pumps (CH-4A and B).

KEY WORD:

EOP

REF:

FCS EP-9, pg 1, Rev 6

Question value is 1.5 pts, 0.5 ea.

FCS EXAMINATION KEY

- 7.7 List the immediate actions for a fire which threatens or is in reactor safeguards equipment, reactor protective equipment, or other equipment vital to the safe operation of the plant per EP-10. (2.5)

ANS:

1. Validate the fire (by direct observation, if possible).
2. Announce the fire and attempt to extinguish it.
3. If the fire has been reported as threatening or in reactor safeguards equipment, reactor protective equipment, or other equipment vital to the safe operation of the plant; or if the alarm is from an inaccessible area containing safeguards equipment:
 - a. Manually trip the reactor. Ensure that all regulating and shutdown CEA's have been fully inserted and that reactor power is decreasing.
 - b. Ensure turbine has tripped and all stop and intercept valves have closed.
 - c. Ensure generator breakers 4 and 5 have tripped and that the generator field breaker has opened.
4. Immediately call the Blair Fire Dept (9-911). If the fire is in the Aux Building Controlled Area or Containment, the fire dept shall be requested to respond. For all other fires, the fire dept. shall respond only on the Shift Supervisor's request.
5. Notify the Radiation Protection Supervisor and initiate standing order G-28.
6. Take action to clear all electrical equipment indicating ground.

KEY WORD:
EOP

REF:
FCS EP-10, pgs 1, 2, Rev 7

Question value is 2.5 pts, 0.25 ea for 1 and 2 and 0.33 ea for 3.a-c, 4-6.

FCS EXAMINATION KEY

7.8 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. (3.0)

1. Steam Generator Level
2. Raw Water Pumps
3. Turbine Generator Throttle Valves
4. Pressurizer Quench Tank
5. Boric Acid Transfer Pumps
6. Reactor Coolant Drain Tank
7. Battery water usage
8. Control Board ECCS valve position indicator lights
9. History of modifications to plant safety systems
10. Florine ion concentration in the RCS

ANS/REF:

1. YES (2.1.1)
2. YES (2.4)
3. NO
4. NO
5. YES (2.2)
6. NO
7. YES - 3.7(2)b
8. NO
9. YES - 5.10.2.a
10. YES - 2.1.5(2)

REF:

FCS Technical Specifications

Question value is 3 pts, 0.25 ea.

FCS EXAMINATION KEY

- 7.9 List four (4) primary system parameter conditions which are positive indications of natural circulation per EP-5. (4.0)

ANS:

1. Core exit thermocouple temperatures are stable, at least 50° below saturation pressure and to the right of the 100°F/hr pressure vs temperature cooldown curve.
2. Core exit thermocouple and RCS T_h are approximately the same.
3. The core Delta T is less than or equal to 50°F and representative of decay heat power level (ex: dT should be about 20° immediately after trip from 100% power and will decrease as decay heat decreases).
4. T_h and T_c are decreasing (after about the first 10 minutes).
Note: This indication is contained in the caution statement.

REF:

FCS EP-5, pg 3

Question value is 4 pts, 1 pt each.

FCS EXAMINATION KEY

- 7.10 List the seven (7) immediate actions applicable to all classifications of emergencies as stated in the Radiological Emergency Response Plan. (3.5)

ANS:

1. Persons discovering the emergency condition shall immediately notify the control room by the most expeditious means available.
2. On-duty Shift Supervisor shall announce the location and nature of the emergency on the public address system and sound the nuclear alarm for all emergency classifications greater than "NOUE."
3. Control room personnel shall place the plant in a safe condition as the emergency warrants.
4. The shift H.P. shall report to the Shift Supervisor and provide radiological coverage/surveillance as requested.
5. Person(s) in the immediate area shall take appropriate action to limit the extent of the incident with available means, if possible, or retreat to a safe location and await assistance and/or direction. If their assistance is not needed in the immediate area, they will quickly evacuate to the assembly area at the warehouse.
6. Shift Operating Personnel not immediately involved with the emergency will report to the Control Room to receive instructions and make protective equipment available.
7. Persons who have evacuated the plant building and do not have specific emergency duties will assemble outside the security fence near the stores warehouse for personnel monitoring, accountability and further instructions.

KEY WORD:

EPLAN EOP

REF:

FCS RERP pgs B-8,9, Rev 4

Question value is 3.5 pts, 0.5 each. Verbatim response is not required. However, for full credit, the essential parts of each of the 7 actions must be given.

FCS EXAMINATION KEY

7.11 Answer TRUE or FALSE for each of the following: (2.0)

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 diesel 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.

ANS:

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

REF:

FCS Tech Spec 2.7

Question value is 2 pts, 0.4 ea.

FCS EXAMINATION KEY

- 7.12 On figure 7.12, fill in the various wholebody exposure limits for the conditions shown. If a limit does not apply to a particular condition, insert "NA". (2.5)

ANS:

mrem	Shutdown	Operating	Max. Perm
Daily	300	100	NA
Weekly	900	300	NA
Qtrly	2400	1250	3000
Yearly	5000	5000	12000

REF:

FCS Rad Man VII-2

Question value is 2.5 pts, 0.25 each (exclude NA).

END OF CATEGORY 7

FCS EXAMINATION KEY

! mrem	! Shutdown	! Operating	! Max. Perm	!
! Daily	!	!	!	!
! Weekly	!	!	!	!
! Qtrly	!	!	!	!
! Yearly	!	!	!	!

FIGURE 7.12

FCS EXAMINATION KEY

8. ADMINISTRATIVE PROCEDURES, CONDITIONS, AND LIMITATIONS

8.1. Fill in the blanks in the following statements taken from the Emergency Plan Implementing Procedure. The blanks may represent single words or short phrases. (3.5)

- A. If in the judgement of the Shift Supervisor or EDO, a release of radioactivity has occurred for ____ and is expected to ____, a Site Area Emergency should be declared.
- B. If in the judgement of the Shift Supervisor or EDO, the general safety of the ____ could degrade by ____ within the plant, a Site Area Emergency should be declared.
- C. If in the judgement of the Shift Supervisor or EDO, the general safety of the ____ could be reduced by the ____ needed for ____, a Site Area Emergency should be declared.

ANS:

- A. longer than 15 minutes
continue for greater than 1 hour
- B. plant
gross contamination
- C. public
unavailability of plant functions
protection of the public

KEY WORD

EPLAN

REF:

FCS EPIP-OSC-1 pg 1 Rev 6

Question value is 3.5 pts, 0.5 per blank.

FCS EXAMINATION KEY

- 8.2 A phone call is received in the control room from a local residence near FCS. The caller reports that the emergency siren near his house is sounding. You know that there is no emergency and so inform the caller. (2.0)

- A. Who do you now call about the false alarm?
- B. If the required FCS staff personnel cannot be reached within 5 minutes, what are your actions?

ANS:

- A. 1. Appropriate Sheriff's Office
2. Communication Dept.
3. Plant Manager or Duty Supervisor
4. EOF Information Specialist.
- B. Contact radio station KFAB
Tell the purpose of the call and read the prepared statement for notification of false alarm.

KEY WORD:
EPLAN

REF: FCS EPIP-OSC-12, pg 2, Rev 1

Question value is 2 pts, 0.25 each in A. and 0.5 each in B.

FCS EXAMINATION KEY

8.3 According to Standing Order G-28, what is the definition of a "large fire?" (1.5)

ANS:

Any fire that lasts longer than 10 minutes after the initiation of fire fighting efforts and all other fires, including all fires in the containment and auxiliary building controlled area, will be considered a large fire. ("all other fires" is taken to mean those beyond the capacity of one or two men to handle with fire extinguishers.)

KEY WORD:

JOB SECSAF

REF:

FCS SO A-G-28, pg 2, Rev 6

Question value is 1.5 points, 0.5 for each underlined section.

FCS EXAMINATION KEY

- 8.4 During the initial phases of an emergency which may be classified as an Unusual Event or higher, the Shift Supervisor must function as the Emergency Duty Officer (EDO) until relieved by an appropriate designee. While functioning as the EDO, there are several specific responsibilities assigned to the EDO. Seven of these responsibilities cannot be delegated. List four (4) of these seven (7) responsibilities. (1.0)

ANS: (ANY 4)

1. Overall direction and coordination of the Emergency Organization effort.
2. Control information releases.
3. Classifiy the emergency (and review for need of up or down grading).
4. Controls the relation of the on-shift personnel to the Emergency Organization interface.
5. Provides overall control of on-site emergency response facilities.
6. Recommends protective actions to authorities responsible for off-site action.
7. Ensures a timely and complete turnover of all information to the Recovery Manager should the Recovery Organization be activated. (The relief EDO may be substituted for the Recovery Manager for this particular case.)

KEY WORD:
EPLAN

REF: FCS EPIP-OSC-14, pg 1, Rev 3

Question value is 1 pt, 0.25 each.

FCS EXAMINATION KEY

8.5 Fill in the blanks for the statements taken from Standing Order G-10, Technical Specifications. Blanks may represent single words or phrases. (1.5)

- A. The Technical Specifications take priority over any other _____. This will not preclude _____ approved by _____ for use on _____ basis.
- B. All Technical Specification violations must be reported immediately to _____ in accordance with Standing Order R-4.

ANS:

- A. verbal or written procedures
exceptions and changes
NRC
an immediate and interim
- B. Manager-FCS

KEY WORD:

JOB TS

REF:

FCS SO G-10, pg 1, Rev 5

Question value is 1.5 pts, 0.3 each.

FCS EXAMINATION KEY

- 8.6 A. When entries are being made into the containment building, how often must the Personnel Air Lock Doors be leak tested? (1.0)
- B. List two methods of administrative access control into the containment building. (1.0)
- C. Whose approval is required for a containment entry during power operation? (1.5)

ANS:

- A. After each opening or daily, whichever is less frequent.
- B. Control Room Log
Containment Access log
- C. Shift Supervisor and
(any two of the following)
Plant H.P.
C/RP Supervisor
Plant Manager

KEY WORD:

JOB	LOG	CNTMT
-----	-----	-------

REF:

FCS SO A-0-22, pgs 1,2, Rev 6

Question value is 3.5 pts, 0.5 ea.

FCS EXAMINATION KEY

- 8.7 A. How often and by whom must each jumper log be reviewed for other than shift turnover? (2.0)
- B. Normally, a jumper or block should not exist for a period of greater than _____ unless amplifying remarks are made on _____. (Fill in the blanks.) (1.0)

ANS:

- A. Monthly and
Prior to each startup from cold shutdown
by the Supervisor - Instrument and Control and Electrical
Field Maintenance (electrical jumper log) and
the Plant Engineer (mechanical jumper log).
- B. 18 months
Form FC-66 (jumper log)

KEY WORD
LOG

REF: FCS SO A-0-25 pgs 2,3, Rev 16

Question value is 3 pts, 0.5 each.

FCS EXAMINATION KEY

- 8.8 Fill in the blanks. Single words or short phrases may be required. (1.5)

The ____ must be notified if a bypass must be effected on any RPS trip unit. No notification is required, however, if such bypassing is required to ____.

The RPS trip unit bypass keys must be maintained in ____ when not in use to effect an authorized bypass.

ANS:

Plant Supervisor or Operations Supervisor (or designate alternates)
perform a PRC approved procedure
Shift Supervisor's key depository

KEY WORD:

RPS SECSAF

REF:

FCS SO A-0-28, pg 1, Rev 2

Question value is 1.5 pts, 0.5 per blank.

FCS EXAMINATION KEY

- 8.9 List eight of the twelve safety related systems which require an independent verification of normal system configuration after a refueling outage. (2.0)

ANS: (ANY 8)

1. RCS
2. Containment isolation
3. Diesel Generators
4. Aux Feed
5. Containment Spray
6. SI - LPSI & HPSI
7. Engineered Safeguards Controls
8. CVCS
9. Fire Protection
10. Raw Water
11. CCW
12. Waste Disposal

KEY WORD:
JOB TAG

REF: FCS SO A-0-37, pgs 2,3, Rev 4

Question value is 2 pts, 0.25 each.

FCS EXAMINATION KEY

8.10 List and explain the basis for the radioactivity limit(s) on the reactor coolant (per Tech. Specs.). (2.0)

ANS:

LIMITS 1 uCi/gm Dose Equivalent I-131

100/E uCi/gm

Basis Assure 2 hr dose at site boundary well within
10 CFR 100 following a tube rupture with loss of
offsite power.

REF:

FCS TS 2.1.3

Question value is 2 pts, 0.5 each for limits, and 1 pt for basis.

FCS EXAMINATION KEY

8.11 Technical Specification 2.7 (Electrical Systems) allows 4.16 kv engineered safeguards bus 1A3 or 1A4 to be inoperable for up to 8 hours. Under what circumstances is this permitted? (2.0)

ANS:

Provided that the associated DG is demonstrated operable immediately and

There are no engineered safeguards components associated with the operable bus.

REF:

FCS TS 2.7

Question value is 2 pts, 1 pt each

FCS EXAMINATION KEY

8.12 The power range safety channels were adjusted to agree with the latest heat balance calculation at the following times. (1.5)

0100	November 3
0300	November 4
0500	November 5
0700	November 6

Were the power range safety channels OPERABLE through the entire time interval? Justify your answer.

ANS:

NO - They became inoperable at 0700, November 6 due to exceeding the 3.25X basic interval surveillance limit, which is a daily requirement.

REF:

FCS TS (surveillance interval and periodicity)

Question value is 1.5 pts, 0.5 each for NO, 3.25X, and daily.

END OF CATEGORY 8

U.S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

Facility: Fort Calhoun Station

Reactor Type: CE-PWR

Date Administered: 6/18/85

Examiner: S.L. McCrory

Candidate: _____

INSTRUCTIONS TO CANDIDATE:

Use separate paper for the answers. Write answers on one side only. Staple question sheets on top of answer sheets. Points for each question are indicated in parentheses after the question. The passing grade requires at least 70% in each category and a final grade of at least 80%. Examination papers will be picked up six (6) hours after the examination starts.

Category Value	% of Total	Candidate's Score	% of Category Value	Category
_____	_____	_____	_____	1. Principles of Nuclear Power Plant Operation, Thermodynamics, Heat Transfer and Fluid Flow
_____	_____	_____	_____	2. Plant Design Including
_____	_____	_____	_____	3. Instruments and Controls
_____	_____	_____	_____	4. Procedures - Normal, Abnormal, Emergency, and Radiological Control
_____	_____	_____	_____	TOTALS
Final Grade			_____ %	

All work done on this examination is my own. I have neither given nor received aid.

Candidate's Signature

FCS EXAMINATION KEY

1. PRINCIPLES OF NUCLEAR POWER PLANT OPERATION, THERMODYNAMICS, HEAT TRANSFER AND FLUID FLOW

- 1.1 The pressurizer is cooled down from normal operating temperature while maintaining saturation conditions and a constant actual level. If no adjustments are made to the level indication circuitry, how and why will indicated level vary as the pressurizer is cooled down. (1.5)

ANS:

The indicated level will go up. The indication is normally density compensated for normal operating temperature. Therefore, as the pressurizer is cooled the density of the water increases but the compensating signal is set for a lower density. As a result, the increased d/p in the level detector is converted to increased level.

REF:

FCS TDB III.1.a and SD I-4-39,41

KEY:

FLUID PZR IND DET

Question value is 1.5 pts, 0.5 for change in level indication change and 1 pt for explanation.

FCS EXAMINATION KEY

- 1.2 Calculate the time required for reactor vessel bulk water temperature to reach 212°F if the conditions below exist simultaneously. STATE ALL ASSUMPTIONS AND SHOW ALL WORK FOR FULL CREDIT. (3.0)

- A. The reactor has been shutdown for 100 hours after a 250 day run at 100% power.
- B. All means of removing heat from the vessel are lost.
- C. No circulation to the primary loops occurs.
- D. Reactor vessel water is initially at 112°F and well mixed.
- E. The reactor vessel head is de-tensioned but still sealed.

ANS:

ASSUMPTIONS:

- a. Vessel water volume = 2956 cu. ft. (+ 10%) (0.5)
- b. Decay heat load = 0.1 - 0.5% of rated thermal power (0.5)
- c. Rated thermal power = 1500 MW (0.5)
- d. Water density = 59.8 - 61.8 lbm/cu. ft. (0.25)
- e. 57,000 Btu/min = 1 MW (0.25)
- f. 1 Btu will raise 1 lbm water 1 degree F. (0.25)

SOLUTION:

- g. water mass = $a \times d = 159,092 - 200,949$ lbm (0.1)
- h. heat load = $c \times b \times e = 85,500 - 427,500$ Btu/min (0.1)
- i. heat required = $g \times f \times (\Delta T = 100) = 15,909,200 - 20,094,900$ Btu (0.1)
- j. time required = $i/h = 3.7 - 23.5$ min (0.45)

REF:

FCS SD-I-4, Rev 4 and TS pg 4, STD HT XFER

KEY:

COREOPS HTTRANS IPR

Question value is 3 pts broken down as indicated.

FCS EXAMINATION KEY

- 1.3 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. (3.0)

ANS: (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 poison 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.

REF:

Std reactor theory and core characteristics

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

FCS EXAMINATION KEY

- 1.4 A. What parameters are directly manipulated by the operator to control cooldown in natural circulation? (1.0)
- B. Describe and explain the major differences you would observe in the establishment of natural circulation in the following two (2) plant conditions:
1. Reactor trip caused by tripping all four (4) reactor coolant pumps simultaneously. (1.0)
 2. Reactor trip with reactor coolant pumps running for one (1) hour after the trip. Then all reactor coolant pumps are lost and no longer available for restart. (1.0)

ANS:

- A. Cooldown during natural circulation is controlled by the steam generator feed and steam rate. (As steam and feed flow is increased the rate of cooldown is increased.)
- B. 1. Decay heat represents 5%-7% of full power immediately following a reactor trip. With no flow, a large delta T will exist across the core. This large thermal driving head will cause rapid development of natural circulation flow and a relatively high flow rate.
2. After one hour following a trip, decay heat represents 1%-3% of full power. Thus, the thermal driving head is relatively small which will prolong the time it takes to establish natural circulation flow and the final flow rate will be relatively small.

REF:

Basic Thermo

Question value is 3 pts, 1 pt for part A, and 1 pt each for parts 1 and 2 in B.

FCS EXAMINATION KEY

1.5 What happens to the moderator temperature coefficient as boron concentration is increased? **Explain.** (1.0)

ANS: The MTC becomes less negative. (0.25)

As the moderator temperature increases the expansion removes boron from the core. This is a positive reactivity addition because less neutrons are absorbed. This also adds negative reactivity due to less thermalization of neutrons. (.75)

REF: Basic Reactor theory

Question value is 1 pt distributed as indicated.

FCS EXAMINATION KEY

- 1.6 The power history below is graphically shown on figure 1.6. Plot Xenon worth on the same axis. Consider the vertical axis to represent the percentage of full power equilibrium Xenon worth. Assume Xenon free initially. (Show relative magnitude and curve shape - not absolute values) (3.0)

Power level 50% for 50 hrs
Power level 100% for next 40 hrs
Trip - power level 0% for next 8 hrs
Power level 100% for next 52 hrs
Power level 50% for next 50 hrs.

ANS: See next page

REF: Standard Reactor Theory

Question value is 3 pts, 0.3 per numbered point.

FCS EXAMINATION KEY

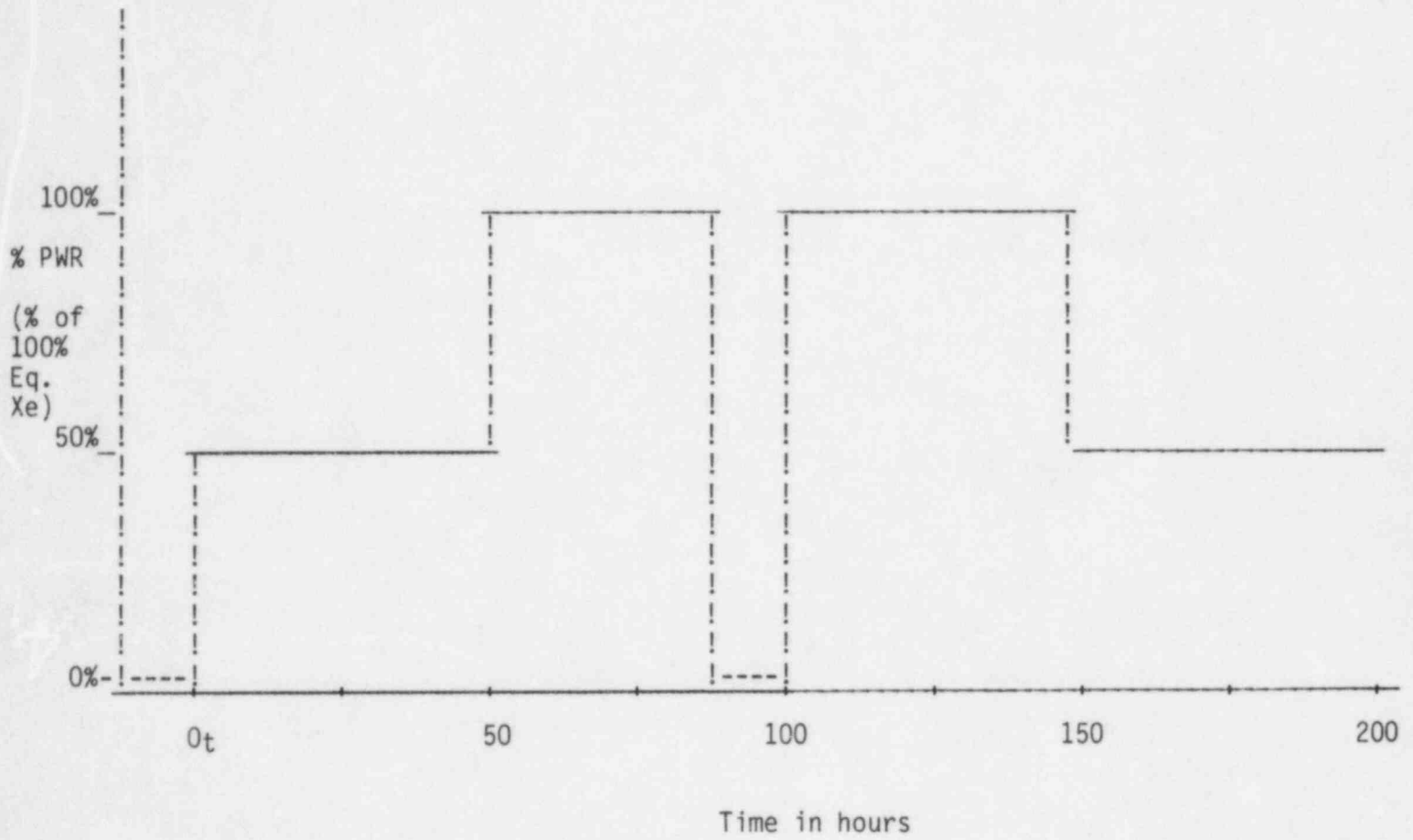


FIGURE 1.6

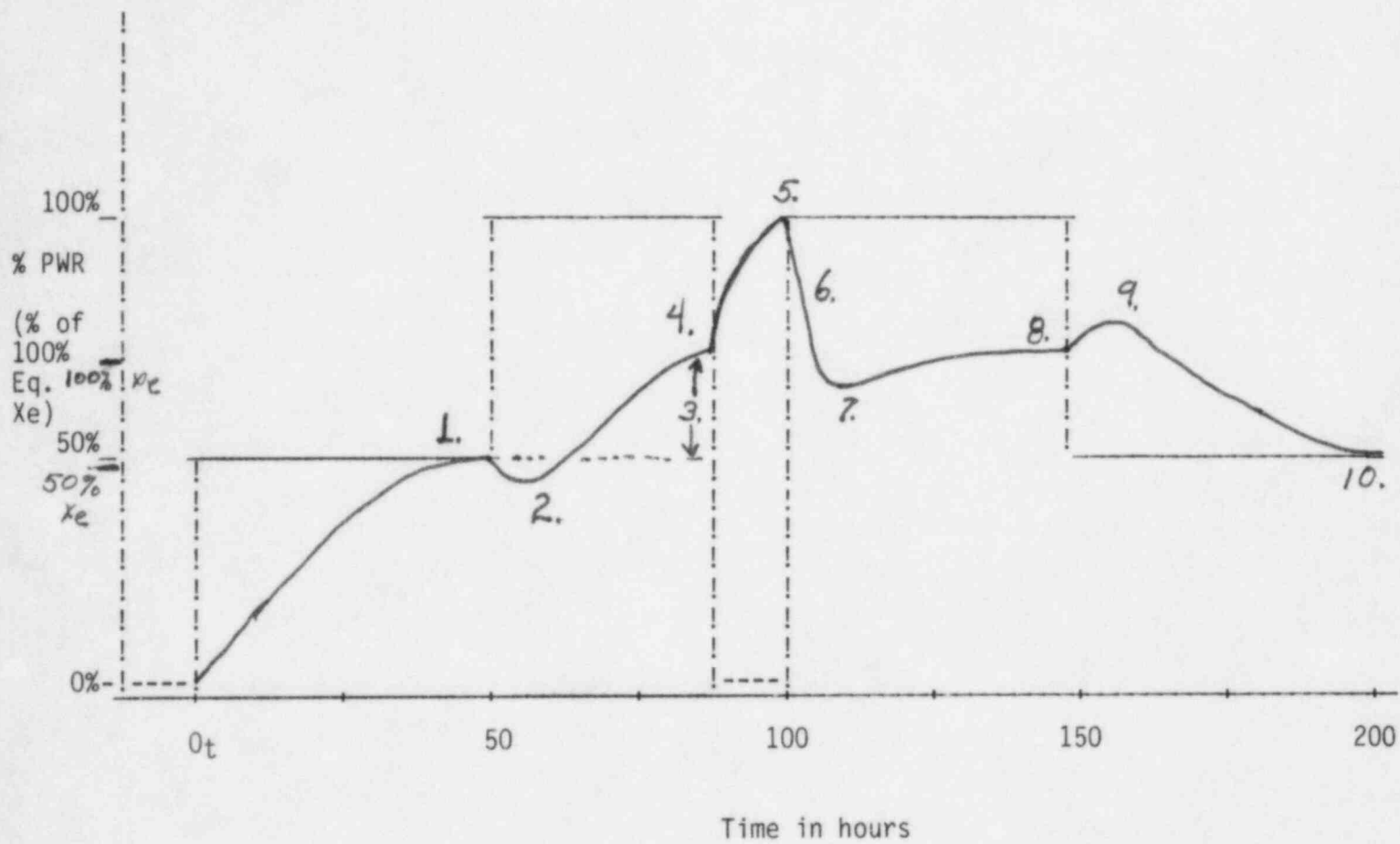


FIGURE 1.6

FCS EXAMINATION KEY

- 1.7 Briefly explain why you agree or disagree with the following statement. (1.5)

A 10° heatup with a +.3 delta K/K MTC will cause power to change as much, but in the opposite direction, as a 10° cooldown with a -.3 delta K/K MTC with an initial power level of 50%.

ANS:

Disagree. Power will increase in both cases, but will not increase as much during heatup because Doppler effects will aid in turning power.

REF:

STD CE CORE CHAR.

Question value is 1.5 pts, 0.5 for disagree, and 1 pt for explanation.

FCS EXAMINATION KEY

- 1.8 Reactor power increases by a factor of 10 in 110 seconds. What was the reactor period for this increase? Show calculations. (1.0)

- A. 10.9 sec
- B. 36.4 sec
- C. 47.8 sec
- D. 100 sec

ANS:

C

$$P_1/P_0 = 10 = e^{t/T} = e^{110/T}$$

$$\ln 10 = \ln e^{110/T}$$

$$2.302 = 110/T$$

$$T = 110/2.302 = 47.8$$

REF:

STD RX TH

Question value is 1 pt, 0.5 for C and 0.5 for correct formulation.

FCS EXAMINATION KEY

1.9 Beta is the fraction of all neutrons released by fission which are delayed: (2.0)

- A. When comparing the individual Betas for thermal fission of U₂₃₅, PU₂₃₉, and fast fission of U₂₃₈, which is largest?
- B. From BOL to EOL, does the average delayed neutron fraction INCREASE, DECREASE, or REMAIN THE SAME? Explain.
- C. Why is Beta_{eff} less than Beta?
- D. For equivalent positive reactivity additions to a critical reactor, will the SUR be larger or smaller at EOL compared to BOL?

ANS:

- A. U₂₃₈
- B. Decreases - Concentration of U₂₃₅ goes down while the concentration of PU₂₃₉ goes up.
- C. Decrease in thermal leakage is outweighed by the decrease in the fast fission factor. (The importance factor is LT 1.)
- D. Larger.

REF:

STD CE CORE CHAR

Question value is 2 pts, 0.3 each for A and D, 0.7 each for B and C.

FCS EXAMINATION KEY

1.10 A startup is commenced 4 hours after a trip from full power. For each of the following indicate whether the actual critical rod height will be HIGHER, LOWER, or SAME as the ECP calculated for the startup. (2.0)

- A. S/G Levels raised by 10%, 5 minutes prior to startup, temperature drops 30°F.
- B. Steam dump pressure setpoint is increased to a value just below code safety setpoints.
- C. The startup is delayed 4 more hours.
- D. Condenser vacuum is decreased by 2" Hg.

ANS:

- A. LOWER
- B. HIGHER
- C. HIGHER
- D. SAME

REF:

STD CE CHAR

Question value is 2 pts, 0.5 each.

FCS EXAMINATION KEY

- 1.11 Explain the reasons for starting a centrifugal pump with the discharge path throttled or shut, and a positive displacement pump with the discharge path open. (2.0)

ANS:

Starting a centrifugal pump with the discharge path closed or throttled prevents a runout condition from occurring (0.25). The motor will draw the same amount of starting current, but for a much shorter time (0.75). (Prevent water hammer is also acceptable.)

Starting a positive displacement pump with a closed discharge path will cause the actuation of protective devices (0.75) and possible damage to the pump and seal (0.25).

REF:

STD PUMP CHAR

Question value is 2 pts, divided as indicated.

FCS EXAMINATION KEY

- 1.12 As the core ages, the delta T from the fuel centerline to the coolant changes, this will subsequently change the fuel temperature at full power. Provide five (5) factors that change over the life of the core which affect the heat transfer ability and subsequent full power centerline temperature. (1.5)

ANS: (any 5)

1. Fuel densification
2. Fuel pellet swelling
3. Clad creep
4. Clad corrosion
5. Crud buildup
6. Gas in the gap
7. Thickness (size) of the gap

REF:
STD CE CORE CHAR

Question value is 1.5 pts, 0.3 each.

FCS EXAMINATION KEY

1.13 TRUE or FALSE. The minimum pressure that is allowed for RCP operation (NPSH limit) increases as reactor coolant temperature increases. (0.5)

ANS: TRUE

REF: STD pump ops curves.

question value is 0.5 pt.

END OF CATEGORY 1.

FCS EXAMINATION KEY

2. PLANT DESIGN INCLUDING SAFETY AND EMERGENCY SYSTEMS

- 2.1 Standing Order 0-30 lists 12 items which are considered safety related equipment for testing purposes. List eight of them. Duplicate or redundant components count as one item. (2.0)

ANS: (ANY 8)

1. LPSI pump(s)
2. HPSI pump(s)
3. Safety injection and Shutdown Cooling System valves, interlocks, or piping
4. Raw Water Pump(s)
5. CCW pump(s)
6. Containment Air Cooling and Filtering Unit(s)
7. Containment Air Cooling Unit(s)
8. Containment Spray pump(s)
9. Containment Cooling System valves, interlocks, or piping
10. Aux Feedwater pump(s)
11. Diesel Generator(s) and associated switchgear
12. Fire Pumps.

KEY WORD:
SURV

REF:
FCS SO A-0-30, pg 1, Rev 3

Question value is 2 pts, 0.25 each.

FCS EXAMINATION KEY

2.2 What are four (4) ways that the Heating, Ventilating and Air Conditioning system helps control the spread or release of radioactivity? (2.0)

ANS: (ANY 4)

1. Ensuring that air flow inside the building is from areas of lower activity to areas of higher activity.
2. Providing sufficient air flow to ensure that legal radioactivity limits are met at points where ventilating air leaves the building.
3. Reducing possible radioactivity release to the atmosphere through HEPA filters.
4. Providing charcoal filtration of effluent air from the safety injection pump rooms, spent regenerant tank room, TSC, and spent fuel area to entrap Iodine.
5. Providing for remote isolation of rooms where larger releases of radioactivity may occur.
6. Maintains a negative pressure on the containment and aux buildings.
7. Limits pressure in containment by condensing moisture on a LOCA or steam leak.

KEY WORD

HVAC DESGN

REF:

FCS SD-I-6, pg 1, Rev 6

Question value is 2 pts, 0.5 each.

FCS EXAMINATION KEY

2.3 On figure 2.3 indicate the position or condition of each component shown for the FLITERED MAKEUP mode of operation. (3.0)

ANS:

SEE FIGURE 2.3

COMPONENT	NORMAL	FILTERED MAKEUP	RECIRCULATION
VA 28	OFF	OFF	OFF
VA 49	ON	OFF	OFF
PCV 860C	OPEN	SHUT	SHUT
PCV 860A	SHUT	OPEN	SHUT
PCV 846	SHUT	SHUT	SHUT
PCV 860B	SHUT	OPEN	SHUT
VA 63	OFF	ON	OFF
PCV 840B	OPEN	OPEN	OPEN
PCV 840A	THROTTLED	THROTTLED	SHUT
VA 46A	ON	ON	ON
COILS	AUTO	AUTO	AUTO

KEY WORD:

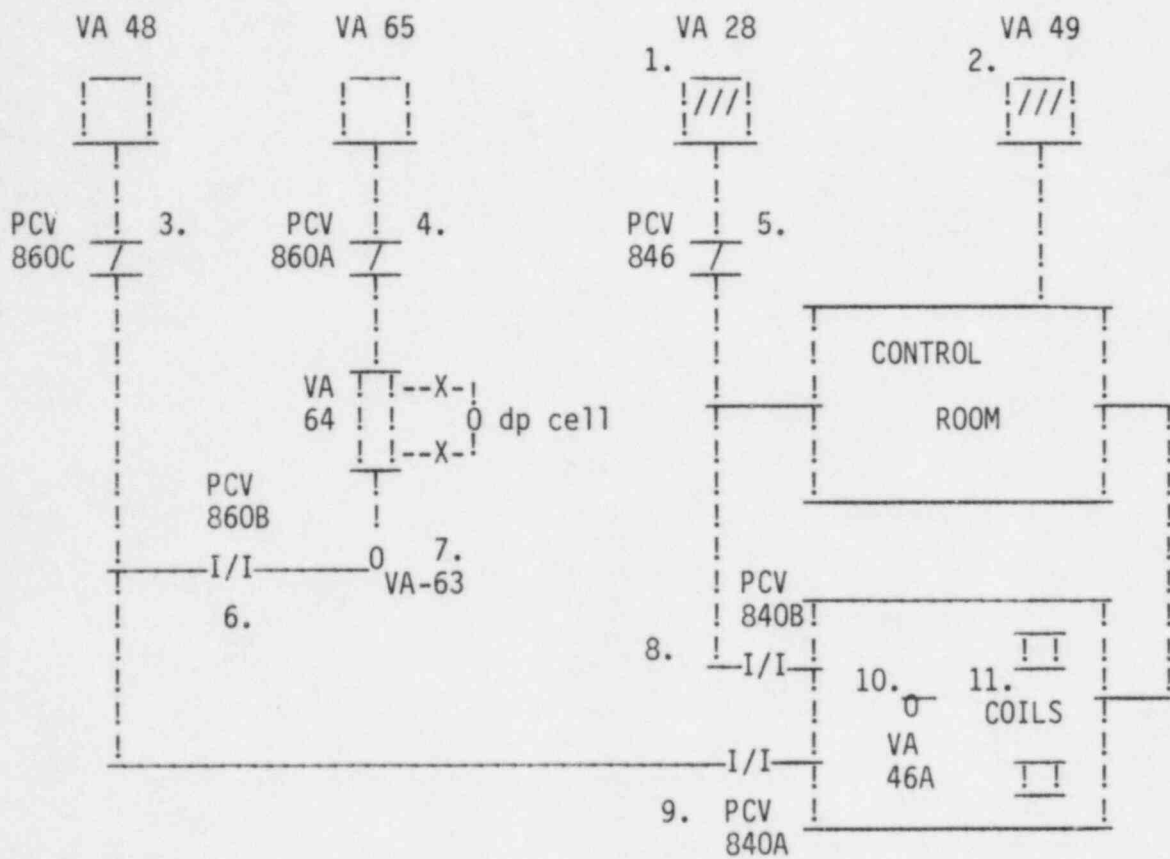
HVAC PATH

REF:

FCS SD-I-6 pgs 7-10, Rev 6

Question value is 3 pts, 0.27 each.

FCS EXAMINATION KEY



/// = fan

⊖ or ⊖ = blower

I/I or I/I = damper valve

FIGURE 2.3

FCS EXAMINATION KEY

2.4 What provides the backup to the Shutdown Cooling system if both
LPSI pumps fail? (1.0)

ANS: The containment spray pumps.

KEY WORD:
RHR AOP PUMP

REF: FCS SD-I-8, pg 2, Rev 1.

Question value is 1 pt.

FCS EXAMINATION KEY

2.5 What is the minimum design operating time for each of the following components during a limiting design basis accident without operator intervention? (2.0)

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

ANS:

- A. 24 min (all pumps injecting) (FSAR)
- B. 5 hr (T.S. 2.7) OR 7 days IF auto operation of the F0 transfer pumps is stated.
- C. 8 hr (S.D. II-2)
- D. 8 hr (T.S. 2.5 basis)

REF:

as indicated

Question value is 2 pts, 0.5 ea.

FCS EXAMINATION KEY

- 2.6 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. (1.5)

ANS:

1. SFPC failure (any of the following may be counted as system failure: valve failure, piping rupture, pump failure, or excessive heat exchanger leakage)
2. full core offload

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

REF:

FCS Sys Description I-13

Question value is 1.5 pts, 0.5 ea.

FCS EXAMINATION KEY

- 2.7 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.) (1.5)

ANS: (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.)

REF:

FCS Sys Description I-16

Question value is 1.5 pts, 0.5 ea.

FCS EXAMINATION KEY

- 2.8 A. List the 16 components which are capable of being cooled by Component Cooling Water (CCW). Where two or more elements of a component are cooled by CCW it is not necessary to identify each separately. Example: For pumps which have both lube oil and seals cooled by CCW, list only the pumps. (2.4)
- B. For each component, indicate (YES or NO) whether it can be cooled directly by Raw Water if CCW is lost. (1.6)

ANS:

- A.
1. Letdown heat exchanger
 2. RCPs (lube oil coolers and seal coolers)
 3. Charging pump oil coolers
 4. CEDM seal coolers
 5. Waste Evaporator
 - * 6. Containment air cooling (Cooling Units - Cooling & Filter unit)
 7. Sampling heat exchangers (Primary & Secondary)
 8. Safety injection tank leakage coolers
 - * 9. Control room air conditioning
 10. Nuclear detector well coolers
 11. Storage pool heat exchanger
 12. Waste gas compressor seal water heat exchangers.
 - * 13. Shutdown heat exchangers
 - * 14. LPSI pumps (seal and bearing coolers)
 - * 15. Containment spray pump (bearing coolers)
 - * 16. HPSI pumps (seal and oil coolers)
- B. Items marked * in A may be cooled directly by Raw Water.

REF:

- A. FCS SD I-7-1,2 (R3 12-3-81)
B. FCS SD III-8-1 (R3 4-19-83)

Question value is 4 pts, 0.15 each for components, and 0.1 for YES or NO.

FCS EXAMINATION KEY

- 2.9 During various abnormal situations, not necessarily nuclear related, two separate fluid systems may be cross connected should one fail or prove inadequate. List five (5) examples. (2.5)

ANS: (ANY 5)

1. Spent fuel pool cooling to shutdown cooling
2. Fire Protection to the auxiliary feedwater storage tank (hose connection)
3. Water plant to fire protection
4. High pressure SI to charging to pressurizer auxiliary spray (SI-163 has had the internals removed)
5. Potable water to turbine plant cooling at the air compressors
6. Screen wash to fire protection (diesel fire pump discharge)
7. Raw water to component cooling via interface valves
8. Containment spray to LPSI for shutdown cooling.
9. Plant air to instrument air.
10. Generator H₂ seal oil to turbine bearing oil.

REF:

FCS SDs

Question value is 2.5 pts, 0.5 each. No partial credit per pair.

FCS EXAMINATION KEY

2.10 Describe the system design and basic operation for each of the following types of fire suppression systems: (3.0)

- A. Deluge.
- B. Wet Pipe
- C. Halon

ANS:

1. Deluge System floods upon receipt of an actuation signal. Sprinkler nozzles in the system contain fusible links which melt at a predetermined temperature to allow flow through the nozzle. Some systems may omit the fusible link.
2. Wet pipe The system is pressurized with water up to the sprinkler heads which contain fusible links. The links melt when the temperature gets high enough and spray action begins.
3. Halon This system uses a gas to interrupt the oxidation process to suppress fire. It contains several bottles pressurized with the Halon in liquid state. When activated, the pressure is released on the bottles causing the Halon to boil off as a gas (similar to CO₂) which is delivered through a piping system to open nozzles.

REF:

FCS SD III-16 (R4 11-01-83)

Question value is 3 pts, 1 pt each.

FCS EXAMINATION KEY

- 2.11 The Safety Injection and Refueling Water Tank (SIRWT) stores water for two functions. (2.5)
- A. Name the two functions.
 - B. Give the sizing criteria for each function.
 - C. Which function requires the larger volume of water?

ANS:

- A.
 - 1. SI/ECCS injection
 - 2. Refueling water
- B.
 - 1. Allow all pumps to inject at design flow for 20 min.
 - 2. Flood refueling cavity to a depth of 24 feet.
- C. Refueling operations require the most water.

REF:

FCS SD I-9-4

Question value is 2.5 pts, 0.5 for each subpart.

END OF CATEGORY 2

FCS EXAMINATION KEY

3. INSTRUMENTS AND CONTROLS

3.1 List five (5) of the nine (9) interlocks which must be satisfied to operate the main disconnect switch, DS-T1, electrically. (1.5)

ANS: (ANY 5)

1. Key interlock switch satisfied (local operation only, Key in custody of Shift Supervisor)
2. 345K breakers 4 and 5 OPEN in Substation 3451.
3. Main Steam Stop Valves 1-4 SHUT.
4. 22 KV Bus - De-energized.
5. Generator field breaker - OPEN
6. 4.16 KV Breakers 1A11, 13, 22, 24 - OPEN (Kirk Key interlocks with breakers need not be operated for this operation).
7. Bus Cooling Unit - OFF
8. Operating Motor overload - CLOSED
9. 69 Permissive satisfied. (This switch operated by the MANUAL - ELECTRIC selector handle on the operator. The 69 Permissive is satisfied when the operator is lined for electrical operation.)

KEY WORD:

ELEDST NOP BKR

REF:

FCS SD-II-1, pgs 13 and 14, Rev 3

Question value is 1.5 pts, 0.3 each.

FCS EXAMINATION KEY

3.2 List three events/conditions which will cause the turbine auxiliary feed pump "trouble" alarm. (1.5)

ANS:

1. Turbine trip on high back pressure
2. DC auxiliary lube oil pump trip on overload
3. Loss of DC power

KEY WORD:

AFW IND

REF:

FCS SD-III-4, pg 11, Rev 5

Question value is 1.5 pts, 0.5 each.

FCS EXAMINATION KEY

- 3.3 Briefly describe the difference in how the discharge flow rate of the motor driven and turbine driven auxiliary feed pumps is controlled. (2.0)

ANS:

The motor driven aux feed pump is run at constant speed and the system backpressure regulates the discharge flow rate. Discharge flow control valves affect backpressure to control flow.

The turbine driven aux feed pump has a variable speed controller which senses both feed and steam header pressures to maintain the discharge of the turbine pump 40 psi above steam header pressure.

KEY WORD:
AFW PUMP CNTRL

REF: FCS SD-III-4, pgs 19 & 20, Rev 5

Question value is 2 pts, 1 pt each.

FCS EXAMINATION KEY

3.4 What conditions will cause one or more Raw Water Pumps to start automatically? (2.0)

ANS:

1. If the running pump trips, the pumps on the opposite bus will start in standby.
2. All four pumps will start when sequencing is actuated by:
PPLS
CPHS
SIAS

KEY WORD:

SWS PUMP CNTRL

REF:

FCS SD-II-1, pg 29, Rev 3, and SD-III-8, pg 9 & 21, Rev 3

Question value is 2 pts, 1 pt each. Give $\frac{1}{2}$ credit if one or more of the ESF signals are given without mentioning the sequencers. If sequencers only, are mentioned, give full credit.

FCS EXAMINATION KEY

3.5 What signals are necessary to auto initiate containment spray?
Include parameter setpoints and channel coincidence logic. (1.5)

ANS:

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

REF:

FCS OP-5, Sys Description II-7

Question value is 1.5 pt, 0.25 each for signal, setpoint, and logic.

FCS EXAMINATION KEY

3.6 Match each of the Engineered Safeguards Control System actuation signals with the parameters which may initiate it: (2.0)

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.

ANS:

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

OR

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

REF:

FCS Sys Description II-7

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

FCS EXAMINATION KEY

- 3.7 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, (2.0)

ANS:

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.

REF:

FCS Sys Description I-4

Question value is 2 pts, 0.5 per underlined area.

FCS EXAMINATION KEY

- 3.8 Following a main steam line break, the following pressures and levels in S/G A and B are recorded. For each combination indicate whether auxiliary feedwater will be activated to S/G A, S/G B, or BOTH. (2.0)

	TIME	W.R. SG A LEVEL	SG A PRS	W.R. SG B LEVEL	SG B PRS
A.	0100	35%	1000 psia	35%	450 psia
B.	0105	20%	550 psia	20%	450 psia
C.	0110	10%	470 psia	10%	310 psia
D.	0115	10%	300 psia	10%	300 psia

ANS:

	SG A	SG B
A.	NO	NO
B.	YES	NO
C.	YES	NO
D.	NO	NO

REF:

FCS TS 2.14 (6) & (7)

Question value is 2 pts, 0.25 per item.

FCS EXAMINATION KEY

- 3.9 List all the automatic control functions generated by the process radiation monitoring system. Include the type of radioactivity (particulate, gaseous, etc), the system monitored, 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. (3.0)

ANS:	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
overboard	5. Waste disposal (RM 55, 55A)	liquid	close RDWS liquid effluent control valve
	6. Waste disposal aux steam cond return (RM 59)	liquid (2 phase)	close RCV-059

REF: FCS Sys Description II-9

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

FCS EXAMINATION KEY

- 3.10 List fifteen (15) signals to the turbine E.H.C. which will cause a turbine trip by de-energizing the master trip solenoid valve (setpoints not required) (3.0)

ANS: (ANY 15)

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

REF:

FCS Sys Description. 17-1

Question value is 3 pts, 0.2 ea.

FCS EXAMINATION KEY

- 3.11 Identify the numbered blocks on Figure 3.11 which represent system conditions/responses. Put your answers on a separate sheet. (4.0)

ANS:

See Figure 3.11

1. High power level
2. High Pressurizer pressure
3. Loss of load
4. Excess steam flow or low SG pressure
5. High containment pressure
6. Rod withdrawal prohibit
7. Open PORVs
8. Close SLIVs or MSIVs
9. Turbine runback (this feature disabled - deleted from required answers)
10. Automatic Bus Transfer for station power distribution from generator to outside power.

KEY WORD:

RPS DESGN

REF:

FCS SD-II-5, pg 69, Rev 2

Question value is 4 pts, 0.44 each.



FCS EXAMINATION KEY

3.12 Give one of two (2) means of detecting reactor coolant leakage into the component cooling water system? (0.5)

ANS:

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

REF:

FCS Sys Description I-7

Question value is 0.5 pt.

END OF CATEGORY 3

FCS EXAMINATION KEY

4. PROCEDURES - NORMAL, ABNORMAL, EMERGENCY, AND RADIOLOGICAL CONTROL

- 4.1 Revision 20 to OP-4 (Load Changes, Normal Power Operations) was issued near the end of March 1985. What was the focus of this revision? (1.0)

ANS: Placed increased emphasis on achieving specified chemistry conditions in the Steam Generators prior to exceeding 30% power.

KEY WORD:
NOP JOB

REF: FCS OP-4, pgs 1 & 2, Revs 19 & 20

Question value is 1 pt, 0.5 for SG chemistry and 0.5 for 30% power.

FCS EXAMINATION KEY

4.2 What is the main function of OP-1? (1.0)

ANS:

To provide a master checklist of items that must be completed prior to plant startup and for trip recovery.

KEY WORD:

NOP

REF:

FCS OP-1, pg 1, Rev 21

Question value is 1 pt, 0.33 ea for checklist, startup, and trip recovery.

FCS EXAMINATION KEY

4.3 During plant startup from cold shutdown, the pressurizer temperature is 500°F and indicated level is 43%. Can heaters be energized to increase or maintain pressure without adjusting level? Explain. (2.0)

ANS: No. The actual level is 39.5% (using figure III.1.a). The minimum level for heater operation is 41.5% which would be 49.5% indicated level at 500°F.

KEY WORD:
NOP IND

REF: FCS OI-RC-3, pg 3, Rev 26 and TDB Fig. III.1.a, Rev 0

Question value is 2 pts, 0.5 for "No" and 1.5 for explanation.

FCS EXAMINATION KEY

4.4 Steps 5 and 6 of OP-3 read as follows: (1.0)

"5. Terminate 345 KV backfeed line up if required and ensure all four 4160 volt electrical busses are being supplied from the house service (161 KV) transformers."

"6. Reset the EHC and perform turbine chest/shell warming per OI-ST-2."

A footnote states that the sequence of these steps is important. Explain why.

ANS:

If the EHC is reset prior to opening PCB-4 and 5, the unit will "roll off". (Roll off - come off the turning gear and speed up to 1800 RPM)

KEY WORD:

NOP MNGEN

REF:

FCS OP-3, pg 3, Rev 18

Question value is 1 pt.

FCS EXAMINATION KEY

4.5 During plant startup, how is reactor power controlled between 1% and 10% power? (1.0)

ANS: By use of the steam dumps or bypass valves.

KEY WORD:
NOP

REF: FCS OP-3, Rev 18

Question value is 1 pt.

FCS EXAMINATION KEY

- 4.6 List the immediate actions when Emergency Boration, EP-9, is required. (1.5)

ANS:

1. Close demineralized water makeup control valve (FCV-269X) makeup stop valve (FCV-269).
2. Open boric acid pump discharge valve (HCV-268) and boric acid gravity feed stop valves (HCV-258 and 265).
3. Start boric acid pumps (CH-4A and B).

KEY WORD:
EOP

REF: FCS EP-9, pg 1, Rev 6

Question value is 1.5 pts, 0.5 ea.

FCS EXAMINATION KEY

- 4.7 List the immediate actions for a fire which threatens or is in reactor safeguards equipment, reactor protective equipment, or other equipment vital to the safe operation of the plant per EP-10. (2.5)

ANS:

1. Validate the fire (by direct observation, if possible).
2. Announce the fire and attempt to extinguish it.
3. If the fire has been reported as threatening or in reactor safeguards equipment, reactor protective equipment, or other equipment vital to the safe operation of the plant; or if the alarm is from an inaccessible area containing safeguards equipment:
 - a. Manually trip the reactor. Ensure that all regulating and shutdown CEA's have been fully inserted and that reactor power is decreasing.
 - b. Ensure turbine has tripped and all stop and intercept valves have closed.
 - c. Ensure generator breakers 4 and 5 have tripped and that the generator field breaker has opened.
4. Immediately call the Blair Fire Dept (9-911). If the fire is in the Aux Building Controlled Area or Containment, the fire dept shall be requested to respond. For all other fires, the fire dept. shall respond only on the Shift Supervisor's request.
5. Notify the Radiation Protection Supervisor and initiate standing order G-28.
6. Take action to clear all electrical equipment indicating ground.

KEY WORD:
EOP

REF:
FCS EP-10, pgs 1, 2, Rev 7

Question value is 2.5 pts, 0.25 ea for 1 and 2 and 0.33 ea for 3.a-c, 4-6.

FCS EXAMINATION KEY

4.8 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. (2.5)

1. Auxiliary Building Crane
2. Raw Water Pumps
3. Turbine Generator Throttle Valves
4. Pressurizer Quench Tank
5. House Service Transformer
6. Reactor Coolant Drain Tank
7. Missouri River Level
8. Control Board ECCS valve position indicator lights
9. Control Room Access doors security locks
10. Fire pump discharge strainers

ANS/REF:

1. YES (2.11)
2. YES (2.4)
3. NO
4. NO
5. YES (2.7)
6. NO
7. YES (2.16)
8. NO
9. NO
10. YES - 3.15(2)f

REF:

FCS Technical Specifications

Question value is 2.5, 0.25 ea.

FCS EXAMINATION KEY

- 4.9 List three (3) primary system parameter conditions which are positive indications of natural circulation per EP-5. (3.0)

ANS: (ANY 3)

1. Core exit thermocouple temperatures are stable, at least 50° below saturation temperature and to the right of the 100°F/hr pressure vs temperature cooldown curve.
2. Core exit thermocouple and RCS T_h are approximately the same.
3. The core Delta T is less than or equal to 50°F and representative of decay heat power level (ex: dT should be about 20° immediately after trip from 100% power and will decrease as decay heat decreases).
4. T_h and T_c are decreasing (after about the first 10 minutes).
Note: This indication is contained in the caution statement.

REF:

FCS EP-5, pg 3

Question value is 3 pts, 1 pt each.

FCS EXAMINATION KEY

- 4.10 While heating up from cold shutdown with RCS at 1400 psi and temp at 400°F, the following alarms/indications are received: (3.0)

Low Pressurizer level
Containment activity high
Containment sump level rising

- A. What has occurred?
B. What are your immediate actions?

ANS:

- A. Loss of primary coolant (1.0)
B. Initiate PPLS manually (by placing the PPLS block switch on CB-1/2/3 to the "EMER RESET" position). (0.5)

Ensure containment isolation has taken place by verifying that containment isolation valves have gone to their accident positions. (0.2)

Ensure SI flow is being delivered to the reactor core by verifying high and low pressure safety injector header flows. HPSI pumps may have to be started by the operator since control switches for these pumps are normally caution tagged in the PULL-STOP position to prevent possible RCS overpressurization. (0.2)

If CPHS is present or containment pressure reaches 5 psig, ensure containment spray flow. If necessary, actuate ESF by operating both Master Emergency Switches. (0.2)

If pressurizer pressure is LE 1350 psia, TRIP ONLY RCPs 3B and 3D. (0.5)

Check CCW pressure:

if greater than 60 psig verify flow to RCP's (0.2)
if less than 60 psig verify HCV-438A/B/C/D closed on CIAS (0.2)

REF:

FCS EP-5A, pgs 1-3

Question value is 3 pts, breakdown as indicated in the key.

FCS EXAMINATION KEY

- 4.11 A. On figure 4.11, fill in the various wholebody exposure limits for the conditions shown. If a limit does not apply to a particular condition, insert "NA". (2.5)
- B. List two (2) persons (by title or job function) who may authorize exceeding specified whole body exposure limits for radiation work permits. (1.0)

ANS:

A.

mrem	Shutdown	Operating	Max. Perm
Daily	300	100	NA
Weekly	900	300	NA
Qtrly	2400	1250	3000
Yearly	5000	5000	12000

- B. Plant Manager
Supervisor-Chem and Rad Protection

REF:

FCS Rad Man VII-2

Question value is 3.5 pts, 0.25 each in A.(exclude NA) and 0.5 ea in B.

FCS EXAMINATION KEY

! mrem !	! Shutdown !	! Operating !	! Max. Perm !
! Daily !	!	!	!
! Weekly !	!	!	!
! Qtrly !	!	!	!
! Yearly !	!	!	!

FIGURE 4.11

FCS EXAMINATION KEY

- 4.12 A. With the plant in a solid condition, what pressurizer temperature and pressure should be established prior to forming a steam bubble in the pressurizer? (1.0)
- B. Describe how a bubble is formed. (1.0)
- C. What are the control board indications that a bubble has been established? (1.0)

ANS:

- A. 486°F
600 psia
- B. Shut both spray valves.
Increase letdown to maximum
- C. Pressurizer pressure indication will level off with no change in letdown flow. (Actual pressurizer level will decrease with no significant change in pressure.)

REF:

FCS OI-RC-3

Question value is 3 pts, 0.5 each per part in A and B, 0.5 each for level pressure and constant letdown flow in C.

END OF CATEGORY 4