Yellow

October 22, 1984

Duke Power Company
ATTN: Mr. H. B. Tucker, Vice President
Nuclear Production Department
422 South Church Street
Charlotte, NC 28242

Gentlemen:

SUBJECT: OCONEE NUCLEAR STATION EXAMINATION REPORT 50-269/OL-84-01

The NRC administered examinations the week of August 13, 1984, to employees of your company who had applied to licenses to operate the Oconee Nuclear Plant. Requalification examinations were also administered on August 3, 14, and 16, 1984, to selected personnel who hold current licenses for the Oconee facility. At the conclusion of the written phases of the Requalification examination on August 3 and the license examination on August 13, the examination questions were discussed with those members of your staff identified in the Examination Report, Enclosure 1. Preliminary findings of the operating phases of both examinations were also discussed with members of your staff at the exit meeting as explained in Enclosure 1.

The Oconee requalification training program is considered satisfactory based upon the pass rate of 91% on the requalification exams administered by the NRC.

A table summarizing the examination results for each examined individual is provided as Enclosure 2. Copies of the written examination questions and answer key are included in this report as Enclosure 3.

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In accordance with 10 CFR 2.790(a), a copy of this letter and Enclosures 1 and 3 will be placed in NRC's Public Document Room unless you notify this office by telephone within ten days of the date of this letter and submit written application to withhold information contained therein within thirty days of the date of this letter. Such application must be consistent with the requirements of 10 CFR 2.790(b)(1). Enclosure 2 is exempt from public disclosure pursuant to 10 CFR 2.790(a) and will not be sent to the Public Document Room.

Should you have any questions concerning this letter, please contact us.

Sincerely,

(Original signed by BAWilson)

Virgil L. Brownlee, Acting Chief
Reactor Projects Branch 2
Division of Reactor Projects

Enclosures: (See page 2)

1/1
IE42

Enclosures:
1. Examination Report No. 50-269/OL-84-01
2. Table of Examination Results (Official Use Only-Privacy Act Information)
3. RO/SRO Requalification Exam Questions and Answer Key and RO License Exam Questions and Answer Key

cc w/encls. 1 & 2:
M. S. Tuckman, Station Manager

cc w/encls. 1, 2, & 3:
R. Bugert, Site Training Director
Senior Resident Inspector

bcc w/encl. 1:
Project Manager, NRR
State of South Carolina

bcc w/encls. 1 & 3:
Operator Licensing Branch, DHFS, NRR
Document Control Desk

**RII	**RII	**RII	**RII	RII	RII
EACook:jw	BWilson	AGibson	JOlshinski	VBrownlee	HDance
10/ /84	10/ /84	10/ /84	10/ /84	10/ /84	10/ /84

**See Previous Concurrence

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Project Manager, NRR
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Operator Licensing Branch, DHFS,NRR
Document Control Desk

RII	RII	RII	RII	RII
EACook:jw	BWilson	AGibson	JOlshinski	VBrownlee
10/15/84	10/9 /84	10/16/84	10/18/84	10/ /84

(Enclosure 3 / 1 of 3)

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

Facility: Oconee

Reactor Type: B&W

Date Administered: August 3, 1984

Examiner: Walter J. Apley

Candidate: ______

INSTRUCTIONS TO CANDIDATE:

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheet. Points for each question are indicated in parenthesis 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 four (4) hours after the examination starts.

Category Value	% of Total	Candidate's Score	% of Cat. Value	Category
~~16~~ ~~15.0~~ 14.5	~~25~~ ~~23.8~~ 23.2			5. Theory of Nuclear Power Plant Operation, Fluids and Thermodynamics
16	~~25.4~~ 25.6			6. Plant System Design, Control and Instrumentation
16	~~25.4~~ 25.6			7. Procedures - Normal, Abnormal, Emergency, and Radiological Control
16	~~25.4~~ 25.6			8. Administrative Procedures, Conditions, and Limitations
~~63.0~~ 62.5				TOTALS

Final Grade ______ %

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

______
Candidate's Signature

Exam review started: 2:50 PM
Exam review done: [illegible] PM

Walter J. Apley
[signatures]

5.0 THEORY OF NUCLEAR POWER PLANT OPERATION, FLUIDS, AND THERMODYNAMICS (16 POINTS)

5.1 In a post-accident containment environment, what minimizes the stratification of the resulting hydrogen concentration (i.e. ensures that it is as uniform as possible in containment) ? (1.0)

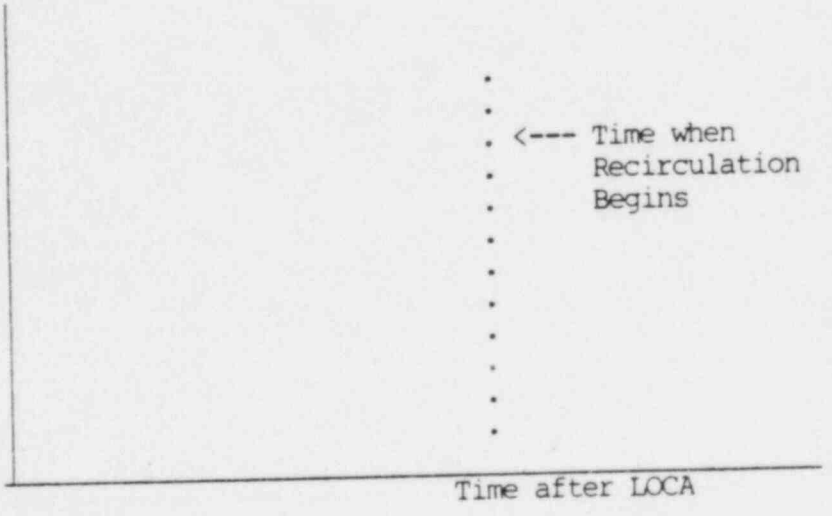
5.2 Explain what indication you should expect to see on the source range count rate monitors as the core is voided by a LOCA ? (1.0)

5.3 TRUE or FALSE:

The Doppler Deficit Curve, found in OP/1/A/1103/15 (Reactivity Balance procedure), is the same as the power coefficient. (0.5)

5.4 Following a large break LOCA, show on a plot (similar to the one below) what would happen to containment building (RB) pressure during the first eight hours. Assume that the BWST supply was depleted, and that recirculation of the containment sump water took place. Explain the shape of the curve. (1.5)

Explained that no numbers required



-Category 5 Continued on Next Page-

5.5 During a startup from a previous reactor trip following sustained operation at full power, will the actual critical position be higher or lower than the estimated critical position (ECP) for the conditions listed below ? Consider each as a separate occurrence and explain each answer.

a. The operator unintentionally over-feeds a steam generator while reaching criticality. (0.75)

b. Actual boron concentration is lower than the concentration used to figure ECP. (0.75)

c. Startup was delayed four (4) hours beyond the ECP time; a shutdown time of sixteen (16) hours was used in the ECP. (0.75)

5.6 The following statements are concerned with subcritical multiplication. Choose the one underlined word that will make the sentence correct.

a. As Keff approaches unity, a larger/smaller change in neutron level results from a given change in Keff. (0.5)

b. As Keff approaches unity, a shorter/longer period of time is required to reach the equilibrium neutron level for a given change in Keff. (0.5)

5.7 a. What is the startup rate corresponding to a 34 second period ? Show calculation.

1. .128 dpm
2. .334 dpm
3. .769 dpm
4. 1.3 dpm. (1.0)

b. The statement is made: "It will take the same amount of time to increase power from 40% to 80% as it will to increase power from 20% to 40% if the startup rate is constant." Is this statement TRUE or FALSE ? Explain your answer. (1.0)

5.8 ~~Explain why the magnitude of the prompt drop in neutron power following a reactor trip depends on the amount of negative reactivity inserted.~~ (1.0)

Deleted

-Category 5 Continued on Next Page-

5.9 a. A cylindrical vented tank has a diameter of 13 feet and a height of 26 feet. It is filled with water to a height of 20 feet. What is the pressure at the bottom of the tank (in psig) ? (1.0)

NOTE: The weight of water is 62.4 lb/ft3.

b. Assume that freezing plugs the vent line of the tank described above. Water is pumped out of the tank so that the actual level is 15 feet. Level is being measured using a pressure transmitter on the bottom of the tank. Will the indicated level be below, above, or the same as the actual level. Explain. (0.75)

Explained no reference leg

5.10 State whether each of the following statements is TRUE or FALSE:

~~a. If reactor power imbalance is excessively negative, APSRs need to be inserted.~~ ~~(0.5)~~ Deleted

b. Reactor power imbalance is the power in the top half of the core minus the power in the bottom half of the core, divided by the actual average core power (expressed in percent). (0.5)

F.C. – [illegible] I.R. –

5.11 List those parameters given in EP/0/A/1800/06 (Loss of Reactor Coolant Flow) which indicate that adequate RCS natural circulation exists. (2.0)

5.12 TRUE or FALSE:

Quadrant Power Tilt is affected by delta Tc changes. (0.5)

5.13 Which one of the following is TRUE regarding the steamline break accident as analyzed in the FSAR:

a. In all cases with or without ICS and/or operator action the reactor returns to some low power level.

b. Operation of the emergency feed water system by the ICS is relied on to mitigate the accident.

c. Concurrent OTSG ruptures were analyzed because they were shown likely to occur as a result of blowdown loading.

d. The analysis includes a stuck rod with only one train of HPI and one train of LPI operable. (0.5)

- End of Category 5 -

6.0 PLANT SYSTEMS DESIGN, CONTROL, AND INSTRUMENTATION (16 POINTS)

6.1 Describe how the Base and STBY HPSW pumps will respond to a decreasing and increasing Elevated Water Storage Tank level. (1.5)

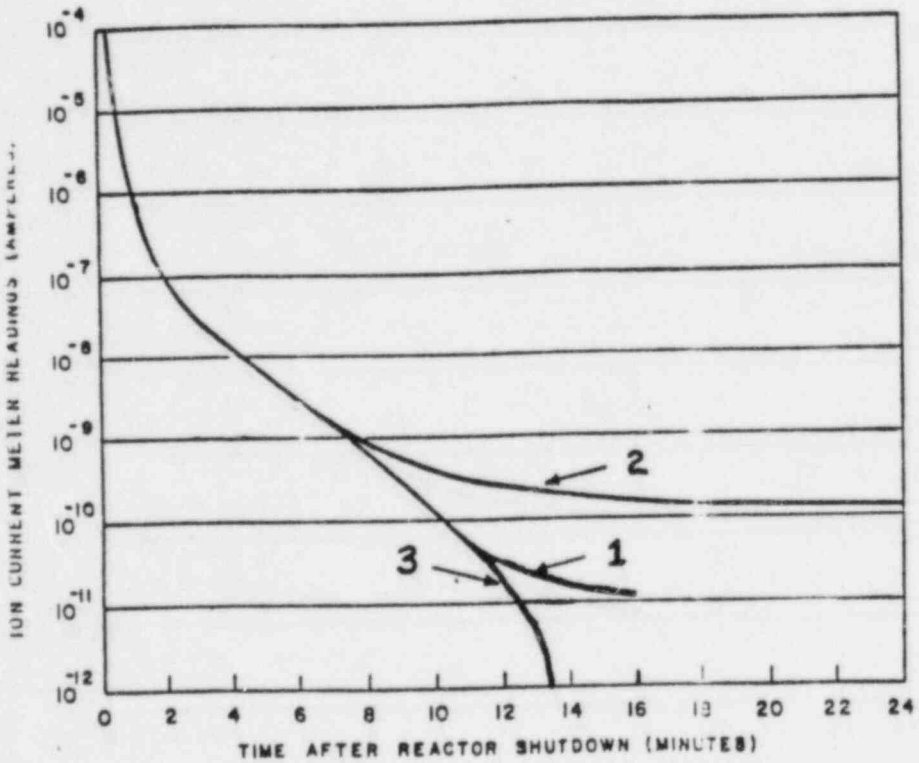
6.2 List the instrumentation available at the Standby Shutdown Facility to Monitor RCS parameters (Be specific as to type of instruments). (2.0)

6.3 The reactor is operating at 100% power. A trip occurs. Indicated count rate (amps) on the Intermediate Range Instrument versus time is shown on the graph below. Identify which trace (1-3) corresponds to each of the conditions listed below:

a. Under-compensated detector

b. Correctly-compensated detector

c. Over-compensated detector (1.0)



-Category 6 Continued on Next Page-

6.4 How is turbine bypass valve control affected by the position of the Auxiliary Shutdown Panel Controllers:

a. If OTSG outlet pressure exceeds 1050 psig ? (0.75)

b. If condenser vacuum is less than 7" ? (0.75)

6.5 Will the loss of a feedwater pump or reactor coolant pump cause turbine control to shift to manual if a greater than 50 psi pressure differential results (demand vs actual) ? (0.5)

6.6 Select the correct statement regarding the main generator:

a. A lagging power factor (pf) below 0.9 means that the machine is carrying a lot of inductive load and the excitation is very low.

b. With a leading pf (below .95) the field is weak and the generator could slip a pole if a large load is quickly added.

c. If an actual high temperature limit is approached, operation is not affected provided you are operating within the generator capability curve.

d. The preferred mode of operation at Oconee is with a leading pf so that the generator looks like an inductive load to other generators. (1.0)

6.7 As a result of depressing the Dam Failure button on Unit 2 which of the following action(s) occur ?

a. All running CCW pumps on all units trip
b. CCW emergency discharge valves on all units open
c. CCW-8 opens
d. All of the above (0.5)

6.8 Shutdown bypass is a function incorporated into all four RPS Cabinets.

a. What three (3) evolutions does shutdown bypass allow you to complete ? (1.5)

b. What four (4) trips are bypassed by the shutdown bypass switch ? (1.0)

c. What new automatic limit is imposed when going to shutdown bypass ? (0.5)

-Category 6 Continued on Next Page-

6.9 IE Information Notice 84-18 issued in March 1984 identified two conditions where a significant potential exists for inadvertent introduction of contaminants into PWR Fluid Systems. Identify the two (2) conditions from those listed below:

a. Corrosion products from BWST

b. Airborne contaminants collecting on the free surface of the spent fuel pool

c. S/G to RCS leakage during shutdowns

d. Uncontrolled open-and-inspect evolutions of RCS piping

e. Purchase of contaminated boric acid

f. Defective Ion exchange resin. (0.5)

6.10 The Emergency Feedwater (EFW) system temperatures should be monitored on a periodic basis even when the system is not in operation. What would a likely cause be for a higher than expected EFW system temperature, and what would be the consequences of an automatic EFW system start if temperatures in the discharge piping were exceptionally high ? (1.5)

6.11 The Diamond panel is operating in automatic. The operator depresses the Sequence/Sequence Override Pushbutton. What happens to the Diamond control system ? (1.0)

6.12 Where do the Core Flood Tanks vent to ? (1.0)

6.13 What is the purpose of the Intercept-Reheat Valves associated with the Turbine Generator ? (1.0)

- End of Category 6 -

7.0 PROCEDURES - NORMAL, ABNORMAL, EMERGENCY, AND RADIOLOGICAL CONTROL (16 POINTS)

As it is today

7.1 Explain the difference between venting CRDMs on Units #1 and #3, and Unit #2 ? (1.0)

7.2 What is the major advantage of using the Hydrogen Recombiner rather than the Hydrogen Purge Unit after a LOCA ? (1.0)

7.3 EP/0/A/1800/14 (Loss of Steam Generator Feedwater) describes how the S/Gs can be supplied with water if the Unit's Main and Emergency Feedwater pumps are lost and no other Unit's Emergency Feedwater pump(s) are available. Describe how water can be supplied (Do not include a discussion of using the Standby Shutdown Facility (SSF) Auxiliary Service Water System). (1.5)

7.4 If one unit has an OTSG tube leak, OP-0C-SPS-SY-AS (Auxiliary Steam System) lists six (6) actions which must be done regarding the Auxiliary Steam System to prevent contaminating unaffected units. List any four (4). (2.0)

7.5 If a major load reduction (100 MW or greater from 600 MW or more) occurs:

a. Why is subsequent MVAR loading subject to special restrictions ? (0.5)

b. What parameter is monitored and must have stabilized before the special restrictions are no longer controlling ? (0.5)

7.6 Following a SBLOCA in which ES 1&2 actuate on low system pressure, the control room operators fail to secure the RCP's. You, the shift supervisor, arrive in the control room (5) five minutes after the E.S. actuation. What direction should you give the reactor operator concerning RCP's and explain the reasons for this answer. (1.5)

7.7 A Limiting Condition for Operation, as defined in Section 3 of the Technical Specifications, cannot be met and the reactor must be shut down. What is the minimum rate, according to Station Directive 3.1.2, at which the reactor must be shut down. (0.5)

-Category 7 Continued on Next Page-

7.8 On a Unit Load Rejection, what would you do with letdown flow for each of the following conditions:

a. The Load Rejection results in a reactor trip ? (0.5)

b. The Load Rejection proceeds without a reactor trip ? (0.5)

7.9 Operating at 97% power, what must be done with reactor power prior to removing a FDW heater from service ? (1.0)

7.10 TRUE or FALSE:

NI's are calibrated to Thermal Power-Secondary Heat Balance for 4 RCP operation, and Thermal Power Best Estimate for 3 RCP operation. (0.5)

7.11 The following relates to operation of the Reactor Building Cooling System. Two RBCUs are operating in high speed. An operator wants to start a 3rd RBCU in slow, stating that (a) he is trying to balance fan service and (b) he has to wait 30 minutes before going to fast speed once he is in slow. OP/1/A/1104/15 (Reactor Building Cooling System) describes four (4) reasons why the above actions would be incorrect. List any two (2) reasons why the above actions would be incorrect. (2.0)

7.12 During a Turbine-Generator Startup, the generator internal temperature must be greater than 20°C. Which one of the methods listed below should NOT be used to raise the temperature ?

a. Running the condensate through the hydrogen cooler

b. Operating the turbine at 1000 to 1400 RPM

c. Running the Stator Coolant System

d. Placing excitation on generator @ speed > 500 RPM. (1.0)

7.13 During the transfer of a spent fuel assembly, gas bubbles are observed originating from the assembly. Upon examination the assembly appears damaged. As part of the immediate manual operator actions if the accident occurred inside the Spent Fuel Pool, which fans are stopped and which are started ? (1.5)

7.14 EP/0/A/1800/15 (Uncontrollable Flooding Turbine Building) has as an immediate action that the operator should increase and maintain steam generator levels. At what OTSG level ? (0.5)

- End of Category 7 -

8.0 ADMINISTRATIVE PROCEDURES, CONDITIONS, AND LIMITATIONS (16 POINTS)

8.1 List any three (3) conditions under which the Diamond panel could be operated with "Safety Rods Out Bypassed." (1.5)

8.2 After any ES valve has been operated manually, what must be done before the valve can be declared as "operable ?" (1.0)

8.3 What must be done, according to Technical Specifications, if any fire detection instrument is found to be inoperable ? Include time restrictions. (1.0)

8.4 Indicate if the following statements from the Technical Specifications for Oconee are TRUE or FALSE.

a. Only one channel bypass key shall be accessible for use in the Control Room. (0.5)

b. A tripped reactor protective channel is considered to be inoperable. (0.5)

c. Containment isolation valves on essential systems are isolated automatically by high containment pressure only. (0.5)

8.5 At approximately what power level is the Incore detector system required to be operable during 3 RCP operation ? Show calculation. (1.0)

8.6 When the station manager or his designee relieves the shift supervisor as Emergency Coordinator, is a "face-to-face" turnover required ? (0.5)

8.7 How soon after the declaration of an emergency action level must the:

a. NRC be notified (0.5)

b. Counties/State of South Carolina be notified ? (0.5)

-Category 8 Continued on Next Page-

Explained that specific time period required

8.8 List the minimum containment integrity requirements during fuel loading. (1.85)

8.9 What are the six critical safety functions (CSF) indicated by the Safety Parameter Display System ? (2.4)

8.10 If the supervisor to whom a tag was issued cannot be located for return of the stub, and it is necessary to remove a Red Tag to clear a component, whose permission (by title) is required to remove the tag ? (1.0)

8.11 Station Directive 5.3.3 discusses the three (3) levels of Fire Protection Systems at the Oconee complex. Match the Level (I-III) with the equipment listed below which belongs in that level category:

a. Portable Fire Extinguishers

b. Automatic Sprinkler Systems

c. Fire Mains and Hydrants (1.5)

8.12 The reactor is subcritical by greater than 1% delta K/K. Tave is 300°F. According to Technical Specifications, in which operating condition listed below is the reactor ?

a. Hot Shutdown
b. Hot Standby
c. Cold Shutdown
d. None of the Above (0.75)

8.13 When it is apparent to an operator that a specific step in a procedure does not have to be performed, what must you do as the Shift Supervisor so that the operator can continue on to the next step ? (1.0)

- End of Category 8 -

- END OF EXAM -

EQUATION SHEET

Where $\dot{m}_1 = \dot{m}_2$

$(\text{density})_1(\text{velocity})_1(\text{area})_1 = (\text{density})_2(\text{velocity})_2(\text{area})_2$

$KE = \frac{mv^2}{2}$ $\quad PE = mgh$ $\quad PE_1+KE_1+P_1V_1 = PE_2+KE_2+P_2V_2$ $\quad$ where V = specific volume, P = Pressure

$Q = \dot{m}c_p(T_{out}-T_{in})$ $\quad Q = UA\ (T_{ave}-T_{stm})$ $\quad Q = \dot{m}(h_1-h_2)$

$P = P_o 10^{SUR(t)}$ $\quad P = P_o e^{t/T}$ $\quad SUR = \frac{26.06}{T}$

delta K $= (K_{eff}-1)/K_{eff}$ $\quad CR_1(1-K_{eff1}) = CR_2(1-K_{eff2})$

$M = \frac{(1-K_{eff1})}{(1-K_{eff2})}$ $\quad SDM = \frac{(1-K_{eff}) \times 100\%}{K_{eff}}$

decay constant $= \frac{\ln(2)}{t_{1/2}} = \frac{0.693}{t_{1/2}}$ $\quad A = A_o e^{-(\text{decay constant})x(t)}$

Water Parameters

1 gallon = 8.345 lbs
1 gallon = 3.78 liters

1 ft^3 = 7.48 gallons

Density = 62.4 lbm/ft^3

Density = 1 gm/cm^3
Heat of Vaporization = 970 Btu/lbm
Heat of Fusion = 144 Btu/lbm
1 Atm = 14.7 psia = 29.9 in Hg

Miscellaneous Conversions

1 Curie = 3.7×10^{10} dps
1 kg = 2.21 lbs

1 hp = 2.54×10^3 Btu/hr

1 Mw = 3.41×10^6 Btu/hr

1 inch = 2.54 centimeters
Degrees F = (1.8) x (Degrees C) + 32
1 Btu = 778 ft-lbf
g = 32.174 $ft\text{-}lbm/lbf\text{-}sec^2$

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

Facility: Oconee

Reactor Type: B&W

Date Administered: August 3, 1984

Examiner: Walter J. Apley

Candidate:

ANSWER KEY

INSTRUCTIONS TO CANDIDATE:

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Category Value	% of Total	Candidate's Score	% of Cat. Value	Category
16	25			5. Theory of Nuclear Power Plant Operation, Fluids and Thermodynamics
16	25			6. Plant System Design, Control and Instrumentation
16	25			7. Procedures - Normal, Abnormal, Emergency, and Radiological Control
16	25			8. Administrative Procedures, Conditions, and Limitations
64				TOTALS

Final Grade _____ %

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

_____
Candidate's Signature

Exam Review total: 2:50 PM
Exam Review Done 3:31 PM

Walt: Thanks,
Regards!
Larry & Rich

ANSWER KEY

5. Theory of Nuclear Power Plant Operation, Fluids, and Thermodynamics

5.1 H_2 has a high diffusion rate, the RB is fairly open, and there is turbulent air flow in the RB due to forced cooling } Any one of answers

Reference : Requal / Volume 3 / paraphrase : Q67

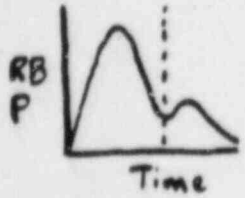
5.2 Count rate would significantly increase (by a factor of 100-8300, number not important), and would be erratic as voiding oscillations took place.

Reference : Requal / Volume 3 / NIs + Incores, p.3

5.3 False — a deficit is total reactivity insertion at the given power level - the coefficient would give the reactivity change per % of power change.

Reference : OP/1/A/1103/15 and Oconee Question #160

5.4



There are two pressure spikes. The first is counteracted by cold water spray from the BWST. When the BWST supply is depleted, a reduced repressurization of the containment vessel occurs since the recirculated spray is of a higher temperature. Slowly the air coolers and decay heat coolers remove energy from the containment system, depressurizing the containment again.

Ref: DB, SSG, Vol. 9, Containment Systems, p. 27

ANSWER KEY

5.5

a. Assuming a negative MTC, lowering RC temp will add positive reactivity; ACP will be lower

b. Lower boron concentration will require less reactivity removal; ACP will be lower.

c. After 16 hours, xenon is decaying and less xenon will have to be overcome; ACP will be lower.

Reference: Rx Theory

5.6 a. larger

b. longer

Reference: Rx Theory

5.7 a. $SUR = \frac{26.06}{\pi} = \frac{26.06}{34} = .769$

∴ Answer = # 3 / Can calculate from formula sheet

b. ~~False~~ TRUE - change in power is a logarithmic function at a steady SUR. The power change given is ~~not~~ a logarithmic; a doubling

Reference: Rx Theory

5.8 Deleted

~~Negative reactivity results in a rapid depletion of the prompt neutron population, with delayed neutrons holding power up. The delayed neutrons in effect act as a subcritical source, and therefore the more negative reactivity, the more rapidly the source achieved an equilibrium value.~~

~~Reference:~~

5.9 a. Pressure = (Density)(Height)

$= (62.4\ ^{lb}/_{ft^3})(20\ ft) / 144\ in^2/ft^2$

$= 8.67$ psig

Use of thumbrules OK (like .5 psi = 1 ft) if final answer ± 2 psig

b. Indicated level will be lower; significantly so because of the pressure drop in the air volume above the water. Tank would basically indicate empty for the described scenario.

Reference: Thermo Theory

5.10 ~~a. / b. True~~ Deleted

b. False — Not divided by actual power

Reference: TS 1-4,

5.11

1. 50°F subcooled monitor
2. OTSG - 50% on operating range
3. $T_H - T_C \cong 30$ to $40°F$
4. Turbine Bypass Valves are controlling T_{ave} at ~ 555°F. (*)
5. Main steam pressure is at ~ 1000 psi. (*)
6. Incore thermocouple temperatures (*) are not increasing.
7. Feedwater valves indicates OPEN and flow is being observed entering steam generators. 1

Ref: EP/0/A/1800/06, p.2

5.12 True

Ref: OP/2/A/1102/04, p.2

5.13 d

Ref: Regual Segment #3, Accident Analysis, p. 20-22.

ANSWER KEY

6. Plant Systems Design, Control, and Instrumentation

6.1 As the water level in EWST reaches a level of 70,000 gallons the Base HPSW Pump starts to supply the HPSW System, if the level continues to decrease to a level of 60,000 gallons the STBY HPSW Pump starts to supply the HPSW System. When the EWST level reaches 90,000 gallons, both Pumps Stop.

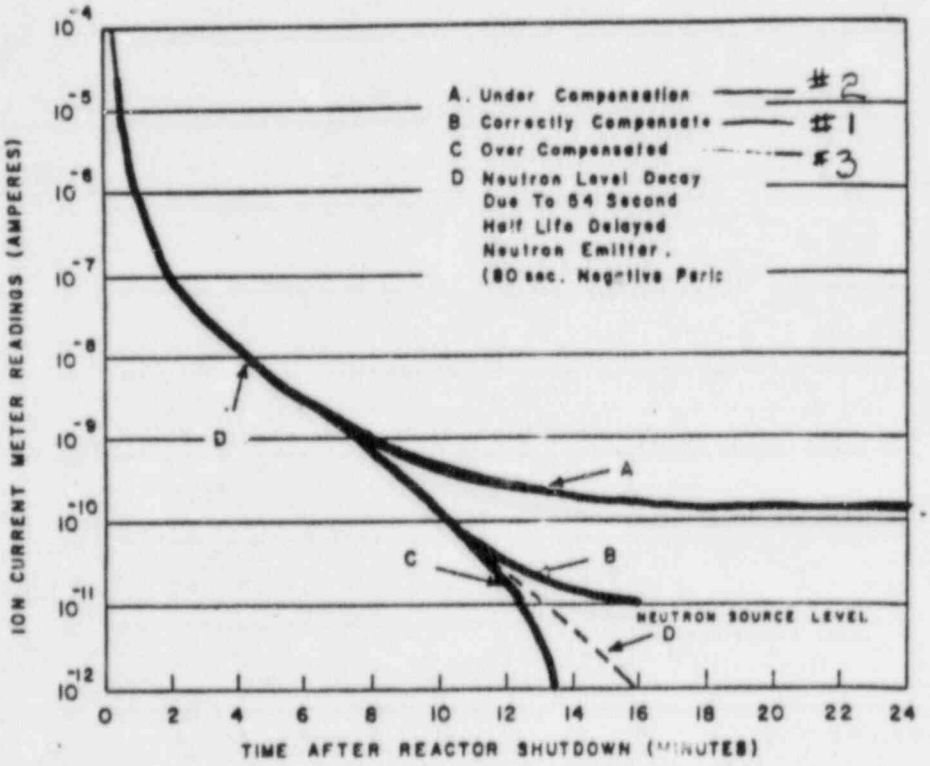
(='s not required)

Ref: Requal / Vol. 2/ Question 7

6.2
1. A & B Loop Wide Range Pressure
2. T_h & T_c Loop A & B - Temperature
3. Pressurizer Level
4. 5 Selected Incore Thermocouples.

Ref: Requal /Vol. 2 / Question 21

6.3



Ref: Requal / Volume 3 / NIs + In-Cores / Figure

ANSWER KEY

6.4 a.

If OTSC outlet pressure exceeds 1050 psig, the bypass valves will open ~~regardless of their station position in the Control Room~~ The Controller at the S/D Panel must be in Auto, ~~though~~.

F.C Same as RO #3.15 - wgs

Q did not ask for this part

b.

The bypass valves are controlled by the respective station in the Control Room either in "Hand" by the operator or automatically by the set point bias if in "Auto" unless condenser vacuum is below 7" at which point the valves close and can only be operated from their Aux S/D Panel Controllers.

Ref: Requal /Volume 4/ Main Steam Section, p. 11

6.5 No

Ref: Requal /Volume 5 /Lecture p. 12

6.6 b

Ref: Requal /Volume 6/ Lecture /p. 21

6.7 c

Reference: Oconee Question #148

ANSWER KEY

6.8 A) (1) Permits performance of CRD test when shutdown and depressurized below 1800#.
(2) Permits zero power physics test
(3) Permits operator to pull group #1 to 50% for negative reactivity available

B) (1) Power/flow - imbalance
(2) Power/Pump
(3) Low Press.
(4) Variable low pressure

C) Automatic: new high pressure trip of 1720#

Ref: Oconee Q# 183

6.9 b, e

Ref: I+E Info Notice, 84-18, 3/7/84

6.10 The potential exists for backleakage into the AFW system. Higher than normal temperatures would indicate that (0.5) % high temperatures do exist, there is a significant potential for water hammer & on automatic pump initiation and as has happened at a number of units, a trip of the AFW pump. (0.5)

CHECK - Did! - steam binding/cavitation also mentioned

* or steam binding/cavitation

Ref: I+E Info Notice 84-06, 1-25-84 *

6.11 ~~Drawdown shifts to manual~~ a F.C. - Nothing

Ref: Requal/CRDM Instr/p. 14 Systems and Procedures Specific, Vol. 1, ICS

* Also INPO SER 5-84 included in Oconee Requal Material, Volume 4, Thermo Review

ANSWER KEY

6.12 Quench Tank

same Δ as RV, also RB (only just mention RB) F.C. 1/2 credit

Ref: Station Directive 5.1.1, p.2
Systems and Procedures Specific, Volume 1, CF

6.13 Following a turbine trip, they protect the turbine from overspeed due to stored steam in the reheat system downstream of the stop valves (i.e., from HP turbine through moisture separator to LP turbine).

ANSWER KEY

7. Procedures - Normal, Abnormal, Emergency, and Radiological Control

7.1 1~~5~~ a Have to remove a vent plug and use an external vent tool

FC: 2,3 Has a quick disconnect hose connection

(credit given for explanation of alternate types)

Ref: Requal / Vol. 1 / p. 12

7.2 Purge unit results in a Radiological Release to the environment, while Recombiner returns isotopes to the containment.

Ref: Requal / Vol. 3 / question 6.3

7.3 Use hotwell and condensate booster pumps

Need to reduce S/G pressure to ~500 psig using turbine bypass or atmospheric steam dumps.

Ref: EP/0/A/1800/14, p. 9

Answer Key

(7.4) — Any 4 —

1. Transfer AS control to unaffected unit.
2. Transfer AS to evaporators/plant heating to unaffected unit.
3. Separate plant heating from affected unit.
4. Ensure condensate return tank returns not cross connected.
5. Do not supply Aux. Boiler from affected unit UST.
6. Use MS for CSAE, Stm. seals, to EFWP, etc... for as long as possible to reduce amount of water going to affected unit's CST from condensed AS drains.

Ref: Regual / Volume 4/ Aux Steam, OP-OC-SY-AS, p. 10 of 19

7.5 a. Thermal stress on the generator during the transient – damage to generator sufficient answer

b. Cold gas temperature

Hydrogen Cooler Outlet Temp (which is way cold gas temp is measured)

Ref: Regual / Volume 6/ Lesson, p. 22 of 22

7.6 I would instruct the operators to leave the RCS's running. (Following a LOCA which depressurizes the RCS to a pressure which actuates ES 1&2 the leak rate may be in the critical break size range. If so, two minutes into the evolution the RCS may have evolved to the maximum 70% void fraction.) Securing the RCP's five minutes after initiation will result in the two phase mixture separation with insufficient liquid initially reflooding the core. This situation will lead to unacceptable core temperatures.

Ref: Oconee Q#103

7.7 10% /hr

Ref: Station Directive 3.1.2

ANSWER KEY

7.8 (b) IA, for Load rejection includes "Increase letdown flow by opening (2)(3) HP-7." (a) But if unit trips (reactor trip), the Reactor Trip EP has as an action that letdown be isolated

Ref: EP/0/A/1800/1, p.1
EP/0/A/1800/3, p.2

7.9 Reduce 4% below allowable power (in this case to 76%)
Ref: OP/1/A/1102/02, p.2

7.10 False - reverse

Ref: OP/2/A/1102/04, p.1

7.11 Any two items below

1. Never operate with one RBCU in fast / one in slow
2. Fans are not to be started, stopped, or speed changed for fan-service considerations
3. The 30 minute limit does not apply on off-low-high.
4. A two step off-low-high sequence is not preferred.

Ref: OP/1/A/1104/15, p.1

7.12 (b) for two reasons

1 - Ref: OP/1/A/1106/01, Encl. 4.1 p. 2
lists the other 3 as the approved ways
2 - Ref: OP/1/A/1106/01, Encl 4.1, p. 1
1000 - 1400 is the critical speed range

7.13 Stop Unit (2) or (3) R.B. Purge Fan if operating,

start fan F-1

or F-2 on the effected Spent Fuel Pool

Filtered Exhaust System

Ref: EP/0/A/1800/13, p. 2

7.14 95% in Full Range

Ref: P/0/A/1800/15, p. 1

ANSWER KEY

8. Administrative Procedures, Conditions, and Limitations

8.1 1. Exercising control rods
2. C.R. latching + PI alignment
3. Recovery of dropped rod
4. Rod drop / trip time test

} 3 of 4

Ref: Requal / Vol. 1 / p. 38

8.2 It must be cycled electrically

Ref: Requal / Vol. 2 / p. 6 of lectures - LPSW

8.3 Within 1 hr establish a fire watch / inspect area once per hour.

Ref: Requal / Vol. 2 / p. 5 of HPSW lecture

8.4 a. TRUE
b. False
c. True

Ref: Requal / Vol. 2 / question 28

8.5 >80% of power allowable for existing RCP combination.

Ref: Requal / Vol. 3 / question 5

∴ if limit 75%, then .8 × .75 = 60%

Answer Key

8.6 Yes

Reference : Requal /Vol. 3/ Emerg. Plan, p.3

8.7 a. Within 1 hr
b. Within 15 minutes

Reference : RP/0/B/1000/02, p.1

8.8 During handling of irradiated fuel in the reactor building at least one door on the personnel and emergency hatches shall be closed. The equipment hatch cover shall be in place with a minimum of four bolts securing the cover to the sealing surface.

Reference : Requal /Volume 4/ Q 837.

8.9 1. Subcriticality
2. Inadequate Core Cooling
3. Heat Sink
4. RCS integrity
5. Containment Integrity
6. RCS inventory

Ref: Requal / Volume 5/ lecture on SPDS, p.1

8.10 Station Manager

Ref: Station Directive 3.1.1, p.4

8.11 b.
I - Automatic sprinkler systems, EWST, HPSW pumps, Halon, fire barriers, and smoke detectors
II - Support systems like piping, hydrants c.
and mains.
III - Fire extinguishers a.
Ref: Station Directive 5.3.3, p. 1-2

ANSWER KEY

B.12 d.

Reference : Tech Specs, p. 1-1

B.13

A supervisors permission (SRO - licensed) must be obtained (may be verbal), and the initials of that Supervisor must be documented on the procedure by the "N/A".

Ref: SD-4.2.1, p. 3

(Enclosure 3/ 2 of 3)

U. S. NUCLEAR REGULATORY COMMISSION

REACTOR OPERATOR REQUALIFICATION EXAMINATION

Facility: Oconee

Reactor Type: B&W

Date Administered: August 3, 1984

Examiner: Walter J. Apley

Candidate: ____________________

INSTRUCTIONS TO CANDIDATE:

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheet. Points for each question are indicated in parenthesis 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 four (4) hours after the examination starts.

Category Value	% of Total	Candidate's Score	% of Cat. Value	Category
~~16~~ 15.1	~~24~~ ~~25~~ 23.9			1. Principles of Nuclear Power Plant Operation, Thermodynamics, Heat Transfer and Fluid Flow
16	25.4			2. Plant Design Including Safety and Emergency Systems
16	25.4			3. Instruments and Controls
16	25.4			4. Procedures: Normal, Abnormal, Emergency, and Radiological Control
~~64~~ 63.1				TOTALS

Final Grade ________ %

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

____
Candidate's Signature

Review Started: 1[40] PM
Review Completed: 2[47] PM

1.0 PRINCIPLES OF NUCLEAR POWER PLANT OPERATION, THERMODYNAMICS, HEAT TRANSFER AND FLUID FLOW (16 POINTS)

1.1 If a 40 second period produces a .66 DPM startup rate, an 80 second period will produce a ___?___ DPM startup rate. (1.0)

1.2 For a large LOCA the transient proceeds through three distinct phases. List and describe each of these phases. (1.5)

1.3 Oconee Unit 1 has been operating at 100% of rated power for the past six months. The reactor operator then reduces power over a two-hour period to 50% for maintenance on the secondary side. Assuming the control rods are in automatic, describe how and why the control rod position of the controlling group(s) would change over the power reduction and for 12 hours after the power reduction. (Assume boron concentration is not changed). (2.0)

1.4 TRUE or FALSE:

Quadrant Power Tilt is affected by delta Tc changes. (0.5)

1.5 According to OP/0/A/1102/16 (Natural Circulation Cooldown), a natural circulation cooldown will be more difficult to control than a cooldown with RCPs in terms of maintaining an adequate pressure/temperature "margin-to-saturation" and "margin-to-PTS." Explain why. (1.5)

1.6 The following statements are concerned with subcritical multiplication. Choose the one underlined word that will make the sentence correct.

a. As Keff approaches unity, a larger/smaller change in neutron level results from a given change in Keff. (0.5)

b. As Keff approaches unity, a shorter/longer period of time is required to reach the equilibrium neutron level for a given change in Keff. (0.5)

1.7 Assume a reactor trip from 100% power. Compare the change in pressurizer level response with and without the 125 psi bias in the ICS. Begin with the normal pressurizer level at full power and show by calculation how much the level will drop with and without the bias (Do not include any operator action). (2.0)

- Category 1 Continued on Next Page -

1.8 A cylindrical vented tank has a diameter of 13 feet and a height of 26 feet. It is filled with water to a height of 20 feet. What is the pressure at the bottom of the tank (in psig) ? (1.0)

NOTE: The weight of water is 62.4 lb/ft^3.

1.9 During a startup from xenon free conditions with constant temperature, reactor power is leveled at 10^{-8} amps and then rapidly increased to 10^{-7} amps and leveled. Which of the statements below is TRUE regarding the relative rod position before and after the power rise (select one) ?

a. The rod position at 10^{-7} amps is the same as the rod position at 10^{-8} amps.

b. The rod position at 10^{-7} amps is higher than it was at 10^{-8} amps by an appreciable amount.

c. The rod position at 10^{-7} amps is lower by an appreciable amount than it was at 10^{-8} amps. (0.5)

1.10 Why is there a limit of 525°F on RCS temperature prior to criticality ? (1.0)

1.11 List those parameters given in EP/0/A/1800/06 (Loss of Reactor Coolant Flow) which indicate that adequate RCS natural circulation exists. (2.1)

1.12 Fill in the blanks for each of the following:

a. A reactivity coefficient of concern at Oconee that is NOT affected by boron is the _____?_____ coefficient. (0.25)

b. When Keff equals one the net reactivity in the core is equal to _____?_____. (0.25)

c. When Keff equals one the shutdown margin in the core is equal to _____?_____. (0.25)

d. Over core life $Beta_{eff}$ decreases because of the increase in fission of _____?_____. (0.25)

Explained — Actual vs Available

1.13 ~~Explain why the magnitude of the prompt drop in neutron power following a reactor trip depends on the amount of negative reactivity inserted.~~ (0.9) Delete

- End of Category 1 -

2.0 PLANT DESIGN INCLUDING SAFETY AND EMERGENCY SYSTEMS (16 POINTS)

2.1 In the event of a rupture of the BWST, what is the major backup source of borated water to the HPI pumps ? (1.0)

2.2 What plant design feature ensures the presence of adequate cooling of the CRDM stators prior to closing the CRDM breakers ? (1.0)

2.3 List the power supplies (including alternate) to the LPSW pumps. (1.5)

2.4 Where do the core flood tanks vent to ? (1.0)

2.5 a. Above what temperature would you expect damage to the letdown demineralizer resin ? (0.5)

b. If a higher temperature condition has caused HP-5 to close, thus protecting the resin, describe how letdown may be re-established. (1.0)

2.6 TRUE or FALSE:

Following a large break LOCA, both core flood tanks are required to adequately recover the core hot spot within an adequate time frame. (0.5)

2.7 What are the sources of water to the Emergency Feedwater Pumps (Include any restrictions or limitations on their use) ? (2.0)

2.8 What is the purpose of the Intercept-Reheat Valves associated with the Turbine Generator ? (1.0)

- Category 2 Continued on Next Page -

2.9 Why must there be sufficient vacuum in the main condenser prior to putting a POWDEX demineralizer in service ? (1.0)

2.10 a. Why do gases that were in solution in the Reactor Coolant System tend to come out of solution in the pressurizer ? List two reasons. (2.0)

b. What would be the operational effect if these gases were allowed to accumulate ? (1.0)

2.11 List the loads in the Auxiliary Building cooled by the Recirculating Cooling Water (RCW) System. (2.0)

2.12 TRUE or FALSE:

With a unit at rated power, feedwater flow oscillations can cause the reactor to trip on high nuclear power. (0.5)

- End of Category 2 -

3.0 INSTRUMENTS AND CONTROLS (16 POINTS)

3.1 The Diamond panel is operating in automatic. The operator depresses the Sequence/Sequence Override Pushbutton. What happens to the Diamond Control System ? (1.0)

3.2 The Diamond panel is operating in automatic. The speed selector is inadvertently left in jog. Will the control rods move in run or jog speed ? (1.0)

3.3 Other than computer and control board indications, what does the Absolute Position Indication associated with the CRD instrumentation output to (two responses required) ? (2.0)

3.4 List three (3) Process Radiation Monitors that have interlocks associated with them and describe the purpose of these interlocks. (1.5)

3.5 TRUE or FALSE:

On a total loss of Instrument Air pressure, all pneumatic valves will fail to their ES position. (0.5)

3.6 What does the Magenta color block on the Safety Parameter Display System indicate ? (0.5)

3.7 According to the Guidelines for Changing Generator VARS, which of the following does the operator do to increase VARS ? one

a. Increase hydrogen pressure
b. Increase generator voltage
c. Decrease hydrogen pressure
d. Decrease generator voltage. (0.5)

3.8 The power factor as read in the control room is (select one):

a. System power factor
b. Unit power factor
c. Station power factor
d. None of the above. (0.5)

- Category 3 Continued on Next Page -

3.9 Assume the manual transfer switch in the KI and KX inverter is in the "Automatic" position. If the static switch should fail to automatically swap KI to the regulated power supply; what manual backup(s) are available to make the transfer ? (1.5)

3.10 What is the purpose of the interlock which results in Containment building sump isolation valves (LP-19 and LP-20) remaining closed until the RCS supply header isolation (LP-3) and the BWST supply isolation valves (LP-21 and LP-22) are closed. (1.0)

3.11 If the last operating CCW pump is secured during a shutdown without valves 1CCW 1-6 being closed and breakers de-energized, what will happen ? (1.0)

FC: 1CCW

3.12 What gases are monitored on-line in the gaseous waste disposal system, and what is the maximum limit(s) for those gases ? (1.0)

3.13 TRUE or FALSE:

High Reactor Building Temperatures will cause pressurizer and steam generator level instruments to indicate low. (0.5)

3.14 In the automatic mode FDW-315 and 316 position is controlled by an input S/G level signal from either the primary or backup string. If the backup string is selected and its power fails, will control automatically transfer to the primary string ? (1.0)

3.15 Explain how turbine bypass valve control is affected by the position of the Auxiliary Shutdown Panel Controllers:

a. If OTSG outlet pressure exceeds 1050 psig ? (0.75)

b. If condenser vacuum is less than 7" ? (0.75)

3.16 Which of the instrumentation listed below is available at the Standby Shutdown Facility to monitor RCS parameters?

a. Compensated Pressurizer Level

b. Loop B Wide Range Pressure

c. Loop A Thot

d. Loop B Tave (1.0)

Explained may be more than one correct

- End of Category 3 -

4.0 PROCEDURES: NORMAL, ABNORMAL, EMERGENCY, AND RADIOLOGICAL CONTROL (16 POINTS)

4.1 Upon receiving an Instrument Air (IA) Trouble Alarm:

a. What two (2) things should an operator dispatched to the IA compressor area check ? (1.0)

b. What two (2) actions should this operator perform locally ? (1.0)

4.2 On March 1, 1984, the boron concentration in "1A" Core Flood Tank (Unit 1) was measured to be 1601 ppm; the backup was 1571 ppm.

a. What is the minimum concentration of borated water allowed in each CFT ? (0.5)

b. What was the cause of the incident ? (1.0)

4.3 TRUE or FALSE:

During Unit Startup with HPI system still in By-Pass mode a LOCA results in loss of 50°F subcooled margin. In this situation all RCP's must be secured immediately. (0.5)

4.4 When performing a reactor startup:

a. How close to the predicted critical position must criticality be achieved ? (0.5)

b. What must be done if criticality is not achieved within the tolerance ? (1.5)

- Category 4 Continued on Next Page -

4.5 To prevent or minimize pressure transients in the RCS, the CRO is to manually trip the reactor when certain conditions exist. For those conditions fill in the blanks below:

a. A turbine trip if Reactor Power is greater than ___?___ %. (0.5)

b. Low OTSG level below ___?___ inches. (0.5)

c. Closure of ___?___ main steam stop valves on one OTSG, or ___?___ main steam stop valves on both OTSGs. (0.5)

4.6 TRUE or FALSE:

When applying a red tag, the tag should be placed on the switch, disconnect, valve or operating device and then the device placed in its correct position according to the tag. (0.5)

4.7 Which of the following actions is NOT an immediate manual action for a Loss of Reactor Coolant (Case A: Excessive RCS Leakage) ?

a. Close (1)(2)(3)HP-5 (Letdown Isolation), if required.

b. Secure makeup to LDST

c. Insure the RC System is $\geq$ 35°F subcooled by the Subcooled Margin Monitors (*) and remains so during power operations.

d. Close (1)(2)(3)RC-4 (Power Operated Relief Block). (1.0)

4.8 On a Steam Supply System rupture, what immediate actions should the operator take to isolate both steam generators ? (1.5)

4.9 E.S. initiates automatically due to a low RC system pressure. What immediate operator action takes precedence over all other immediate actions ? (1.0)

-Category 4 Continued on Next Page-

4.10 A runback due to an asymmetric rod alarm occurs. The runback stops at 71% power when the asymmetric rod alarm clears. Which of the following actions should the operator take ?

a. Manually run back to 55%

b. Reduce power to less than 60% of the Thermal Power Allowed for the RC Pump combination

c. Continue operation at 71%

d. Shut down the plant due to the failure of a protective action. (1.0)

4.11 TRUE or FALSE:

Maneuvering restrictions related to CRD withdrawal and APSR motion are the same. (0.5)

4.12 On a steam generator tube rupture, why should all nonessential secondary system drains be secured ? (1.0)

4.13 How is the Feedwater System operated to ensure that the FWPT will not trip on Low Bearing Oil Pressure ? (1.0)

4.14 What is the maximum allowable reading (% or MR) on a direct-reading dosimeter (prior to requiring it to be brought to Health Physics for recording of the reading and rezeroing) ? (0.5)

4.15 TRUE or FALSE:

According to Station Directive 3.8.10 (Procedure for Use of Count Rate Meters and Portal Monitors) 30 seconds is a sufficient time for an adequate whole body frisk. (0.5)

- End of Category 4 -

- END OF EXAM -

EQUATION SHEET

Where $\dot{m}_1 = \dot{m}_2$

$(\text{density})_1(\text{velocity})_1(\text{area})_1 = (\text{density})_2(\text{velocity})_2(\text{area})_2$

$KE = \frac{mv^2}{2}$ $\quad PE = mgh$ $\quad PE_1+KE_1+P_1V_1 = PE_2+KE_2+P_2V_2$ $\quad$ where V = specific volume, P = Pressure

$Q = \dot{m}c_p(T_{out}-T_{in})$ $\quad Q = UA\,(T_{ave}-T_{stm})$ $\quad Q = \dot{m}(h_1-h_2)$

$P = P_0 10^{sur(t)}$ $\quad P = P_0 e^{t/T}$ $\quad SUR = \frac{26.06}{T}$

$\text{delta } K = (K_{eff}-1)/K_{eff}$ $\quad CR_1(1-K_{eff1}) = CR_2(1-K_{eff2})$

$M = \frac{(1-K_{eff1})}{(1-K_{eff2})}$ $\quad SDM = \frac{(1-K_{eff})}{K_{eff}} \times 100\%$

$\text{decay constant} = \frac{\ln(2)}{t_{1/2}} = \frac{0.693}{t_{1/2}}$ $\quad A = A_0 e^{-(\text{decay constant})x(t)}$

Water Parameters

1 gallon = 8.345 lbs
1 gallon = 3.78 liters

1 ft^3 = 7.48 gallons

Density = 62.4 lbm/ft^3

Density = 1 gm/cm^3
Heat of Vaporization = 970 Btu/lbm
Heat of Fusion = 144 Btu/lbm
1 Atm = 14.7 psia = 29.9 in Hg

Miscellaneous Conversions

1 Curie = 3.7×10^{10} dps
1 kg = 2.21 lbs

1 hp = 2.54×10^3 Btu/hr

1 Mw = 3.41×10^6 Btu/hr

1 inch = 2.54 centimeters
Degrees F = (1.8) x (Degrees C) + 32
1 Btu = 778 ft-lbf
g = 32.174 $ft\text{-}lbm/lbf\text{-}sec^2$

U. S. NUCLEAR REGULATORY COMMISSION

REACTOR OPERATOR REQUALIFICATION EXAMINATION

Facility: Oconee

Reactor Type: B&W

Date Administered: August 3, 1984

Examiner: Walter J. Apley

Candidate:

ANSWER KEY

INSTRUCTIONS TO CANDIDATE:

Use separate paper for the answers. Write answers on one side only. Staple question sheets on top of the answer sheet. Points for each question are indicated in parenthesis 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 four (4) hours after the examination starts.

Category Value	% of Total	Candidate's Score	% Category Value	Category
16	25			1. Principles of Nuclear Power Plant Operation, Thermodynamics, Heat Transfer and Fluid Flow
16	25			2. Plant Design Including Safety and Emergency Systems
16	25			3. Instruments and Controls
16	25			4. Procedures: Normal, Abnormal, Emergency, and Radiological Control
64				TOTALS

Final Grade _____%

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

_____
Candidate's Signature

Review Started: 1:40 PM
Review Completed: 2:47 PM

Bruce A. Wilson
Walter J. Apley
Elizabeth
Larry [illegible]

ANSWER KEY

1. Principles of Nuclear Power Plant Operation, Thermodynamics, Heat Transfer and Fluid Flow

1.1 .33 DPM

Ref: Oconee Q# 129 - Paraphrased

1.2 1) blowdown- rapid depressurization and loss of coolant thru break- usually leaves core voided - continues until system pressure equals containment pressure

2) refill- time for ECCS systems to begin to cover core- during this phase vessel is refilled to bottom of fuel

3) reflood/recover - during this phase core is recovered by ECCS systems - level will continue to increase until level is at elevation of break.

Ref: Oconee Q # 137

1.3 Initially the control rods would be driven in to offset the power defect. Then as xenon began to "peak" following the power reduction the control rods would have to be withdrawn to offset xenon effects. After the "peak" is reached by xenon (~ 4-6 hours) the xenon concentration will then begin to decrease to its equilibrium value for 50% power, therefore to offset this, the rods will then be driven in again.

Ref: Oconee Q #179

1.4 True

Ref: OP/2/A/1102/04, p. 2

1.5 Without RCPs there will be no pressurizer spray and depressurization will only occur at the rate heat is lost from the pressurizer (assuming no PORV) operation

Ref: OP/0/A/1102/16, p 8.

ANSWER KEY

1.6 a. Larger
b. Longer

Reference : Rx Theory

1.7 Tave 579°F 100% FP
Normal Pressurizer level = 200"
Tave 532°F No load
Tave + bias = 557°F

F.C. - May use 220" - may also give 5" per °F

Pzr level ≈ 5½" /°F

With bias = 200 - (5½"/°F × (579 - 557))
= 200 - 121
With bias = 79"

w/o bias = 200 - (5½"/°F × (579 - 532))
= 200 - 258.5"
w/o bias = - 58.5"

Empty indicating

Reference : Systems + Procedures Manual, ICS Section

1.8 Pressure = (Density) (Height)
= (62.4 lb/ft³) (20 ft) / 144 in²/ft²
= 8.67 psig

Use of thumbrules OK (like .5 psi = 1 ft)
if final answer ± 2 psig

Reference : Thermo Theory

Answer Key

1.9 a.

Reference : Rx Theory

F.C. - positive or less negative MTC worse at lower temperatures

1.10

At the beginning of the initial fuel cycle, the moderator temperature coefficient is expected to be slightly positive at operating temperatures with the operating configuration of control rods.(1) Calculations show that above 525°F, the consequences are acceptable.

(Since the moderator temperature coefficient at lower temperatures will be less negative or more positive than at operating temperature,(2) startup and operation of the reactor when reactor coolant temperature is less than 525°F is prohibited except where necessary for low power physics tests.)

Ref: Tech Specs 3.1.3, p. 3.1-8

1.11

1. 50°F subcooled monitor
2. OTSG - 50% on operating range
3. $T_H - T_C \cong 30$ to 40°F
4. Turbine Bypass Valves are controlling T_{ave} at ~ 555°F. (*)
5. Main steam pressure is at ~ 1000 psi. (*)
6. Incore thermocouple temperatures (*) are not increasing.
7. Feedwater valves indicates OPEN and flow is being observed entering steam generators.

Ref: EP/0/A/1800/06, p.2

Answer Key

1.12
a. Doppler
b. Zero
c. Zero
d. Pu-239

Reference : Oconee Q's 125-127

1.13 Negative reactivity results in a rapid depletion of the prompt neutron population, with delayed neutrons holding power up. The delayed neutrons in effect act as a subcritical source, and therefore the more negative the reactivity, the more rapidly the source achieves an equilibrium value.

Reference:

Deleted

5 of 13

ANSWER KEY

2. Plant Design Including Safety and Emergency Systems

2.1 Spent fuel pool

Ref: EP/0/A/1800/25, p.1

2.2 Interlock prevents energizing stators if total CC flow is less that 138 gpm (69 CRDMs x (2 GPM/CRDM)).

Ref: Requal Vol 1 / CRDM, p.6

2.3 A 1 TC
B 1 TD or 2 TD
C 2 TC

F.C. Will not take off if don't include Unit #3

F.C. - DO to Not have to specify exact pump to power supply

Ref: Requal / Vol. 2 / Lecture - p.5

2.4 Quench Tank

F.C. - S.D. Proc - Con vent to RB (1/2 credit if only RB given)

Ref: Station Directive 5.1.1, p.2 Systems + Procedures Specific, CF Section

2.5 a. 130°F is alarm (135°F is interlock); either value OK or 140°-160°F with explanation.

b. Demineralizers can be bypassed, then high temperature interlock bypassed.

Ref: Lesson Plan, HPI, p.3

2.6 True

Ref: Lesson Plan, Core Flood, p. 3

ANSWER KEY

2.7 Turbine Driven Emergency Feedwater Pump suction can be taken from Upper Surge Tank or from the hotwell (under vacuum if flow is limited).

Motor Driven Emergency Feedwater Pump suction can be taken from Upper Surge Tank or from the hotwell if vacuum is broken.

Ref: Oconee Q # 55

2.8 Following a turbine trip, they protect the turbine from over-speed due to stored steam in the reheat system down stream of stop valves. (i.e., from HP turbine through moisture separator to L.P. turbine)

Ref: Oconee Q #1

2.9 Oxygen would not be below (50 ppm) FC: Limits "#" Not reqd

Ref: Lesson Plan, Condensate, p.2

2.10 a. ① De-aerating effect of pressurizer spray
② Decreased solubility due to higher temperature

b. Sprays become less effective at reducing pressure due to non-condensability of gases. This is frequently called a "hard bubble." A less directly operational effect would be the buildup of total gas in the RCS (½ credit).

Reference: OP/0/A/1103/05

ANSWER KEY

2.11

1. Interim Evaporator* (.2)
2. Seal Return Coolers (.4)
3. Primary Sample Sink (.2)
4. Misc. Waste Evaporator (.2)
5. RC Bleed Evaporator (.2)
6. SFP Coolers (.4)
7. GWD Compressors (.4)

Ref: Requal, Section 2, Lecture Outline on RCW, p.3
RCW P&ID

2.12 True

Ref: Oconee Trip Reports

FC: * NOT IN Aux bldg

8013

ANSWER KEY

3. Instruments and Controls

3.1 ~~Drained ships to manual~~ [a] Nothing F.C.

Ref: Requal / CRDM Instr / p. 14
Systems and Procedures Specific, Vol. 1, ICS

3.2 Run

Ref: Requal / CRDM Instr / p. 15

3.3 1. Asymmetric fault runback circuit
2. Sequence inhibit enable circuit
3. Cable Room Indication
ANY TWO

Ref: Requal / Vol. 1 / Question 27

3.4 any three:

1)	RIA-33 & 34:	Terminate LWD - Releases
2)	RIA-37 & 38:	Terminate GWD - Releases
3)	RIA-45:	Terminate Purge of Reactor Building
4)	RIA-49:	Closes LWD-2 - Terminate release from Reactor Bldg. Sounds evacuation alarm to warn people in containment.
5)	RIA-54:	Terminates releases from Turbine Building Sump.

Ref: Requal / Vol. 2 / Question 20

3.5 True

Ref: Requal / Vol. 4 / Instrument Air, B-1362, p. 8

3.6 Invalid or bad computer point

Ref: Requal / Vol. 5 / Lecture on SPDS, p 2

3.7 b.

Ref: Requal / Vol. 6 / Lecture, p. 59

ANSWER KEY

3.8 b.

Reference : Requal / Vol. 4 / Question 6 50

3.9 Recently a manually operated ABT has been added ; In addition there are 3 switches (51, 52, 53) which can be manually aligned to bypass the inverter.

F.C – 51, 52, 53

Ref: Training, Vital Instr, p.5
: 1107-04, 1.2+2.2, Encl. 4.

3.10

This interlock prevents flow from the RCS being dumped to the RB emergency sump.

Reference : OP/3/A/1104/04, change 27, p. 4 of letter

F.C. → T only unit 3

3.11 Emergency gravity flow initiation will occur.

Reference : OP/1/A/1104/12, Encl. 4.2, p.1

3.12 3% – Oxygen and Hydrogen

Reference : OP/1+2/A/1104/18, p.1

3.13 False – high

Reference : OP/0/A/1106/35, p. 1

3.14 No

Reference : Lesson Plan, Emerg FW, p.8

ANSWER KEY

3.15

a.

F.C. If OTSG outlet pressure exceeds 1050 psig, the bypass valves will open, ~~regardless of their station position in the Control Room~~ The Controller at the S/D Panel must be in Auto, ~~though~~

Not asked for in Q

b.

F.C. Same as "a" D. The bypass valves are controlled by the respective station in the Control Room either in "Hand" by the operator or automatically by the set point bias if in "Auto" unless condenser vacuum is below 7" at which point the valves close and can only be operated from their Aux S/D Panel Controllers.

Ref: Requal / Volume 4 / Main Steam Section, p. 11

3.16

a. No, only uncompensated available

b. Yes

c. Yes

d. No

Ref: Requal / Vol 2 / Paraphrase of Q#21

ANSWER KEY

4. Procedures: Normal, Abnormal, Emergency, and Radiological Control

4.1 a. (1) Check the After Coolers
(2) Check the Compressor lineup
b. (3) Shutdown the malfunctioning compressor and shut the discharge valve.
(4) Place all available compressor in base.

Ref: Requal / Volume 4 / Question B18

4.2 a. 1835 ppm

b. Inleakage of water caused by leaking HPI valves.

Ref: Oconee Incident Report No. 084-008-1
Requal / Volume 5 / Lecture

4.3 True

Ref: Requal / Volume 5 / Questions 29+30

4.4 a. ± 1% ΔK/K

b. He will shutdown the reactor and insert the control rods to 50% withdrawn on Group 1 and inform his supervisor (so Performance and Operations can evaluate actual core conditions, verify adequate shutdown margin and core physics data prior to startup)

F.C.

Ref: Oconee Q# 110

12 of 13

ANSWER KEY

4.5 a. 20%
b. ≤ 15"
c. Two on same OTSG or all 4 valves

Reference: Station Directive 3.1.3.0 and paraphrased Oconee Q # 219.

4.6 False - valve ~~the~~ (etc) should be positioned before tag applied.

Ref: Station Directive 3.1.1, p.2

4.7 b

You initiate not secure makeup

Ref: EOP/0/A/1800/04, p.2

4.8 Place MAIN, STARTUP FDW, EMERG FDW, AND TURBINE BYPASS VALVES IN MANUAL AND CLOSE.

Ref: EP/0/A/1800/°, p.1

F.C. – MAY NEED TO SHUT BLOCKS (Not credited one way or other as part of answer)

4.9 Trip RCPs

Ref: EP/0/A/1800/20, p.3

4.10 c.

Ref: EP/0/A/1800/21, p.1

4.11 False

Ref: OP/1/A/1102/04, Encl 4.1

ANSWER KEY

4.12 Minimize Turbine Building sump volumes, and total contaminated liquid inventory and necessary de-contamination.

Ref: OP/O/A/1106/31, p.5

4.13 The Cent. oil pump is run all the time.

Ref: Oconee Lesson Plan, FW System, p.1

4.14 60% of full scale / 300 mR

Ref: SD 3.8.1, p.2

4.15 False - (two minutes)

Ref: SD 3.8.10, Encl. 5.1

(Enclosure 3 / 3 of 3)

U. S. NUCLEAR REGULATORY COMMISSION

REACTOR OPERATOR LICENSE EXAMINATION

Facility: Oconee

Reactor Type: Babcock & Wilcox

Date Administered: August 13, 1984

Examiner: J. C. Huenefeld

Candidate: MASTER

INSTRUCTIONS TO CANDIDATE:

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheet. Points for each question are indicated in parenthesis 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 Cat. Value	Category
25	25			1. Principles of Nuclear Power Plant Operation, Thermodynamics, Heat Transfer and Fluid Flow
25	25			2. Plant Design Including Safety and Emergency Systems
25	25			3. Instruments and Controls
25	25			4. Procedures: Normal, Abnormal, Emergency, and Radiological Control
100				TOTALS

Final Grade _____ %

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

_____
Candidate's Signature

Reviewed By:

James P. Dunn

Paul M. Storall

Richard M. Conner

Henry R. Lowery

1.0 PRINCIPLES OF NUCLEAR POWER PLANT OPERATION, THERMODYNAMICS, HEAT TRANSFER AND FLUID FLOW (25 Points)

1.1 Which of the following parameters would be most useful to determine the enthalpy rise across an operating RCP? (Select one) (1.0)

a. Pump motor current and Delta P
b. Pump motor current, and voltage, and Delta T
c. Pump motor current, and voltage, and flowrate
d. Pump motor current, voltage, and RPM

1.2 TRUE or FALSE. The enthalpy of water is primarily dependent on temperature rather than pressure. (0.5)

1.3 Given a quantity of superheated steam, would the following processes cause specific enthalpy to increase, decrease, or stay the same?

a. an iso-thermal compression (0.5)

b. an iso-baric (constant pressure) increase in temperature (0.5)

1.4 The amount of energy being delivered by the OTSGs is actually greater than the thermal energy being supplied by the nuclear core. How can this imbalance exist during steady-state conditions? (1.5)

1.5 TRUE or FALSE. For a constant speed centrifugal pump, as the volume flowrate increases, the pump head decreases. (0.5)

1.6 TRUE or FALSE. A pump whose centerline is above the level of water in a tank from which it is taking a suction will cavitate even though the NPSH is positive. (0.5)

- Section 1.0 continued on next page -

1.7 During the process of drawing a Pressurizer bubble, nitrogen is vented from the Pressurizer to the Quench Tank. Explain how you determine that all of the nitrogen has been vented. (1.5)

1.8 TRUE or FALSE. During normal power operation, the Pressurizer temperature is sometimes less than 50°F above the highest RCS temperature. (0.5)

1.9 All four NIs are reading equal to thermal power best. With this in mind, select the correct statement from below: (Select one) (1.0)

a. If one of the NIs were to exceed thermal power best (TPB), then it would be reading non-conservatively and power would have to be adjusted such that the other three read less than TPB.

b. This case (all four NIs equal to TPB) may be non-conservative if less than 4 RCPs are operating.

c. This would indicate that the heat being added to the RCS by RCPs is no longer a significant contributor to TPB.

d. This is indicative of the fact that the reactor has reached equilibrium samarium and xenon conditions.

1.10 One RCP is operating in one loop; two RCPs are operating in the other loop. Because of an ICS malfunction both OTSGs continue feeding and steaming at equal rates (i.e., there is no reratio of feed water).

a. What would be the steady state relationship between the primary water Delta T across the two OTSGs? (0.5)

b. What would be the steady state relationship between the levels of the two OTSGs? (1.5)

c. What would be the steady state effect on Quadrant power tilt? (0.5)

- Section 1.0 continued on next page -

1.11 a. Oconee has an Antimony Beryllium source installed in the core. When a source is lowered into the core, is its presence adding reactivity (decreasing the Shutdown Margin)? Explain your answer. (1.0)

b. If when the source is lowered into the core it doubles the total effective source strength, what should happen to the indicated source range nuclear indication? (1.0)

1.12 TRUE or FALSE. If the reactor could be made exactly critical, countrate would be increasing at a linear rate proportional to the source strength. (0.5)

1.13 Select from the following list of parameters those parameters that have a direct effect on the Startup Rate of a subcritical reactor during rod withdrawal: (Note: there may be more than one). (1.0)

a. the ratio of source strength to the current count rate.

b. the instantaneous rate of change of K effective (i.e., rod speed).

c. the current value of K effective.

1.14 TRUE or FALSE. Because of the half-life of the longest lived delayed neutron precursors, reactor power cannot be lowered any faster than .333 Decades per Minute (DPM). (0.5)

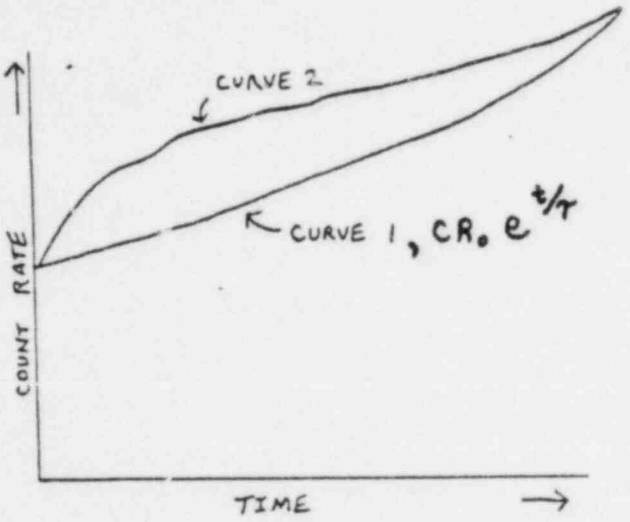
1.15 Recall that equilibrium subcritical count rate can be represented as:

$$CR = S + SK + SK^2 + SK^3 + \ldots + SK^n$$

Utilizing this relationship, explain why startup rate takes longer and longer to return to zero as you get closer and closer to criticality. (1.5)

- Section 1.0 continued on next page -

1.16 Curve 1 in the figure below shows the predicted exponential behavior of countrate after a step insertion of reactivity at low reactor power, with the reactor less than prompt critical. Curve 2 is more representative of what actually happens as a result of a step insertion of reactivity. Curve 2 eventually matches up with Curve 1. Briefly explain the difference between the predicted (Curve 1) and the actual (Curve 2) response. (3.0)



1.17 Which of the following statements is true regarding control rod worth? (Select one) (1.0)

a. It is proportional to rod speed.

b. It is not affected by the presence of boron.

c. It is higher in regions of higher neutron flux.

d. It is not dependent upon rod position.

- Section 1.0 continued on next page -

1.18 Boron concentration decreasing over cycle life is a primary contributor to: (Select one) (1.0)

a. making the moderator temperature coefficient more negative.

b. making the moderator temperature coefficient less negative.

c. causing the moderator temperature coefficient to not change at all.

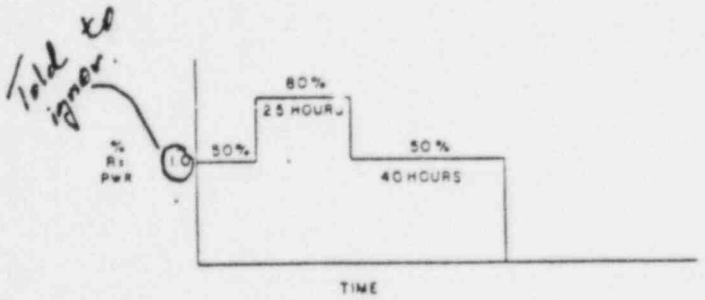
d. causing the moderator temperature coefficient to become zero.

1.19 TRUE or FALSE: Xenon worth becomes less negative over core life partly because the ratio of the thermal flux to the fast flux increases. (0.5)

1.20 TRUE or FALSE: Because samarium does not decay, it continues to accumulate in the core and becomes a primary reason for the reduction of boron over cycle life. (0.5)

1.21 List the four (4) operating parameters that the operator directly controls that have maximum effect upon DNBR. (1.0)

1.22 Given the below power history, sketch a graph of xenon concentration versus time. (2.0)



- End of Section 1.0 -

2.0 PLANT DESIGN INCLUDING SAFETY AND EMERGENCY SYSTEMS (25 Points)

2.1 State the interlock that would prevent a Keowee unit from emergency starting and give four of the six conditions that will activate this interlock. (1.5)

2.2 Describe the operation of Oconee Unit One's CCW System if electrical power was lost to all CCW pumps during full power operation? (1.0)

2.3 What two (2) control and/or protective features are included in Oconee Plant design to prevent the overfilling of the Steam Generators? (1.0)

2.4 TRUE or FALSE. The "switch over" mode of decay heat removal can use either the "A" or "B" LPI coolers; however, by procedure, only the "B" cooler is used. (0.5)

2.5 Following a Loss of Instrument Air, give the failure position of the following valves ("opened," "closed," or "as is"): (1.0)

(i) HP-5 (Letdown)

(ii) HP-120 (Makeup)

(iii) HP-31 (Seal Supply)

(iv) Pneumatic Feedwater Control Valves

2.6 a. List eight (8) starting interlocks for Oconee's Westinghouse Reactor Coolant Pumps. (1.6)

b. Give two (2) reasons for the #1 Seal Bypass for Westinghouse Reactor Coolant Pumps. (1.0)

- Section 2.0 continued on next page -

2.7 Why does the allowable maximum pressure of the LDST decrease with decreasing LDST level? (1.0)

2.8 The spare purification demineralizer is essentially the same as the normal purification demineralizer except for one difference. What is that difference? (1.0)

2.9 There are interlocks associated with the inlet and outlet valves of one of the spare purification demineralizers and one of the spare deborating demineralizers at Oconee. What do these interlocks prevent? (1.0)

2.10 Makeup is manually increased with the RCS at normal full power operating temperature and pressure. Calculate the corresponding steady state increase in Pressurizer level if the LDST level is decreased by 10 inches. (Show any assumptions.) (2.0)

2.11 TRUE or FALSE. LPI flow can be directed through a purification demineralizer. This design feature is not permitted when the RCS is in a drained down condition except at the direction of the Operating Engineer. (0.4)

2.12 TRUE or FALSE. One LPSW pump is sufficient to supply both Unit 1 and Unit 2 during power operation of both units. (0.5)

2.13 Why is the switchover mode of LPI operation necessary for Units 1 and 2 at Oconee? (1.0)

2.14 List five (5) components cooled by the Recirculating Cooling Water System (RCW). (1.5)

- Section 2.0 continued on next page -

2.15 There is a design feature that alerts the operator to a significant leak in a Reactor Building cooler.

a. What is this design feature? (Elaborate briefly) (1.0)

b. Why is a leaking Reactor Building cooler a significant problem? (1.5)

2.16 Name five (5) of the Main Feedwater Pump trips. (Numbers not required) (1.5)

2.17 Under what two (2) conditions will the emergency feedwater pumps automatically start? (1.0)

2.18 Briefly explain the importance of keeping the Emergency Discharge Line from the CCW System primed at all times that it is required to be operable? (1.0)

2.19 When HPI auto-initiates at Oconee Unit 1, with all three HPI pumps operating, more flow goes to the "A" loop than to the "B" loop. Briefly explain why this is so. (1.0)

2.20 a. What signals generate a load shed command? (1.5)

b. What protection does the load shed function perform? (0.5)

- End of Section 2.0 -

3.0 INSTRUMENTS AND CONTROLS (25 Points)

3.1 List the Process Radiation Monitors which have interlocks associated with them and state what function each interlock performs. (2.5)

3.2 The RC system ~~narrow~~ low range pressure indicator for Unit One, because of the location from where it is sensed, is susceptible to erroneous indications during certain operations. State where this indicator senses its indication, and give an example of an operation that could cause erroneous indication of pressure. (2.0)

3.3 Feedwater temperature is decreased when a high pressure feedwater heater string is removed from service. To maintain the same electrical power output from the plant, how must the ICS change feedwater flow rate, and reactor power? (2.0)

3.4 List the four (4) signals which are used to derive the BTU limit in the Integrated Control System, and indicate whether increasing power raises or lowers the BTU limit for each signal. (2.0)

3.5 During a heatup from 250°F to hot shutdown conditions (OP/1/A/1102/01), if Safety Rod Group 1 is withdrawn it must be inserted before exceeding 1690 psia. Explain why this is necessary? (1.0)

3.6 During a Loss of Reactor Coolant, the differential pressure level detectors for the Core Flood Tanks, the OTSG, and the Pressurizer can deliver inaccurate indication because of the elevated Reactor Building temperature.

a. Explain why and in which direction this inaccuracy in level indication occurs. (2.0)

b. TRUE or FALSE. The Pressurizer level and OTSG level inaccuracy caused by elevated ~~RCS~~ Reactor Building temperature is compounded (i.e., made worse) if OTSG and Pressurizer temperatures are themselves high. (0.5)

- Section 3.0 continued on next page -

3.7 When there is an out inhibit lamp on the Diamond Panel, under what three (3) conditions will control rods not respond to an out command if in automatic?. (1.5)

3.8 TRUE or FALSE. Channel A RPS high temperature bistable trips, channel C RPS high pressure bistable trips. This results in a reactor trip. (0.5)

3.9 Explain the difference in the response of the source range NI system between the following two situations: (1.0)

(i) One Intermediate Range Nuclear instrument channel fails low at about 1% full reactor power.

(ii) One Intermediate Range Nuclear instrument channel fails low at near full power.

3.10 The power range nuclear instrumentation is not compensated for gamma radiation. The reason for this is: (Select one) (1.0)

a. The power range detectors are already shielded against N^{16} gamma radiation and therefore not affected by gamma radiation.

b. As power increases the cold leg temperature drops, thus becoming a better gamma shield.

c. By the time reactor power is 10^{-9} amps, the effect of the gamma radiation is negligible in relation to the neutron flux.

d. The gain of the power range instruments is considerably lower than that of the intermediate range instrument.

3.11 The source range instrument has a preamplifier located inside the reactor building. Why not mount the preamplifier along with the rest of the source range instrument in the RPS cabinet? (1.0)

- Section 3.0 continued on next page -

3.12 Because of the nature of the detector assemblies used for incore instrumentation: (Select one.) (1.0)

a. they are very good for observing the ~80 second period of delayed neutrons during a shutdown.

b. they are not used for determining quadrant power tilt.

c. they must be compensated for gamma interactions that take place in their inconel lead wire.

d. they are used for correcting Thermal Power Best.

3.13 TRUE or FALSE: The incore thermocouples are located near the core midplane so that they will give a representative indication of core temperature near the area of highest neutron flux. (0.5)

3.14 a. TRUE or FALSE: The primary and backup OTSG level indicators used for emergency feedwater level control are temperature compensated. (0.5)

b. What level in the OTSGs will the Emergency Feedwater System automatically maintain after an automatic start signal? (With and without RCPs running) (1.0)

3.15 Give the function and purpose of the Source Interruption device in case of a momentary loss of power to the CRD''s. (1.0)

3.16 List the load limiting conditions that can cause ICS runbacks and give the final power limit the ICS will finally control at and the rate at which this limit will be reached. (2.0)

- Section 3.0 continued on next page -

3.17 State the Engineered Safeguards Actuation set points for the following: (1.0)

(i) High Pressure Injection

(ii) Low Pressure Injection

(iii) Reactor Building Isolation

(iv) Reactor Building Spray

3.18 TRUE or FALSE. Loss of power to any of the ES analog channels results in the trip that is normally associated with that channel, with the exception of the Reactor Building Spray System. (0.5)

3.19 TRUE or FALSE: Group 8 rods can be positioned without taking the diamond panel out of automatic. (0.5)

- End of Section 3.0 -

4.0 PROCEDURES: NORMAL, ABNORMAL, EMERGENCY, AND RADIOLOGICAL CONTROL (25 Points)

4.1 Concerning Duke Power Company's Administrative Limits for whole body exposure: (Fill in the correct response) (1.5)

a. the Basic Permissible Dose Limit is _____.

b. the Maximum Dose Limit is _____.

c. the Radiation Exposure Control Guide is _____ for the first _____ weeks and _____ for each week thereafter in the quarter, not to exceed _____ without authorization.

4.2 TRUE or FALSE. Any ES valve that has been cycled electrically must be cycled manually to assure operability. (0.5)

4.3 State in detail the immediate automatic and manual actions for a "Case B" Small Break LOCA as given in EP/07A/1800/04. (3.0)

4.4 During the early phases of an RCS heatup from cold shutdown to 250 Deg F 300 psi, in accordance with OP/1/A/1102/01 Enclosure 4.1, the operator is directed to take the following action with regard to letdown: (Select one). (1.0)

a. Maintain letdown secured until all four RCP number one seal bypass valves are shut.

b. Maximize letdown with one letdown cooler in service to achieve maximum heatup rate.

c. Minimize letdown with one letdown cooler in service to maximize heatup rate.

d. Maximize letdown to prevent boron precipitation during possible boron additions.

- Section 4.0 continued on next -

4.5 TRUE or FALSE. During an RCS heat-up from 250 Deg F to Hot Shutdown conditions, withdrawing Group 1 control rods to 50% is not required provided it can be shown that the reactor will be greater than 1.0% Delta K/K shutdown at 532 Deg F. (0.5)

4.6 During cold conditions, state two (2) actions taken to protect against over pressurization of the reactor vessel (i.e., violation of NDT limits)? (2.0)

4.7 TRUE or FALSE. An LPI pump may run at no flow conditions for up to 30 minutes, but may run with minimum recirc flow indefinitely. (0.5)

4.8 What temperature indication is used to establish heatup and cooldown rates while on LPI cooling with no RCPs operating? (1.0)

4.9 Give two (2) conditions requiring that the reactor coolant system and the control rod drives be vented. (2.0)

4.10 Match the tenth values (TVL) for gamma radiation for the following materials: (1.0)

a.	Water	1.	2"
b.	Concrete	2.	4"
c.	Steel	3.	12"
d.	Lead.	4.	24"

- Section 4.0 continued on next -

4.11 Hydrazine is removed from the reactor coolant system by: (Select one) (1.0)

a. By directing letdown through the normal or spare purification demineralizer.

b. By spraying the pressurizer and venting the LDST during heatup.

c. By bleed and feed prior to heat up.

d. Both a and c.

4.12 During an RCS cooldown from 250°F, when cooling down the pressurizer, and depressurizing the RCS, makeup is controlled to prevent an outsurge from the pressurizer into the hot leg. Why is this done? (1.0)

4.13 TRUE or FALSE. The fuel pin in compression limit is less restrictive than the 50°F subcooled curve during RCS cooldown for all temperatures and pressures. (0.5)

4.14 TRUE or FALSE. According to EP/0/A/1800/04, Loss of Reactor Coolant, starting a Reactor Coolant Pump (RCP) is permissible at RC pressure >1600 psig; even if saturation conditions exist. (0.5)

4.15 Enclosure 1 (Pressure vs. Temperature Curves) of EP/0/A/1800/04, Loss of Reactor Coolant, defines a "Thermal Shock Operating Region" (TSOR) and gives two guidelines for determining when the RCS must be maintained within the TSOR. State the two (2) guidelines for determining whether or not the RCS should be maintained within the TSOR. (2.0)

4.16 TRUE or FALSE. To protect against boiling the steam generators dry, the operator should manually trip the reactor immediately upon loss of both main feedwater pumps unless emergency feedwater pumps are operating and flow is verified. (0.5)

- Section 4.0 continued on next -

4.17 TRUE or FALSE. Red Tags and Yellow "Hold" Tags may be hung for personnel safety, whereas White Tags are largely for protection of equipment. (0.5)

4.18 During a planned initiation of Natural Circulation Cooldown, OP/O/A/1102/16, the operator is directed to monitor pressurizer level and LDST level. A sudden increase in either level while pressure is constant or decreasing, according to this procedure, is indicative of what problem? (1.0)

4.19 a. With Reactor Coolant Pumps off, how is reactor coolant temperature determined? (1.0)

b. If a Natural Circulation Cooldown is being conducted using only one OTSG, how is the bulk temperature of the loop with the nonsteaming OTSG best determined? (1.0)

4.20 If the HPI System has actuated because of low pressure conditions, it must remain in operation until one of two criteria is satisfied. State these two (2) criteria. (2.0)

4.21 For non-LOCA overcooling events where pressure drops below 1550 psig, select the one correct statement from the following. (1.0)

a. HPI should be reset and throttled immediately once the cause of the problem has been determined to be non-LOCA overcooling.

b. Reactor coolant pumps should be restarted immediately once the cause of the problem has been determined to be non-LOCA overcooling.

c. Reactor coolant pumps should be restarted immediately after correcting the cause of the overcooling if the 50°F subcooling margin is regained.

d. Reactor Coolant pumps should not be stopped if the cause of the problem has been determined to be a non-LOCA overcooling, even if the 50°F subcooling margin is lost.

- End of Section 4 -

EQUATION SHEET

Where $\dot{m}_1 = \dot{m}_2$

$(\text{density})_1(\text{velocity})_1(\text{area})_1 = (\text{density})_2(\text{velocity})_2(\text{area})_2$

$KE = \frac{mv^2}{2}$ $\quad PE = mgh$ $\quad PE_1+KE_1+P_1V_1 = PE_2+KE_2+P_2V_2$ $\quad$ where V = specific volume, P = Pressure

---

$Q = \dot{m}c_p(T_{out}-T_{in})$ $\quad Q = UA\,(T_{ave}-T_{stm})$ $\quad Q = \dot{m}(h_1-h_2)$

$P = P_o 10^{sur(t)}$ $\quad P = P_o e^{t/T}$ $\quad SUR = \frac{26.06}{T}$

$\text{delta } K = (K_{eff}-1)/K_{eff}$ $\quad CR_1(1-K_{eff1}) = CR_2(1-K_{eff2})$

$M = \frac{(1-K_{eff1})}{(1-K_{eff2})}$ $\quad SDM = \frac{(1-K_{eff}) \times 100\%}{K_{eff}}$

$\text{decay constant} = \frac{\ln(2)}{t_{1/2}} = \frac{0.693}{t_{1/2}}$ $\quad A = A_o e^{-(\text{decay constant})x(t)}$

Water Parameters

1 gallon = 8.345 lbs
1 gallon = 3.78 liters

$1\ ft^3 = 7.48$ gallons

Density = 62.4 lbm/ft^3

Density = 1 gm/cm^3
Heat of Vaporization = 970 Btu/lbm
Heat of Fusion = 144 Btu/lbm
1 Atm = 14.7 psia = 29.9 in Hg

Miscellaneous Conversions

1 Curie = 3.7×10^{10} dps
1 kg = 2.21 lbs

1 hp = 2.54×10^3 Btu/hr

1 Mw = 3.41×10^6 Btu/hr

1 inch = 2.54 centimeters
Degrees F = (1.8) x (Degrees C) + 32
1 Btu = 778 ft-lbf
g = 32.174 $ft\text{-}lbm/lbf\text{-}sec^2$

ANSWER KEY

Sam P. Owen
Gene M. Stovall
David M. Covey
Henry R. Lowery

1.0 PRINCIPLES OF NUCLEAR POWER PLANT OPERATION, THERMODYNAMICS, HEAT TRANSFER AND FLUID FLOW (25 Points)

1.1 Which of the following parameters would be most useful to determine the enthalpy rise across an operating RCP? (Select one) (1.0)

a. Pump motor current and ΔP
b. Pump motor current, and voltage, and ΔT
c. Pump motor current, and voltage, and flowrate
d. Pump motor current, voltage, and RPM

Answer:

c ~~a, d, e, f, b~~ ~~(full credit for any four)~~

Reference: Duke TFF + HT training manual.

1.2 TRUE or FALSE. The enthalpy of water is primarily dependent on temperature rather than pressure. (0.5)

Answer:

True.

Reference: Duke TFF + HT training manual pg 2.

1.3 Given a quantity of superheated steam, would the following processes cause specific enthalpy to increase, decrease, or stay the same?

a. an iso-thermal compression (0.5)

b. an iso-baric (constant pressure) increase in temperature (0.5)

Answer:

a) Causes specific enthalpy to very nearly stay the same or decrease (either is acceptable).

b) Causes specific enthalpy to increase sharply.

Reference: Duke TFF+HT training manual Pg 2L.

1.4 The amount of energy being delivered by the OTSGs is actually greater than the thermal energy being supplied by the nuclear core. How can this imbalance exist during steady-state conditions? (1.5)

Answer:

Some of the energy (≈ 16 MW) from the steam generators is removed from the grid and deposited directly back into the RCS through flow friction resulting from the energy input of the RCPs.

Reference: Duke TFF + HT training manual

1.5 TRUE or FALSE. For a constant speed centrifugal pump, as the volume flowrate increases, the pump head decreases. (0.5)

Answer:

True.

Reference: Duke TFF+HT training manual pg 149

1.6 TRUE or FALSE. A pump whose centerline is above the level of water in a tank from which it is taking a suction will cavitate even though the NPSH is positive. (2.57)

Answer:

False.

Reference: Duke TFF+IIT training manual- PT pg 149

1.7 During the process of drawing a pressurizer bubble, nitrogen is vented from the Pressurizer to the Quench Tank. Explain how you determine that all of the nitrogen has been vented. 1.5 (~~1.0~~)

Answer:

When Quench Tank pressure stops increasing during pressurizer venting, the venting of nitrogen from the pressurizer will be considered complete. (90% credit given for saying "check saturation pressure and temperature").

Reference: OP/O/A/1103/05 Pg 2

1.8 TRUE or FALSE. During normal power operation, the pressurizer temperature is sometimes less than 50°F above the highest RCS temperature. (0.5)

Answer:

True. At power, T_h may be less than 50° subcooled.

Reference: Normal operational parameters

1.9 All four NIs are reading equal to thermal power best. With this in mind, select the correct statement from below: (Select one) (1.0)

a. If one of the NIs were to exceed thermal power best (TPB), then it would be reading non-conservatively and power would have to be adjusted such that the other three read less than TPB.

b. This case (all four NIs equal to TPB) may be non-conservative if less than 4 RCPs are operating.

c. This would indicate that the heat being added to the RCS by RCPs is no longer a significant contributor to TPB.

d. This is indicative of the fact that the reactor has reached equilibrium samarium and xenon conditions.

Answer:

b

Reference: OP/1/A/1102/04, Encl 4.2 pg 1

1.10 One RCP is operating in one loop; two RCPs are operating in the other loop. Because of an ICS malfunction both OTSGs continue feeding and steaming at equal rates (i.e., there is no reratio of feed water).

a. What would be the relationship between the primary water ΔT across the two OTSGs? (0.5)

b. What would be the relationship between the levels of the two OTSGs? (1.5)

c. What would be the effect on Quadrant power tilt? (0.5)

Answer:

a) The ΔT across the OTSG with the lower T flow would be greater.

b) Given that the two OTSGs are steaming at the same rate (i.e., "Q"s are equal) and assuming that the T_H's of the two loops are equal, the T_{AVE} of the loop with the lower flow would decrease forcing the level to be a little higher in that OTSG.

$$\vec{Q} = (LA)\vec{h}(T_{AVE} - T_{SAT})$$

c) Because of the resulting ΔT_c, quadrant power tilt will increase.

Reference: Duke Training Material, Ics Feedwater Control Subsystem, and TFFHT training material.

1.11 a. Oconee has an Antimony Beryllium source installed in the core. When a source is lowered into the core, is its presence adding reactivity (decreasing the Shutdown Margin)? Explain your answer. (1.0)

b. If when the source is lowered into the core it doubles the total effective source strength, what should happen to the indicated source range nuclear indication? (1.0)

Answer:

a) No. Other than the geometrical sheilding/moderating affects of the source assembly, the source does not affect reactivity.

b) The equilibrium count rate for subcritical multiplication is given by:

$$CR = \frac{(\text{Constant}) \times \text{Source Strength}}{1 - K}$$

The CR is linearly proportional to the source strength, therefore, a doubling of the souce strength should yeild a doubling of indicated count rate.

Reference: Fundamentals of Nuclear Reactor Engineering, Duke Power Company. Pg117

1.12 TRUE or FALSE. If the reactor could be made exactly critical, countrate would be increasing at a linear rate proportional to the source strength. (0.5)

Answer:

~~True~~, $S + SK + SK^2 + SK^3 + \ldots + SK^n$ becomes equal to:

$S + S + S + S + \ldots + S = nS$ where n equals the number of neutron generations.

Reference: FNRE pg 117

1.13 Select from the following list of parameters those parameters that have a direct effect on the Startup Rate of a subcritical reactor during rod withdrawal: (Note: there may be more than one). (1.0)

a. the ratio of source strength to the current count rate.

b. the instantaneous rate of change of K effective (i.e., rod speed).

c. the current value of K effective.

Answer:

a, b, and c

Reference: FNRE pg 89, pg 101, pg 115

1.14 TRUE or FALSE. Because of the half-life of the longest lived delayed neutron precursers, reactor power cannot be lowered any faster than .333 Decades per Minute (DPM). (0.5)

Answer:

False, there is a relatively large and rapid prompt drop associated with any negative reactivity insertion.

Reference: FNRE pg 106

1.15 Recall that equilibrium subcritical count rate can be represented as:

$$CR = S + SK + SK^2 + Sk^3 + \ldots + SK^n$$

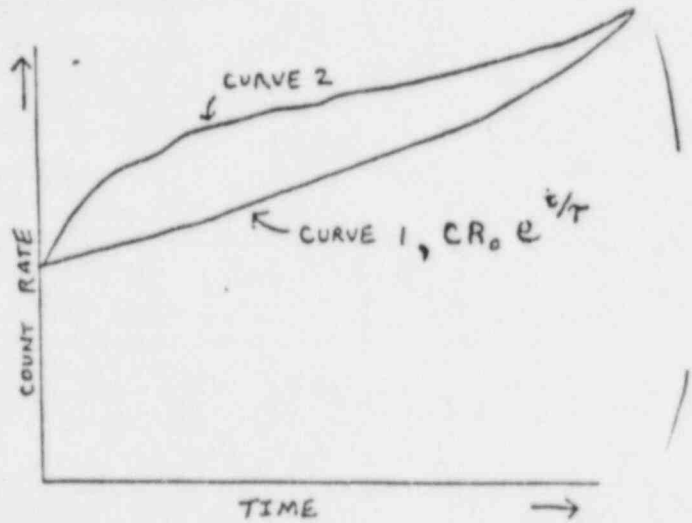
Utilizing this relationship, explain why startup rate takes longer and longer to return to zero as you get closer and closer to criticality. (1.5)

Answer:

As K effective becomes closer and closer to 1, the number of neutron generations (i.e., value of "n") ~~be~~ necessary for K^n to become appreciably negligable increases.

Reference: Duke Power Company FNRE pg 116

1.16 Curve 1 in the figure below shows the predicted exponential behavior of countrate after a step insertion of reactivity at low reactor power, with the reactor <u>less</u> <u>than</u> prompt critical. Curve 2 is more representative of what actually happens as a result of a step insertion of reactivity. Curve 2 eventually matches up with Curve 1. <u>Briefly</u> <u>explain</u> the difference between the predicted (Curve 1) and the actual (Curve 2) response. (3.0)



Answer:

The early part of curve 2 is dominated by the multiplication of the prompt neutron population as a result of the step insertion of reactivity. Because the reactor is not prompt critical (i.e. the reactor is subcritical on prompt neutrons alone) this response rapidly dies away. The secondary part of Curve 2 (i.e., the "wavy" part) is dominated by the shorter lived delayed neutron precursors. The final phase is dominated by the longest lived delayed neutron precursors, and approaches a stable period.

Reference: Duke Power Company FNRE pg 101

1.17 Which of the following statements is true regarding control rod worth? (Select one) (1.0)

a. It is proportional to rod speed.

b. It is not affected by the presence of boron.

c. It is higher in regions of higher neutron flux.

d. It is not dependent upon rod position.

Answer:

c

Reference: Duke Power FNRE

1.18 Boron concentration decreasing over cycle life is a primary contributor to: (Select one) (1.0)

a. making the moderator temperature coefficient more negative.

b. making the moderator temperature coefficient less negative.

c. causing the moderator temperature coefficient to not change at all.

d. causing the moderator temperature coefficient to become zero.

Answer:

a

Reference: Duke Power FNRE pg 154.

1.19 TRUE or FALSE: Xenon worth becomes less negative over core life partly because the ratio of the thermal flux to the fast flux increases. (0.5)

Answer :

False.

Reference: Duke FNRE pg 168

1.20 TRUE or FALSE: Because samarium does not decay, it continues to accumulate in the core and becomes a primary reason for the reduction of boron over cycle life. (0.5)

Answer :

False.

Reference: Duke FNRE pg 169

1.21 List the four (4) operating parameters that the operator directly controls that have maximum affect upon DNBR. (1.0)

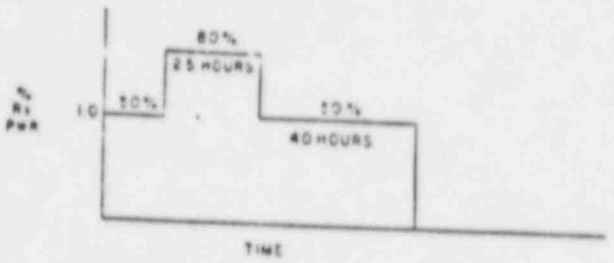
Answer:

Reactor Pressure
Reactor Power
Reactor Coolant Flow
TH OR TO → Reactor Average Temperature.

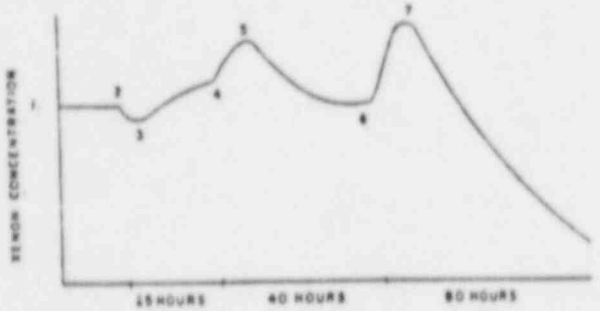
Reference: Duke FNRE

1.22 Given the below power history, sketch a graph of xenon concentration versus time. (2.0)

~~Answer~~



Answer:



3/4 credit for general shape ½ credit for relative times.

References: Duke Power FNRE pg 163

2.0 PLANT DESIGN INCLUDING SAFETY AND EMERGENCY SYSTEMS (25 Points)

2.1 State the interlock that would prevent a Keowee unit from emergency starting and give four of the six conditions that will activate this interlock. (1.5)

Answer:

Emergency Lockout due to : 0,3

CO_2 fire release
Keowee generator bus differential
S/U inhibit switch in "inhibit"
Keowee generator loss of field
Keowee generator neutral ground
Keowee generator diferential

} 0.3 for ea of the 4 given

Reference: Oconee Question Bank Q#22

2.2 Describe the operation of Oconee Unit One's CCW System if electrical power was lost to ALL CCW pumps during full power operation? (1.0)

Answer:

ALL CCW pumps stop
CCW pumps discharge valves stay open ← Optional
Main Condenser discharge valves will close
CCW-1 thru 6 will open
CCW-8 will open and establish gravity flow to the Keowee Tailrace.

} 0.25 ea

Reference. Oconee Question Bank Q# 68

2.3 What control and/or protective features are included in Oconee Plant design to prevent the overfilling of the Steam Generators? (1.0)

Answer:

The ICS provides a "High Steam Generator Level" Limiter which prevents the Main Feedwater Valves from opening further than their present position to limit Feedwater Flow and a "High Steam Generator Level" trip is provided to trip both Main Feedwater pumps if this level is reached.

Reference: Oconee Question Bank Q# 90

2.4 TRUE or FALSE. The "switch over" mode of decay heat removal can use either the "A" or "B" LPI coolers; however, by procedure, only the "B" cooler is used. (0.5)

Answer:

False. There is no "switch over" piping and valves installed for the "A" LPI cooler.

Reference: Duke LPI training material, Encl 4 pg 13.

2.5 Following a Loss of Instrument Air, give the failure position of the following valves ("opened," "closed," or "as is"): (1.0)

(i) HP-5 (Letdown)

(ii) HP-120 (Makeup)

(iii) HP-31 (Seal Supply)

(iv) Pneumatic Feedwater Control Valves

Answer:

i) closed
ii) closed
~~iii) closed~~ or
iii ~~iv~~) open
iv ~~v~~) as is

Reference: Oconee Question Bank Q#153

2.6 a. List eight (8) starting interlocks for Oconee's Westinghouse Reactor Coolant Pumps. (1.6)

b. Give two (2) reasons for the #1 Seal Bypass for Westinghouse Reactor Coolant Pumps. (1.0)

Answer

a) RCP Interlocks are as follows:

1) Upper Oil Pot Level Low
2) Lower Oil Pot Level Low
3) Total Seal Injection Flow ≤ 22 GPM
4) Component Cooling Flow ≤ 575 GPM
5) Seal #1 ΔP ≤ 275 PSIG
6) Reactor Power ≥ 50%
7) Oil Lift Pump Discharge Pressure ≤ 600 PSIG
8) Oil Lift Pump Running
9) T_c ≤ 430°F (For Starting Fourth RCP)

Reference

b) To prevent excessive temperature of the radial bearing, and to prevent excessive seal leakoff temperature.

Reference: OP/1/A/1103/06 pg 2, Encl 9.4 pg 3, and the Oconee Training Manual

2.7 Why does the allowable maximum pressure of the LDST decrease with decreasing LDST level? (1.0)

Answer:

This is to prevent gas binding of the HPI pumps in the event of emergency HPI actuation.

Reference: OP/1/A/1104/02 pg 1

2.8 The spare purification demineralizer is essentially the same as the normal purification demineralizer except for one difference. What is that difference? (1.0)

Answer:

The spare purification demineralizer is not lithium saturated.

Reference: Duke HPI training material

2.9 There are interlocks associated with the inlet and outlet valves of one of the spare purification demineralizers and one of the spare deborating demineralizers at Oconee. What do these interlocks prevent?

(1.0)

Answer:

They prevent cross connecting unit one and unit two through the spare demineralizer.

Reference: Duke HPI training material

2.10 Makeup is manually increased with the RCS at normal full power operating temperature and pressure. Calculate the corresponding steady state increase in Pressurizer level if the LDST level is decreased by 10 inches.

(2.0)

Answer:

LDST = 31.3 gal/in
Pzr = 24 gal/in
Specific volume of 90°F Water = 0.016
" " " 645°F Water = 0.026

$(31.3\ \text{gal/in})(10\ \text{in}) = 313\ \text{gal}$

$(313\ \text{gal})\left(\frac{.026}{.016}\right) = 508.6\ \text{gal}$

$(508.6\ \text{gal})/(24\ \text{gal/in}) = 21\ \text{inches}$

Reference: ~~Duke~~ HPI training material

2.11 TRUE or FALSE. LPI flow can be directed through a purification demineralizer. This design feature is not permitted when the RCS is in a drained down condition except at the direction of the Operating Engineer. (0.4)

Answer:

True

Reference: OP/1/A/1104/04 Encl 5.6 pg 1 Chg 25

2.12 TRUE or FALSE. One LPSW pump is sufficient to supply both Unit 1 and Unit 2 during power operation of both units. (0.5)

Answer:

False.

Reference: OP/1+2/A/1104/10 Pg 2

2.13 Why is the switchover mode of LPI operation necessry for Units 1 and 2 at Oconee? (1.0)

Answer:

The combination of RCS pressure with LPI pump discharge pressure would exceed the LPI cooler design pressure.

Reference: Duke ~~Comm~~ LPI training Material Pg 5.

2.14 List five (5) components cooled by the Recirculating Cooling Water System (RCW). (1.5)

Answer:

Any ~~10~~ 5 of the following:

1) IA Comp. - Water Jackets
2) Sec. Sample Sink
3) HWP's - Upper Bearing
4) CBP's - Oil Cooler
5) 'D' HTR - Drain Pumps
6) EHC Oil Coolers
7) 'E' HTR - Drain Pumps
8) MFWP - Oil Coolers
9) Alterex Air Coolers
10) Isolated Phase Bus Coolers
11) Interim Evap.
12) Seal Return Coolers
13) Primary Sample Sink
14) Misc. Waste Evap.
15) RC Bleed Evap.
16) SFP Coolers
17) GWD Compressors
18) Sullair Compressors

Reference: Ocnee Question Bank Q# 5 (Required Segment 2)

2.15 There is a design feature that alerts the operator to a significant leak in a reactor building cooler.

a. What is this design feature? (Elaborate briefly) (1.0)

b. Why is a leaking Reactor building cooler a significant problem? (1.5)

Answer:

a) Cooler Rupture Alarm. It senses differential flow between the inlet to the cooler and the outlet from the cooler.

b) The LPSW that leaks from the cooler is un-borated, and could therefore dilute the Boron in the RB sump in the event of a LOCA.

Reference: Duke Reactor Building Cooling System training material.

2.16 Name five (5) of the Main Feedwater Pump trips. (Numbers not required) (1.5)

Answer:

Manual
Overspeed
Low Vacuum
High discharge pressure
Low bearing oil pressure
Steam generator high level
Low oil level
Thrustwear detector trip
Low suction pressure

Reference: Duke Feedwater Training Material Question Bank Q#51

2.17 Under what two (2) conditions will the emergency feedwater pumps automatically start? (1.0)

Answer:
Loss of hydraulic pressure on both MFW P's
Low discharge pressure on both MFW P's

Reference: Duke Emergency Feedwater Training Material

2.18 Explain the importance of keeping the Emergency Discharge Line from the CCW System primed at all times that it is required to be operable? (1.0)

Answer:

This line is used at Oconee to provide gravity flow of the CCW thru the Main Condenser upon loss of all CCW pumps. By maintaining this line primed at all times we can insure that siphon flow will occur.

Reference: Oconee Question Bank Q#75

2.19 When HPI auto-initiates at Oconee Unit 1, with all three HPI pumps operating, more flow goes to the "A" loop than to the "B" loop. Briefly explain why this is so. (1.0)

Answer:

The "A" and "B" HPI pumps are pumping in parallel to the "A" loop. The "C" HPI pump is the sole supplier to the "B" loop.

Reference: Normal Operational Parameters (taken from ORNL NUREG/CR-3770)

2.20 a. What signals generate a load shed command? (1.5)

b. What protection does the load shed function perform? (0.5)

Answer:

a) One or more of the following must exist for ≥ 1 sec.

A) ES 1 or 2 actuation along with an undervoltage on 2 of 3 phases on both the Normal and Start up transformers

B) ES 1 or 2 with the normal and startup breakers tripped and an undervoltage on the M.F.B.

C) An initiate signal from the MFB monitor panel

b) Load shed prevents overloading the standby transformer CT-4 or CT-5. This is based on auxiliary loads for three shutdown units with one unit having the added loads of the Engineered Safeguards Equipment following a LOCA:

CT-4 or CT-5 rated @ 20 MVA			
Auxiliary per unit	6 MVA	18	MVA / 3 unit
Added loads from ES actuation		+4.8	MVA
		22.8	MVA

Load shed reduces the load to less than 20 MVA.

References: Oconee Question Bank #36, #35

3.0 INSTRUMENTS AND CONTROLS (25 Points)

3.1 List the Process Radiation Monitors which have interlocks associated with them and state what function each interlock performs. (2.5)

Answer:

other acceptable in lieu of #'s

RIA 33 & 34 (0.2)	on alert alarm will close LWD132 and stop running condensate monitor tank pumps 2 (0.3)
RIA 37 & 38	on alert alarm will close GWD4, GWD5, GWD6, GWD7, GWD206, GWD207, GWD215 (if open) and stop waste gas exhauster
RIA45	on alarm will stop main purge, mini purge, and close PR2, PR3, PR4, and PR5
RIA49	on alert alarm close LWD2 and sound Reactor Building evacuation alarm
RIA54	on Loss of flow or alarm trips turbine bldg. Sump pumps.

0.5 (0.2)

Reference: Oconee Question Bank Q# 16

3.2 The RC system narrow range pressure indicator for Unit One, because of the location from where it is sensed, is susceptible to erroneous indications during certain operations. State where this indicator senses its indication, and give an example of an operation that could cause erroneous indication of pressure. (2.0)

Answer:

This indicator senses pressure from the pressurizer water space. An erroneous indication may result during continuous venting from the pressurizer steam space, or if pressurizer steam space sampling is in progress (only one is required, additional operations resulting in erroneous indication may be possible, and will be individually judged on their own merrit.

Reference: OP/1/A/1104/04 pg 3 under "Initial Condiditons".

3.3 Feedwater temperature is decreased when a high pressure feedwater heater string is removed from service. To maintain the same electrical power output from the plant, how must the ICS change feedwater flow rate, and reactor power? (2.0)

Answer:

Feedflow rate must decrease. The steam that was going to the removed feedwater heaters is no longer needed.

Reactor power must increase slightly. This is because of the decrease in efficiency created by the decrease in feedwater temperature. Another way to look at this (not required for full credit) is that there is now a larger increase in enthalpy across the OTSGs. This increase in enthalpy is only partially compensated for by the decrease in mass flow rate that was going to the feedwater heaters.

Reference: Taken from Duke NRC Question Bank Q#10

(changed to add integrated plant emphasis)

3.4 List the four (4) signals which are used to derive the BTU limit in the Integrated Control System, and indicate whether increasing power raises or lowers the BTU limit for each signal. (2.0)

Answer:

Th increases during the power change, therefore tending to increase the BTU limit.

S/G pressure increases (due to head loss) during a power escalation, therefore tending to lower the BTU limit.

RC flow remains the same, assuming no change in RCS pump status, and therefore has no effect on the BTU limit.

FDW temperature will increase slightly during the power change, therefore tending to increase the BTU limit.

Reference: Duke NRC Question Bank Q#4, B & W (Sec. 19 pg 32) and Duke ICS (no page #) training Material on ICS (not verbatim)

3.5 During a heatup from 250°F to hot shutdown conditions (OP/1/A/1102/01), if Safety Rod Group 1 is withdrawn it must be inserted before exceeding 1690 psia. Explain why this is necessary?

(1.0)

Answer:

This is necessary because the shutdown bypass switch sets the high pressure trip lower than the normal low pressure trip.

Reference: OP/1/A/1102/01 Encl 4.2 pg 7

3.6 During a Loss of Reactor Coolant, the differential pressure level detectors for the Core Flood Tanks, the OTSG, and the Pressurizer can deliver inaccurate indication because of the elevated Reactor Building temperature.

a. Explain why and in which direction this inaccuracy in level indication occurs.

(2.0)

b. TRUE or FALSE. The Pressurizer level and OTSG level inaccuracy caused by elevated ~~RBT~~ RB temperature is compounded (i.e., made worse) if OTSG and Pressurizer temperatures are themselves high.

(0.5)

Answer

a) The higher RB temperature decreases the density of the reference leg of the level detectors relative to the density of the water in the tank being measured. The result is that level indicates higher than it actually is

b) True.

Reference: OP/0/A/1800/04 Encl 3 pg 1

7

3.7 When there is an out inhibit lamp on the Diamond Panel, under what three (3) conditions will control rods not respond to an out command if in automatic?. (1.5)

Answer:

1) Safety Rods not out.

2) Assymetric Fault and Pwr > 60%.

3) High start up rate..

Reference: Duke Control Rod Drive System training Material Pg 8

3.8 TRUE or FALSE. Channel A RPS high temperature bistable trips, channel C RPS high pressure bistable trips. This results in a reactor trip. (0.5)

Answer:

True

Reference: ~~Oconee~~ Duke Reactor Protection System training material.

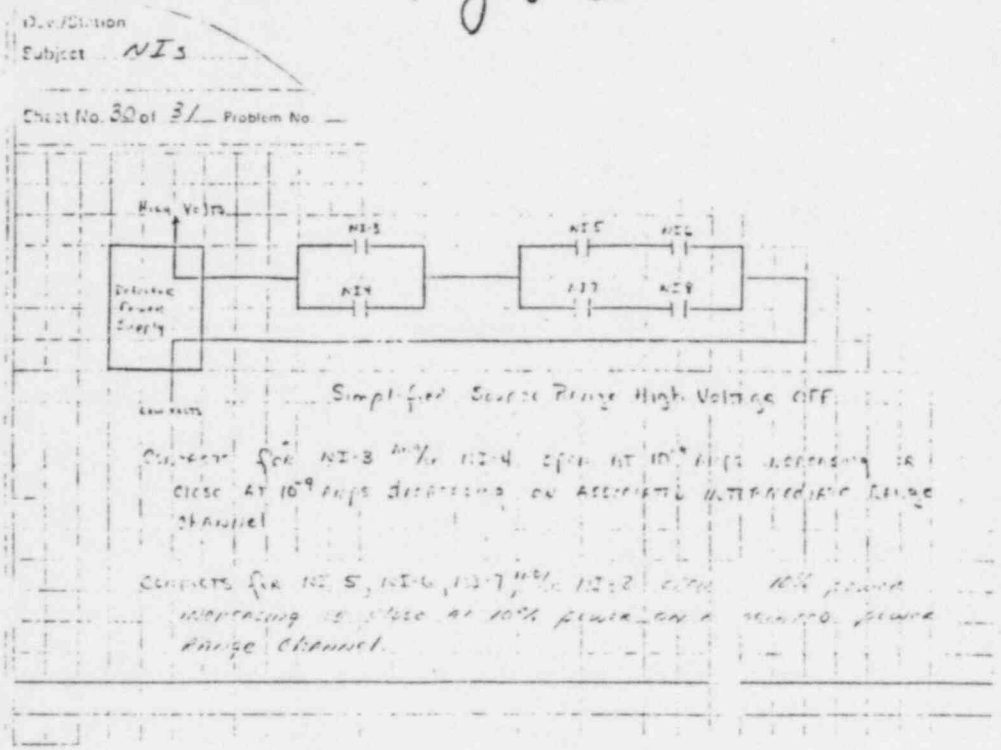
3.9 Explain the difference in the response of the source range NI system between the following two situations: (1.0)

(i) One Intermediate Range Nuclear instrument channel fails low at about 1% full reactor power.

(ii) One Intermediate Range Nuclear instrument channel fails low at near full power.

Answer:

In case i) the source range detector is energized. In case ii) the backup interlock (i.e., Power >10%) ensures that the source range detector does not become energized.



Reference: Duke Nuclear Instrumentation Training Material pg. 30

3.10 The power range nuclear instrumentation is not compensated for gamma radiation. The reason for this is: (Select one) (1.0)

a. The power range detectors are already shielded against N^{16} gamma radiation and therefore not affected by gamma radiation.

b. As power increases the cold leg temperature drops, thus becoming a better gamma shield.

c. By the time reactor power is 10^{-9} amps, the effect of the gamma radiation is negligible in relation to the neutron flux.

d. The gain of the power range instruments is considerably lower than that of the intermediate range instrument.

Answer:

C

Reference: Duke Nuclear Instrument training material Pg 20

3.11 The source range instrument has a preamplifier located inside the reactor building. Why not mount the preamplifier along with the rest of the source range instrument in the RPS cabinet? (1.0)

Answer:

Because the neutron pulses sent from the detector are very weak and could be masked or partially masked by inductive coupling from other electrical sources near the source range cable.

Reference: Duke Nuclear Instrument training material

3.12 Because of the nature of the detector assemblies used for incore instrumentation: (Select one.) (1.0)

a. they are very good for observing the ~80 second period of delayed neutrons during a shutdown.

b. they are not used for determining quadrant power tilt.

c. they must be compensated for gamma interactions that take place in their inconel head wire.

d. they are used for correcting Thermal Power Best.

Answer:

c

References: Duke Incore Instrumentation training material Pg 3

3.13 TRUE or FALSE: The incore thermocouples are located near the core midplane so that they will give a representative indication of core temperature near the area of highest neutron flux. (0.5)

Answer:

False.

Reference: Duke Incore Instrumentation training Material pg. 4

3.14 a. TRUE or FALSE: The primary and backup OTSG level indicators used for emergency feedwater level control are temperature compensated. (0.5)

b. What level in the OTSGs will the Emergency Feedwater System automatically maintain after an automatic start signal? (With and without RCPs running) (1.0)

Answer:

a) False.

Reference:

b) 24" on Emer. S/G level with no RCPs
25" if RCPs are operating.

Reference: Exam Question Bank Q#72.

3.15 Give the function and purpose of the Source Interruption device in case of a momentary loss of power to the CRD's. (1.0)

Answer:

The Source Interruption device will open the A & B AC BKRS to the CRDM's. This is done in this situation so a ratchet trip would not occur which could damage the lead screw & cause power distribution problems.

Reference: Exam. Question Bank Q# 41
(Required Segment 1)

3.16 List the load limiting conditions that can cause ICS runbacks and give the final power limit the ICS will finally control at and the rate at which this limit will be reached. (2.0)

Answer:

Load Limiting Conditions -

		0.2 limit	0.1 Rate
① Loss of	(1) RCP -	75%	- 50%/min
	(2) RCPs -	50%	"
	(3) RCPs -	25%	"
② Loss of RC Flow		- Linear	- 20%/min
③ Loss of FW Pump		- 65%	- 50%/min
④ Asymetric Load		- 60%	- 30%/min

0.5 ea

Reference: Request Segment 5

3.17 State the Engineered Safeguards Actuation set points for the following: (1.0)

(i) High Pressure Injection

(ii) Low Pressure Injection

(iii) Reactor Building Isolation

(iv) Reactor Building Spray

Answer:
i) 1550 psig RCS, 3.0 psig RB press
ii) 550 psig RCS, 3.0 psig RB press
iii) 3.0 psig RB press
iv) 10.0 psig RB press.

Reference: Duke Engineered Safeguards training Mat pg. 1

3.18 TRUE or FALSE: Loss of power to any of the analog channels results in the trip that is normally associated with that channel, with the exception of the Reactor Building Spray System. (0.5)

Answer:

True.

Reference: Duke Engineered Safeguards Training Material Pg 3.

3.19 TRUE or FALSE: Group 8 rods can be positioned without taking the diamond panel out of automatic. (0.5)

Answer:

True.

Reference: Duke Control Rod Drive System Training Material Pg 8.

4.0 PROCEDURES: NORMAL, ABNORMAL, EMERGENCY, AND RADIOLOGICAL CONTROL (25 Points)

4.1 Concerning Duke Power Company's Administrative Limits for whole body exposure: (Fill in the correct response) (1.5)

a. the Basic Permissible Dose Limit is _____.

b. the Maximum Dose Limit is _____.

c. the Radiation Exposure Control Guide is _____ for the first _____ weeks and _____ for each week thereafter in the quarter, not to exceed _____ without authorization.

Answer:

a) 1000 mRem / qtr (0.5)
b) 2500 mRem / qtr (0.5)
c) 500 mRem (0.1)
5 weeks (0.1)
100 mRem (0.2) (0.1)
1000 mRem/qtr (the Basic Permissible Dose Limit)

Reference: Ocenee Question Bank Q#190

4.2 TRUE or FALSE. Any ES valve that has been cycled electrically must be cycled manually to assure operability. (0.5)

Answer:

False. The opposite is true.

Reference: EP/0/A/1103/05

4.3 State in detail the immediate automatic and manual actions for a "Case B" Small Break LOCA as given in EP/0/A/1800/04. (3.0)

Answer:

2.0 Immediate Actions

2.1 Automatic

2.1.1 Reactor/Turbine Trip.

2.1.2 Possible E.S. Actuation. } 0.2

2.2 Manual

NOTE: Securing RC pump operation takes precedence over all other immediate manual actions.

2.2.1 (0.7) IF E.S. has been initiated automatically and RCS pressure (*) is less than 1550 psig,

OR the 50°F subcooling margin is lost,

Then trip all RCPs IMMEDIATELY.

2.2.2 (0.7) Verify automatic actions have occurred; if not, perform manually. If ES has been bypassed due to heatup or cooldown, initiate manually, as required, to maintain pressurizer level and Reactor Coolant System pressure.

2.2.3 (0.7) Check immediately for flow indication (*) on both HPI loop injection lines.

A. If no flow is indicated in "B" loop, open (1)(2)(3)HP-409 ("B" Bypass Injection) within 10 minutes of ES actuation.

B. If no flow is indicated in "A" loop, open (1)(2)(3)HP-410 ("A" Bypass Injection) within 10 minutes of ES actuation.

2.2.4 Verify appropriate S/G Levels are being maintained. (Low level limit with RC pumps, or 50% on the operating range without RC pumps.)

Reference. EP/0/A/1800/04 Loss of Reactor Coolant

4.4 During the early phases of an RCS heatup from cold shutdown to 250 Deg F 300 psi, in accordance with OP/1/A/1102/01 Enclosure 4.1, the operator is directed to take the following action with regard to letdown: (Select one). (1.0)

a. Maintain letdown secured until all four RCP number one seal bypass valves are shut.

b. Maximize letdown with one letdown cooler in service to achieve maximum heatup rate.

c. Minimize letdown with one letdown cooler in service to maximize heatup rate.

d. Maximize letdown to prevent boron precipitation during possible boron additions.

Answer:

c. Minimize letdown.

Reference: OP/1/A/1102/01 Encl 4.1 pg 4 "Note"

4.5 TRUE or FALSE. During an RCS heat-up from 250 Deg F to Hot Shutdown conditions, withdrawing Group 1 control rods to 50% is not required provided it can be shown that the reactor will be greater than 1.0% Delta K/K shutdown at 532 Deg F. (0.5)

Answer: False. Rods must be withdrawn, and shutdown margin verified.

Reference: OP/1/A/1102/01 Encl 4.2 pg 1

4.6 During cold conditions, state two (2) actions taken to protect against over pressurization of the reactor vessel (i.e., violation of NDT limits)? (2.0)

Answer:

1)The PORV setpoint is adjusted using the PORV NDT selector switch when RCS temperature is less than 325 Deg F.

2)The HPI loop "A" and "B" injection valves and their bypass valves are tagged shut and their breakers tagged open.

Reference: OP/1/A/1102/10 Encl 4.2 pg 7 and 9.

4.7 TRUE or FALSE. An LPI pump may run at no flow conditions for up to 30 minutes, but may run with minimum recirc flow indefinitely. (0.5)

Answer: False. Can run with minimum recirc for 30 min max.

Reference: OP/1/A/1104/04 pg 1

4.8 What temperature indication is used to establish heatup and cooldown rates while on LPI cooling with no RCPs operating? (1.0)

Answer:

LPI cooler outlet temperature.

Reference: OP/1,2,3/A/1104/04 pg 2

4.9 Give two (2) conditions requiring that the reactor coolant system and the control rod drives be vented. (2.0)

Answer: (Any two)

If the RCS Temperature/Pressure fall below or to the right of the curve in the "Control Rod Drive System (CRDS)" procedure.

Following a loss of level in the pressurizer below "0" inches if nitrogen is in the pressurizer.

Following a loss of RC system pressure indication during which it cannot be shown that pressure did not drop below the curve in the "CRDS" procedure.

Following loss of level in either Core Flood Tank below 0 inches if RC pressure is below Core Flood Tank pressure.

Loss of level indication in the ~~Makeup~~ Letdown Storage Tank.

Reference: Duke NRC Question Bank 0=111.

4.10 Match the tenth values (TVL) for gamma radiation for the following materials: (1.0)

a.	Water	1.	2"
b.	Concrete	2.	4"
c.	Steel	3.	12"
d.	Lead.	4.	24"

Answer:

a) 24" b) 12" c) 4" d) 2"

Reference: Duke NRC Question Bank O#122

4.11 Hydrazine is removed from the reactor coolant system by: (Select one) (1.0)

a. By directing letdown through the normal or spare purification demineralizer.

b. By spraying the pressurizer and venting the LDST during heatup.

c. By bleed and feed prior to heat up.

d. Both a and c.

Answer:

b

Reference: OP/1/A/1102/01 Encl 4.2 Pg 6

4.12 During an RCS cooldown from 250°F, when cooling down the pressurizer, and depressurizing the RCS, makeup is controlled to prevent an outsurge from the pressurizer into the hot leg. Why is this done? (1.0)

To prevent the hot pressurizer water from possibly voiding at the top of the hot legs where the pressure is ~~lowered~~ below the saturation pressure for the temperature of the pressurizer.

Reference: OP/1/A/1102/10 Encl 4.3 pg 5 + pg 7

4.13 TRUE or FALSE. The fuel pin in compression limit is less restrictive than the 50°F subcooled curve during RCS cooldown for all temperatures and pressures. (0.5)

Answer:

False.

Reference: OP/1/A/1102/10 Encl 4.5 pg 1

4.14 TRUE or FALSE. According to EP/0/A/1800/04, Loss of Reactor Coolant, starting a Reactor Coolant Pump (RCP) is permissible at RC pressure >1600 psig; even if saturation conditions exist. (0.5)

Answer:

True.

Reference: EP/0/A/1800/04 pg 11

4.15 Enclosure 1 (Pressure vs. Temperature Curves) of EP/0/A/1800/04, Loss of Reactor Coolant, defines a "Thermal Shock Operating Region" (TSOR) and gives two guidelines for determining when the RCS must be maintained within the TSOR. State the two (2) guidelines for determining whether or not the RCS should be maintained within the TSOR. (2.0)

Answer:

Maintain the RCS within the TSOR whenever:

a) The RCS is less than 560°F and the cooldown rate exceeds 100°F/hr.

or

b) The RCS is less than 560°F, and all RCPs are off and HPI is on with any of the following valves not fully closed: HP-2, HP-409, HP-27, HP-410

Reference: OP/0/A/1800/04 Encl 1

4.16 TRUE or FALSE. To protect against boiling the steam generators dry, the operator should manually trip the reactor immediately upon loss of both main feedwater pumps unless emergency feedwater pumps are operating and flow is verified. (0.5)

Answer:

False.

Reference: Oconee NS Directive 3.1.21

4.17 TRUE or FALSE. Red Tags and Yellow "Hold" Tags may be hung for personnel safety, whereas White Tags are largely for protection of equipment. (0.5)

Answer:

True.

Reference: Oconee NS Directive 3.1.1 pg 6

4.18 During a planned initiation of Natural Circulation Cooldown, OP/O/A/1102/16, the operator is directed to monitor pressurizer level and LDST level. A sudden increase in either level while pressure is constant or decreasing according to this procedure, is indicative of what problem? (1.0)

Answer: Possible voiding in the RCS

Reference: OP/O/A/1102/16 pg 1

4.19 a. With Reactor Coolant Pumps off, how is reactor coolant temperature determined? (1.0)

b. If a Natural Circulation Cooldown is being conducted using only one OTSG, how is the bulk temperature of the loop with the nonsteaming OTSG best determined? (1.0)

Answer:

a) By averaging the five highest incore thermocouples.

b) By determining the saturation temperature corresponding to the pressure in the "idle" OTSG.

Reference: OP/O/A/1102/16 Encl 5.1

4.20 If the HPI System has actuated because of low pressure conditions, it must remain in operation until one of two criteria is satisfied. State these two (2) criteria. (2.0)

Answer:

CAUTION: If the HPI System has actuated because of low pressure conditions, it must remain in operation until one of the following criteria is satisfied:

1. The LPI System is in operation and a flow rate in excess of 1000 gpm in each line and the situation has been stable for 20 minutes;

OR

2. All RCS hot and cold leg temperatures are at least 50°F less than the saturation temperature for the existing RCS pressure (see Enclosure 1), and the action is necessary to prevent the indicated PZR level from going off scale high.

Reference: EP/O/A/1800/C4 pg 6

4.21 For non-LOCA overcooling events where pressure drops below 1550 psig, select the one correct statement from the following. (1.0)

a. HPI should be reset and throttled immediately once the cause of the problem has been determined to be non-LOCA overcooling.

b. Reactor coolant pumps should be restarted immediately once the cause of the problem has been determined to be non-LOCA overcooling.

c. Reactor coolant pumps should be restarted immediately after correcting the cause of the overcooling if the 50°F subcooling margin is regained.

d. Reactor Coolant pumps should not be stopped if the cause of the problem has been determined to be a non-LOCA overcooling, even if the 50°F subcooling margin is lost.

Answer:

c

Reference: EP/C/A/1800/C4 pg 6.