U. S. NUCLEAR REGULATORY COMMISSION REGION I
OPERATOR LICENSING EXAMINATION REPORT

EXAMINATION REPORT NO. 50-289/85-31 (OL)

FACILITY DOCKET NO. 50-~~354~~289

FACILITY LICENSE NO. DPR-50

LICENSEE: GPU Nuclear Corporation
P. O. Box 480
Middletown, Pennsylvania 17057

FACILITY: Three Mile Island Unit 1

EXAMINATION DATES: December 13-18, 1985

CHIEF EXAMINER: N Dudley — 1-21-86
N. Dudley, Lead Reactor Examiner — Date

REVIEWED BY: Robert M. Keller — 1/27/86
Robert M. Keller, Chief, Projects Section 1C — Date

APPROVED BY: Harry B. Kister — 1/28/86
Harry B. Kister, Chief, Projects Branch No. 1 — Date

SUMMARY: Five written, five oral, and four operating examinations were administered to four Senior Reactor Operator Candidates and one Instructor Certification Candidate. All candidates passed all portions of the examinations. No significant generic weaknesses were noted during the examination.

REPORT DETAILS

TYPE OF EXAMS: Replacement

EXAM RESULTS:

	RO Pass/Fail	Inst. Cert Pass/Fail
Written Exam	4/0	1/0
Oral Exam	4/0	1/0
Simulator Exam	4/0	-/-
Overall	4/0	1/0

CHIEF EXAMINER AT SITE: N. Dudley, NRC

OTHER EXAMINERS: W. Apley, PNL

1. Summary of generic deficiencies noted from grading of written exams:

   Over the last two SRO examinations, some of the licensed reactor operators who have been assigned to the Training Department have done poorly on Section 5, "Theory of Nuclear Power Plant Operations."

2. Personnel present at Exit Interview:

   NRC Personnel

   N. Dudley, Lead Reactor Engineer (Examiner)

   Facility Personnel

   M. Ross, Manager Plant Operations
   B. Leonard, Operator Training Manager

3. Summary of NRC Comments made at exit interview:

   The NRC reviewed the number and types of examinations administered. A discussion was held to clarify some technical details relating to candi-

dates' oral responses. The NRC then presented the following training program weaknesses noted during the examination.

- The Training Center's copy of the Technical Specifications and the copies of the Technical Specifications provided to the NRC for examination preparation were not up to date.

- There is no basis for operating two Reactor Cooling Pumps (RCP) on the same bus vise separate buses during a control room evacuation. The Manager Plant Operations stated he would evaluate whether to change the procedure to have two RCP operating from separate buses.

4. Changes made to written exam during examination review:

Question No.	Change	Reason
7.2 b.4	Change "26-inches high to "26-inches Hg."	Clarifies units of condenser vacuum.
8.3	Change "Environmental Technical Specifications Appendix B" to "NPDES Permit".	Environmental T.S. have been replaced by the NPDES Permit.

Answer No.	Change	Reason
6.6 b.	Delete "STOP PUSH BUTTON (Engine and Control Room)".	Trip is not actuated by ES signal.
6.7 a.	Add "It is also possible for BTU limit to clear as reactor power increases which causes Th to increase and therefore feedwater should start increasing".	Expands answer to allow additional correct response.
6.8 1.	Add "pump runout; starving other OTSG".	Expands answer to allow additional correct response.
8.8	Add "b".	The responsibility of notifying offsite organizations has been assigned to Emergency Support Director by a recent Temporary Change Notice (TCN 1-85-0157).

8.10 b.	Add "(322 Elevation)".	Provides elevation of the remote shutdown panel.

Attachments:

1. Written Examination and Answer Key (SRO)
2. Facility Comments on Written Examinations made after Exam Review

MASTER

Attachment 1

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

Facility: TMI-1

Reactor Type: Babcock & Wilcox - PWR

Date Administered: December 16, 1985

Examiner: W. J. Apley/N. Dudley

Candidate: _____

INSTRUCTIONS TO CANDIDATE.

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

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

Final Grade _____ %

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

_____
Candidate's Signature

5.0 THEORY OF NUCLEAR POWER PLANT OPERATION, FLUIDS, AND THERMODYNAMICS (25.0)

5.1 State whether each of the following statements is TRUE or FALSE? NO explanation required.

a. The operator can increase the heat removal rate from the RCS by reducing steam pressure or increasing OTSG level. (0.5)

b. A LOCA with no RCPs running can result in more inventory loss than a LOCA with RCPs running. (0.5)

c. A total and prolonged loss of OTSG feed can lead to a loss of RCS liquid inventory. (0.5)

d. The primary concern when fuel clad temperature reaches 1400 degrees F is the production of hydrogen. (0.5)

5.2 Give two (2) reasons why when a single feedwater pump trips at 92% power, there will be a small initial increase in generated Megawatts. (2.0)

5.3 The condensate booster pumps discharge into parallel strings of low pressure stage heaters (12, 10, 8, 6). Why is the condensate temperature controlled below approximately 370°F at this point? (1.0)

5.4 During power operations at 45% with three (3) reactor coolant pumps (RCP) in operation, the fourth RCP (loop A) is started. Briefly discuss the following parameters during the transient:

Note: Question poor because there is a 30% limit on starting 4th RCP.

a. Hot leg temp, Cold leg temp, and dTc (each loop) (1.5)

b. Feed Flow (each OTSG) (1.0)

c. OTSG level (each OTSG) (1.0)

Include the control actions of the ICS where applicable.

5.5 Why for the same reactivity change does the reactor respond more rapidly at End-of-Cycle (EOC) than at Beginning-of Cycle (BOC)? (2.0)

-Section 5 Continued on Next Page-

5.6 The reactor is subcritical with a K-eff of 0.96. Source channels are indicating 5 counts per second (cps). What is K-eff when source channels show a count rate of 60 cps after rods are withdrawn? Show all work for full credit. (2.0)

5.7 Why is the worth of two (2) rods together not necessarily the same as the sum of their individual worths? (2.0)

5.8 Control rod worth increases as moderator temperature increases. Describe how the amount of boron concentration affects the magnitude of that increase. (2.0)

5.9 Which of the following reactor conditions would least aggravate a Xenon oscillation? Select one.

a. Low Power, Positive MTC
b. Low Power, Negative MTC
c. High Power, Positive MTC
d. High Power, Negative MTC

MTC = Moderator Temperature Coefficient (0.5)

5.10 One hour after shutdown, the heat generation in the fuel assemblies is approximately 1% of operating values, but in the reflector and shield it is approximately 10% of operating values. Explain the difference. (2.0)

5.11 TRUE or FALSE: Departure from Nucleate Boiling (DNB) occurs when the surface temperature of the fuel assembly exceeds the saturation temperature of the liquid by 6 to 8°F. (0.5)

5.12 If the pressure in a leaking subcooled water pipe is reduced by 50%, approximately how much will the leak rate decrease? Explain any assumptions. (2.0)

5.13 Explain what indication you should expect to see on the source range count rate monitors as the core is voided by a Loss of Coolant Accident (LOCA). (1.0)

5.14 TRUE or FALSE: According to Operating Procedure 1104-9 (Circulating Water), Station Net Megawatt Generation is significantly improved by reducing to four (4) circulating water pumps during cold ambient conditions. (0.5)

-Section 5 Continued on Next Page-

5.15 During a RCS cooldown and depressurization, the following condition occurs. A large rapid increase in pressurizer level occurs while reducing RCS pressure, even though an adequate saturation margin is indicated between T-hot and RCS pressure.

a. According to the Plant Cooldown Operating Procedure (OP-1102-11), what is the cause of this condition? (1.5)

b. Regardless of the cause, which action would you consider most appropriate: Select one. (0.5)

1. Increase RCS pressure
2. Increase cooldown rate
3. Increase letdown
4. Open the PORV

-End of Section 5-

6.0 PLANT SYSTEMS DESIGN, CONTROL, AND INSTRUMENTATION (25.0)

6.1 The Reactor Building purge rate is limited by ambient air temperatures. Why? (1.0)

6.2 The reactor is at 50% with three (3) Reactor Coolant Pumps. Load is reduced. Since one (1) loop's generator will go on level control before the other, how does the Integrated Control System (ICS) function to permit a further reduction of load after the one (1) generator is on level control? (2.0)

6.3 Why is letdown entering the makeup tank sprayed in? (1.0)

6.4 What are the power supplies to each of the nuclear services closed cooling pump motors (NS-P-1A, 1B, and 1C). (2.0)

6.5 What are the three (3) sources of steam to the main feed pump turbines? Indicate which one(s) of the three are preferred. (2.0)

6.6 Following an ESAS actuation:

a. What must be done to transfer the AC Transfer Switch (ABT) for 1C ES Valves MCC from the 1P to 1S 480 Volt bus? (1.5)

b. List three (3) trip signals to the emergency diesel generator that are still in effect? (1.5)

6.7 For the cases below, describe how ICS and the plant would respond to the conditions given. Assume each case in independent, all plant conditions are normal, and control systems are in automatic.

a. The NSSS Demand from the SG - Reactor increases 10% while a Btu limit from T(hot) exists on feedwater. (1.5)

b. The NSSS Demand from the SG - Reactor increases 10% while the CRD out relay is stuck (no outward rod motion available). (1.5)

6.8 What are the two (2) design purposes of the cavitating venturis installed on the OTSG side of the EF-V-30s? (2.0)

-Section 6 Continued on Next Page-

6.9 TRUE or FALSE: The Group Out Limit cannot be bypassed for any of the eight (8) rod groups. (0.5)

6.10 On a reactor trip, one (1) intermediate range channel decreases from 10^{-8} to 10^{-11} in 7 minutes; the other channel decreases initially, then levels out at 5×10^{-10}. Describe what problems with the compensation settings could have caused these erroneous readings. (2.0)

6.11 Under what conditions are the Reactor Coolant Inventory Tracking System (RCITS) hot leg level and Reactor Vessel level indications designed to be used? (1.0)

6.12 Dilute Permit 1 is terminated when Group 5 reaches 80%. Dilute Permit 2 is obtained when Group 6 reaches 95%. How can dilution be enabled when Group 5 is greater than 80%, but Dilute Permit 2 has not yet been obtained? (1.0)

6.13 a. Where are the controls for the fuel transfer system (2 upenders and carriage travel) located? (1.0)

b. Describe the three (3) interlocks associated with the fuel transfer system. (1.5)

6.14 At 50% power, loss of the "A" DC Distribution System will cause a reactor trip; loss of the "B" DC Distribution System will probably not. What causes the reactor trip on a loss of the "A" DC Distribution System? (1.0)

6.15 Why were the orifice rod assemblies (ORAs) removed from the core design prior to the current cycle 5? (1.0)

-End of Section 6-

7.0 PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL (25.0)

7.1 What is the difference in the expected dose rate between a "High Radiation Area" and a "Locked High Radiation Area"? (1.0)

7.2 Select the condition from each of the following that requires the operator to manually trip the reactor.

a. 1. Loss of RCP (resulting in only 3 running)
2. CRD stator temperature 165°F
3. Pzr. level of 295 inches
4. Channel A Th of 602°F (0.5)

b. 1. CRD stator temperature of 185°F
2. Loss of 1 main feed pump
3. Loss of ~~P~~zr. heaters
4. Condenser vacuum of 26-inches ~~high~~ Hg (0.5)

c. 1. Dropped control rod
2. Btu limit (ICS)
3. Two MSIVs close
4. 0.25 gpm OTSG tube leak (0.5)

7.3 a. What is the rated breathing time for a full air bottle in a "Scott Air Pack"? Select one. (0.5)

1. 15 minutes
2. 30 minutes
3. 45 minutes
4. 60 minutes

b. Can the cylinder be changed safely in a contaminated atmosphere area? (0.5)

-Section 7 Continued on Next Page-

7.4 Fill in the following numbers from the list provided below: Select one.

a. During boration, boron concentration should be verified every estimated _____?_____ ppm. (0.5)

b. Do not attempt to start a reactor coolant pump when power is greater than ___?___ %. (0.5)

c. Do not exceed ___?___ % power unless both feed pumps and two (2) condensate booster pump pairs are in operation. (0.5)

d. Following a thermal power change exceeding ___?___ % of the rated thermal power within a 1-hour period, a reactor coolant sample shall be taken. (0.5)

1. 15
2. 30
3. 40
4. 50

7.5 Why does Operating Procedure 1102-15 (Fill and Drain of Fuel Transfer Canal) prohibit filling the fuel transfer canal through the reactor vessel? (1.0)

7.6 a. What are the four (4) criteria used to verify natural circulation in the RCS? (2.0)

b. During a Natural Circulation Cooldown, why does the Operating Procedure (1102-16) state that it is better to use the motor- driven rather than the steam-driven emergency feedwater pump? (1.0)

7.7 List the three (3) primary methods at power for determining which OTSG has the tube leak. (2.0)

7.8 Under which four (4) criteria can HPI be throttled? (3.0)

7.9 List the immediate manual and automatic actions required in the event of a CRD malfunction where one (1) or more groups of rods are driven out with no command for out motion present. Assume the reactor is initially at steady-state, 50% power. (2.5)

-Section 7 Continued on Next Page-

7.10 At what instrument air pressure should the reactor be tripped? Select one. (0.5)

1. 50 psig
2. 60 psig
3. 70 psig
4. 80 psig

7.11 On a steam leak what determines whether the operator trips the reactor or shuts down at 10% per minute? (2.0)

7.12 Abnormal Procedure 1203-40 (Loose Parts Monitor System) lists twelve (12) unit parameters that should be checked for abnormalities if a loose parts monitor system alarm is received. Two (2) are RC flow and RC pump vibration. Name five (5) of the remaining ten (10) parameters that should be checked. (1.5)

7.13 On an OTSG tube leak (ATP-1210-5), if the condenser was not available and OTSG pressure could not be maintained below 1000 psig in the contaminated generator, which action below should you order according to procedure as shift supervisor? (0.5)

a. Use the atmospheric dump valve to prevent MS safety valve actuation.

b. Wait for automatic MS safety valve actuation to preclude unnecessarily discharging additional amounts of contaminants.

7.14 What OTSG levels should be maintained after a reactor trip if:

a. The 25°F subcooling margin is lost? (0.5)

b. RCPs are on, adequate subcooling? (0.5)

c. RCPs are off, adequate subcooling? (0.5)

7.15 TRUE or FALSE: If either the Diamond Rod Control or the Bailey Reactor Demand stations are in Hand and a feedwater cross limit occurs, the operator should use the "Raise-Lower" switch, and adjust the reactor power upward to be compatible with the total Feedwater Flow. (0.5)

-Section 7 Continued on Next Page-

7.16 Explain why the following minimum power limits exist.

a. The CRD Control Panel should not be placed in AUTO unless reactor power is greater than 5% on the Nuclear Instrumentation Channel feeding the ICS. (0.75)

b. With the CRD Control Panel in AUTO, the Reactor Demand Hand auto station should not be placed in AUTO until reactor power is greater than 15%. (0.75)

-End of Section 7-

8.0 ADMINISTRATIVE PROCEDURES, CONDITIONS, AND LIMITATIONS (25.0)

8.1 a. Per Technical Specification 3.0, on general Limiting Conditions for Operation (LCO), what action must be initiated if an LCO is not met? (1.0)

b. What is the minimum time permitted for initiating this action? (0.5)

8.2 What two (2) special procedural requirements have been established especially for Special Temporary Procedures (STPs) which involve the Engineered Safeguards Actuation System (ESAS) or the Emergency Feedwater System (EF)? (2.0)

8.3 List two (2) of the parameters that are subject to Limiting Conditions for Operation in the Environmental Technical Specifications, Appendix B. (2.0)

Pointed out during exam that NPDES Permit has replaced Env Tech Specs (questions retained)

8.4 Temporary Changes to the valve line-ups required by Procedure Valve Checklists do not require the use of a TCN (Temporary Change Notification). However, what three (3) things must be done to allow those deviations? (1.5)

8.5 Anytime the Departmental Foreman is not on site, who is authorized to sign in the Departmental Foreman's space on the completed tagging application? (1.0)

8.6 A licensed Senior Reactor Operator, with no other concurrent responsibilities, must directly supervise all core alterations. Where can he be located? Select one. (0.5)

a. The Control Room

b. Reactor Building Operating Floor Area

c. Spent Fuel Pool

d. Auxiliary Building

-Section 8 Continued on Next Page-

8.7 During heatup the plant is at 450°F when it is reported that the block valve for a PORV is shut and cannot be opened until repairs are completed in 2 days. What actions, if any, should be taken? Justify your answer. (2.0)

8.8 The Emergency Director is initially responsible for:

A. Classification of an emergency event.

B. Approving and directing official notifications to offsite agencies.

C. Approving and directing information releases to the media.

D. Approving and, if possible, personally conveying appropriate Protective Action Recommendations to the Bureau of Radiation Protection.

E. Directing on-site evacuation at the Alert or lower level emergency classification based on potential hazard to non-essential personnel.

F. Authorizing emergency workers to exceed 10 CFR 20 Radiation Exposure Limits.

G. Approving and directing deviation from established operating procedures, emergency operating procedures, normal equipment operating limits or technical specifications during attempts to control the emergency.

When the Emergency Support Director (ESD) arrives, which two (2) of the above responsibilities does the ESD assume? (2.0)

8.9 Under what condition would a person injured in a radiologically controlled area (RCA) be de-contaminated on-site? (1.0)

8.10 a. What is the minimum Emergency Classification that requires activation of the Technical Support Center? (1.0)

b. Where is the Technical Support Center located? (0.5)

c. Where is the backup location for the Technical Support Center if the primary location is uninhabitable? (0.5)

8.11 What are Exception and Deficiency (E&D) sheets used for? (1.0)

-Section 8 Continued on Next Page-

8.12 a. During STARTUP, HOT STANDBY, and POWER OPERATION, list three (3) of the six (6) allowable reasons for containment purging to reduce airborne activity to facilitate containment entry. (1.5)

b. During STARTUP, HOT STANDBY, and POWER OPERATION, which of the containment parameters listed below may be controlled by conducting purge operations? (1.5)

1. Temperature
2. Pressure
3. Humidity

8.13 For each of the following situations indicate what REQUIREMENT, if any, applies and what ACTION, if any should be taken. Consider each situation separately.

a. Diesel generator A's operability load test, which is required every 31 days, is scheduled for today. The last three tests were completed 36, 68, and 102 days ago, respectively. The plant is at 100% power. (1.5)

b. The plant is at 295^{o}F and heating up at 1^{o}F per minute, when a decay heat removal pump is found inoperable. (1.0)

c. The plant is at 100% power when it is determined that the discharge valves for two emergency feedwater pumps are failed shut. (1.0)

8.14 How often during refueling operations must startup checks be performed? (0.5)

8.15 While reviewing logs you note an obvious error. Explain exactly how you would correct the entry (in accordance with AP-1001G: Procedure Utilization). (1.5)

-End of Section 8-

-End of Exam-

EQUATION SHEET

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

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

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

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

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

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

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

$\text{decay constant} = \frac{\ln(2)}{t_{1/2}} = \frac{0.693}{t_{1/2}}$ $\quad A_1 = A_0 e^{-(\text{decay constant})x(t)}$

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 Btu = 778 ft-lbf

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

MASTER

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

Facility: TMI-1

Reactor Type: Babcock & Wilcox - PWR

Date Administered: December 16, 1985

Examiner: W. J. Apley/N. Dudley

Candidate: ANSWER KEY

INSTRUCTIONS TO CANDIDATE:

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

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

Final Grade _____ %

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

_____
Candidate's Signature

5.0 THEORY OF NUCLEAR POWER PLANT OPERATION, FLUIDS, AND THERMODYNAMICS (25 POINTS)

5.1 a. TRUE
b. FALSE
c. TRUE
d. TRUE

Reference: Question Bank 013928
B&W ATOG Guidelines, Part II, Vol. 1.

5.2 1. With a drop in feedwater flow, less steam is drawn through the aspirating port in the OTSG to heat the feedwater. That steam becomes available to the TG.

2. Steam used by the tripped turbine-driven feedwater pump is diverted to the TG.

Higher pressure to turbine = increase in generated MW.

Reference: Open Training Manual, Vol. VII, p. III-1.

5.3 If it was raised any higher you would not satisfy the minimum NPSH requirements for the main feedwater pumps.

Reference: Operator Training Manual, Vol. VI, Condensate Lesson, p. 3.

5.4 a. Th and dT will decrease, **(+0.6)** Tc will increase **(+0.4)**. This is to maintain energy (heat) balance, Q = M dT **(+0.5)**.

b. Feed flow will be adjusted by ICS to maintain Tc's equal **(+0.5)**. 'A' OTSG will have increased feed flow and 'B' OTSG will have decreased feed flow **(+0.5)**. (OTSG may reach low level limits.)

c. OTSG level will follow feed flow to that OTSG **(+0.5)**. 'A' OTSG level will increase and 'B' OTSG level will decrease, again to balance Tcs **(+0.5)**.

Reference: Question Bank 0014103
Oper. Training Manual, Vol. III, Heat Exchanger Heat Transfer, p. 153.

5.5 Pu builds up during the cycle until eventually at EOC it may be responsible for 40% of reactor power. Pu has a beta of 0.0021, much less than that of U-235 (0.0065), thereby resulting in a much lower beta-effective later in cycle life.

Reference: Oper. Training Manual, Vol. II, p. 39.

5.6 $\frac{CR_1}{CR_2} = \frac{(1 - K2)}{(1 - K1)}$ formula sheet

$$K2 = 1 - \frac{CR_1}{CR_2} (1 - K1)$$

$$= 1 - 5/60(1 - 0.96)$$

$$= 0.9967$$

Reference: Formula Sheet; Oper. Training Manual, Vol. II, p. 120.

5.7 The introduction of one rod distorts the flux distribution and thereby affects the worth of the second rod, since rod worth is approximately proportional to the square of the thermal neutron flux at any one point.

Reference: Oper. Training Manual, Vol. II, p. 136.

5.8 As the moderator temperature increases, boron in solution spreads out as the moderation density decreases. A temperature increase with boron in the moderator would cause boron density and moderator density to decrease. This results in an increase in the thermal diffusion length but also a decrease in the number of soluble boron poison atoms. The decrease in soluble poison in solution and the increase in thermal diffusion length, with no change in control rod density, causes more neutrons to be available to the control rods for capture; the higher the boron concentration, the greater the increase.

Reference: Oper. Training Manual, Vol. II, pp. 143-144.

5.9 b. low power, negative MTC

Reference: Oper. Training Manual, Vol. II, p. 166.

5.10 The heat generation after shutdown is no longer primarily due to the kinetic energy of the fission fragments in the fuel; it is now due to the absorption of gamma radiation from fission-product decay.

Reference: Oper. Training Manual, Vol. II, p. 187.

5.11 False - actually that is the definition of nucleate boiling

Reference: Oper. Training Manual, Vol. II, p. 197.

5.12 Leak rate is proportional to the area of leak times velocity of fluid leaving pipe. From Bernoulli's equation, pressure is proportional to the square of velocity, so halving pressure will only reduce velocity by square root of two (or drop of about 29.3%).

Reference: Oper. Training Manual, Vol. III, p. 94.

5.13 Count rate would significantly increase (by a factor of 10^2 to 10^4, number not important), and would be erratic as voiding oscillations took place ... both due to increased leakage.

Reference: Oper. Training Manual, Vol. VII, TMI-2 Accident Description, p. 14.

5.14 False

Reference: OP-1104-9, p. 5.

5.15 a. Voids are occurring in the reactor vessel head due to head water temperature being higher than RCS temperature.

b. Definitely #1 - Increase RCS pressure; other alternatives would aggravate the problem.

Reference: OP-1102-11, p. 3.

6.0 PLANT SYSTEMS DESIGN, CONTROL, AND INSTRUMENTATION (25 POINTS)

6.1 The containment isolation valves have a relatively high NDTT ($60^{o}F$). Number not required.

Reference: Oper. Training Manual, Vol. VII, p. 23, RB Ventilation Systems.

6.2 ΔTc control is blocked and the total flow control circuit is released. This total flow controller will modify the loop demand (for generator not on level control) to ensure that the change in feedwater flow is sufficient to satisfy the unit demand.

Reference: Oper. Training Manual, Vol. VI, p. IV-5.

6.3 To absorb hydrogen for subsequent scavenging of oxygen in the primary system(½ credit only for allowing degas)

Reference: Oper. Training Manual, Vol. VI, p. 20, Makeup and Purification System

6.4 NS-P-1A receives power from the 1P 480 volt engineered safeguards bus and motor NS-P-1C receives power from the 1S 480 volt engineered safeguards bus. Motor NS-P-1B's power source can be selected from either the 1P or 1S 480 volt engineered safeguards bus. During normal operation, motor NS-P-1B receives power from the 1P 480 volt engineered safeguards bus.

Reference: Oper. Training Manual, Vol. VI, p. 10, Nuclear Services Closed Cooling

6.5 1. LP steam from aux. boiler
2. LP from extraction steam (4th and 6th moisture separator)
3. HP from main steam

LP steam is preferred

Reference: Oper. Training Manual, Volume VI, Feedwater System Lesson, p. 3.

6.6 a. 1. Reset ESAS
2. Push ABT Reset button on panel PCR
3. Select ABT to 1S

b. Any three (3) of:

- 2 out of 3 low lube oil pressure running
- 2 out of 3 high crankcase pressure running
- engine overspeed
- ~~stop pushbutton (engine and control room)~~ Not ES trip
- 86/G

Reference: Oper. Training Manual, Vol. VI, Electrical Distribution System, p. 33/ Emergency Diesel Lesson plan (pp. 61 + 62)

6.7 a.* Rx power will increase (+0.3) with FW staying the same (+0.3) until FW-demand > FW-flow + 5% (+0.3) which then causes a cross limit (+0.3) which will reduce Rx power to keep power within 5% of FW flow (+0.3).

b. FW flow will increase (+0.3) and a rod out demand will occur (+0.3) until FW-flow > FW-demand/Rx power +5 % (+0.3) which causes a cross limit (+0.3) to reduce FW flow to within 5% of Rx power (+0.3).

Reference: STM-1-64, p. 17, 18.
Question Bank 0013947

6.8 To limit EFW flow to an OTSG on a steam line rupture accident:

1. limit containment pressure / pump runout / starving other OTSG
2. prevent restart if OTSG is overfed

Reference: Oper. Training Manuasl, Vol. VI, AFW, p. 30.

6.9 False - Group 7 (group not required)

Reference: Oper. Training Manual, Vol. V, CRDM System, p. CRD-28.

6.10 The rapid decrease represents the over-compensated instrument; the leveling off is an indication of no compensation at all.

Reference: Oper. Training Manual, Vol. II, p. 269.

* It is also possible for BTU limit to clear as reactor power ↑ which causes T_H ↑ ∴ FW would start increasing.

6.11 After a reactor trip:

1. With NO reactor coolant pumps operating

   (full credit)

2. RCITS will not be reliable if associated loop vent valve is open (hot leg level) or vessel head vent valve is open (vessel level)

   (+0.25 pts credit if only answer #2 is provided)
   (This response not required for full credit.)

Reference: OP-1103-1, p. 2.

6.12 A keylock switch labeled DILUTE SIGNAL is provided to enable dilution. This keylock switch is located in System Logic Cabinet 2. (Location not required for full credit.)

Reference: OP-1105-9, p. 36.

6.13 a. One, located in the fuel storage building, controls the carriage travel and the upender in the spent fuel pool. The other, in the Reactor Building, controls the upender in the fuel transfer canal.

b. Interlocks are provided to prevent moving the carriage when the upenders are in an upright position, to prevent moving the upenders when the carriage is not stopped in the proper position, and to prevent lowering the fuel hoist grapple tubes over the upender locations if the upenders are not vertical.

Reference: RP-1507-7, p. 2.

6.14 Loss of DC power to EHC system; reactor trips on turbine trip.

Reference: EP-1202-9A, p. 1.

6.15 There were mechanical problems with the ORA latching mech[illegible]ainers have needed to be installed to ensure positive retention of the source clusters.

Reference: Cycle 5 Reload Report, p. 6-1.

7.0 PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL (25 POINTS)

7.1 Locked - 1000 mrem/hr
High Radn - 100 mrem/hr

Reference: Oper. Training Manual, Vol. VII, Module 8, Radn. Protection Program, p. 93.

7.2 a. 3
b. 1
c. 3

Reference: Question Bank 0010310
CR Ques. Cat. 4 and 7, No. 39 (OP-204, AP-521)

7.3 a. #2 - 30 minutes

b. No - must be changed in a clean area

Reference: Oper. Training Manual, Vol. VII, Module GET-103, p. 40.

7.4 a. 30 ppm (2)
b. 30% (2)
c. 40% (2)
d. 15% (1)

Reference: a. OP-1102-10, p. 2.
b. OP-1102-2, p. 2.
c. OP-1102-4, p. 3.
d. OP-1102-4, p. 12.

7.5 It causes a CRUD burst which causes high refueling radiation levels.

Reference: OP-1102-15, p. 3.

7.6 a. 1. RCS ΔT increases to approximately $30^{o}F$ to $50^{o}F$ (dependent on Decay Heat) and stabilizes and Th is less than $600^{o}F$.

2. Incore thermocouple temperatures stabilize and are tracking T_H.

3. Cold leg temperatures approach saturation temperature for secondary side pressure (normally within 5 minutes).

4. Verify heat removal from OTSGs.

a. Steam flow indication

b. Feed flow indication

Reference: ATP-1210-10, pp. 10 - 11.

b. It eliminates the RCS uncontrolled heat loss (steam to the EFW turbine).

Reference: OP-1102-16, p. 7.

7.7 1. Sample OTSG (Beta-gamma, H-3, Na-24, I-133, CS-137; Isotopes not required). **(+0.75)**
2. Surveying steam lines **(+0.5)**
3. Observing OTSG levels and feed rates **(+0.75)**

Reference: ATP-1210-5, p. 1.

7.8 1. HPI must be throttled to prevent pump runout (550 gpm/pump).

2. HPI must be throttled to prevent violation of the applicable brittle fracture/thermal shock curve limitations.

3. HPI may be throttled if LPI flow is greater than 1000 gpm in each line and stable for 20 minutes.

4. HPI may be throttled if the required $25^{o}F$ subcooling margin exists and pressurizer level is established greater than 0 in.

Reference: ATP-1210-10, p. 4.

7.9 *a. Verify that the CRD operators console is in manual.

b. Select jog speed.

*c. Verify that the GROUP and SINGLE select switches are OFF.

d. Select sequence override.

e. If out motion continues, select the affected group with the GROUP select switch and place the Manual Command Switch in the insert position.

*Expected Automatic Action

Reference: EP-1202-08, p. 17.

7.10 b. 60 psig

Reference: EP-1202-36, p. 3.

7.11 If a. SLRDS actuates on either SG or

b. Continued operation presents a hazard to personnel or equipment required for safe shutdown

Then manually trip the reactor.

If a. Continued operation is not posing a hazard to personnel or equipment required for safe shutdown but is severe enough to require shutdown or

b. RB pressure exceeds 2 psig

Then reduce load at 10% per minute.

Reference: AP-1203-24, p. 2.

7.12 1. R.C. Pressure

2. R.C. Pump Seal Flow

3. R.C. Pump and Motor Bearing Temperatures

4. Power Range Power Level

5. CRDM Drive Temperatures

6. RM-L1

7. Letdown Filter d/p

8. Letdown Sample

9. Obtain Secondary System Samples for activity

10. Incore thermocouple indication for possible blocked channels.

Any five (5): 0.3 pts each

Reference: AP-1203-40, p. 3.

7.13 a.

Reference: ATP-1210-5, p. 4.

7.14 a. 90 to 95% Operating Range

b. 30 in. Startup Range

c. 50% Operating Range

Reference: ATP-1210-10, p. 5.

7.15 False - Reactor power should never be raised to clear FW x limits.

Reference: OP-1105-4, p. 5.

7.16 a. Going into AUTO at a very low power level could result in a continuous rod withdraw signal.

b. There is a 15% low limit in the Reactor Demand signal.

Reference: OP-1105-9, p. 9.

8.0 ADMINISTRATIVE PROCEDURES, CONDITIONS, AND LIMITATIONS (25 POINTS)

8.1 a. Place the plant in a condition where the TS LCO does not apply.

b. Within 1 hour.

Reference: Tech. Spec. 3.0.1, p. 3-1.
Question Bank 0014034.

8.2 a. The STP must contain a step which requests the Shift Supervisor/ Shift Foreman verify that the redundant system(s), component(s), channel(s), etc. is operable (satisfied T.S. requirements) prior to removing the system, component, channel, etc. affected by the STP, from service.

b. The STP must contain a step which requires an independent valve and/or switch position verification check be performed within the boundary of the system(s), component(s), channel(s), etc. affected by the STP prior to returning the system(s), component(s), channel(s), etc. to service. This independent check will provide positive assurance that the system is returned to a fully operational status.

Reference: AP-1001A, p. 21.

8.3 1. Thermal (both maximum and ΔT will give full credit)

2. Chemical

Full credit if any two of three chemical parameters (chlorine, pH, suspended or dissolved solids) are listed.

Reference: Environmental Technical Specifications/ NPDES Permit Lesson Plan

8.4 The deviations must be noted in indelible marker on the applicable check off sheet and must be reviewed and approved by two Licensed Reactor Operators, one of whom must be a Shift Supervisor/Shift Foreman with a SRO License. The deviations must be noted in the Shift Foreman's Log.

Reference: AP-1001A, p. 26.

8.5 Shift Supervisor

Reference: AP-1102, p. 13.

8.6 b. RB Operating Floor Area

Reference: RP-1501-1, p. 2.

8.7 Verify PORV shut **(+1.0)**
Remove power from PORV **(+1.0)**

Reference: Tech. Spec., pp. 3-18c, 3.1.12.

8.8 c. and d. (also b)

Reference: EPIP-1004.2, p. 2. (TCN 1-85-0157)
TCN Answer acceptable but not required for full credit

8.9 The injury was minor enough that it could be treated on-site; if they have to be moved off-site for treatment, any decontamination would be incidental to ensuring the condition of the person.

Reference: EPIP-1004.16, p. 2.

8.10 a. Alert

b. Remote S/D Panel Room (322 Elevation)

c. I and C Shop

Reference: EPIP-1004.28, pp. 1, 4.

8.11 To record problems encountered during surveillance testing.

Reference: AP-1001J, p. 14.

8.12 During STARTUP, HOT STANDBY and POWER OPERATION:

a. Any three (3) of

1. Non-routine safety-related corrective maintenance

2. Non-routine safety-related surveillance

3. Performance of Technical Specification required surveillances

4. Radiation surveys

5. Engineering support of safety-related modifications for pre-outage planning

6. Purging prior to shutdown to prevent delaying of outage commencement (24 hours prior to shutdown)

b. Temperature - No
Pressure - Yes
Humidity - No

Reference: Tech. Spec., p. 3-4/a, b.

8.13 a. Each test is within 25% of required time **(+0.35)** and each three (3) consecutive tests are not within 3.25 of required time **(+0.4)**. Declare DG A inoperable **(+0.25)**. Prove operability of DG B within 1 hour **(+0.3)**. Conduct load test on DG A **(+0.2)**.

b. Decay heat removal pumps are not required until Rx is critical. No action besides repair of pump is required. **(+1.0)**

c. Within 1 hour initiate shutdown. **(+1.0)**

Reference: Tech. Spec., pp. 1-8, 3-25.
Question Bank 007914.

8.14 At least once per shift.

Reference: RP-1507-3, p. 6.

8.15 1. Asterisk it
2. Put correct entry by it
3. Sign your name by the explanation
4. Time and date the explanation
5. Have supervisor (1 level higher) review and ensure person making error is informed.

Reference: AP-1001G, p. 9.

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

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

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

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

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

$\text{decay constant} = \frac{\ln(2)}{t_{1/2}} = \frac{0.693}{t_{1/2}}$ $\quad A_1 = A_0 e^{-(\text{decay constant})x(t)}$

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 Btu = 778 ft-lbf

Degrees F = (1.8 x Degrees C) + 32
1 inch = 2.54 centimeters
g = 32.174 ft-lbm/lbf-sec^2

Attachment 2

5.1 ok

5.2 ok

5.3 ok

5.4 cant start fourth RCP >30% ; is question looking for fourth top parameters or overall averages

5.5 answer selected by question so not in same details as key. Answer if "decrease in B_{eff}" would suffice

5.6 ok

5.7 ok

5.8 ok

5.9 ok

5.10 ok ?

5.11 ok

5.12 ok

5.13 ok

5.14

5.15 a. ok

b. ok

6.1 ok

6.2 ok (ATc blocked)

6.3 add: release gases for degassing

6.4. ok

6.5.

6.6a ok ?

b. ~~ok~~ stop AB

6.7 a. ok

b. ok

6.8 a. ok

6.9. ok

6.10. ~~[illegible] problem~~ ok.

6.11 ok

6.12 ok

6.13 a. ok

b. ok

6.14 ok

6.15 ok

7.1 ok

7.2 a. ok

b. ok

c. ok

7.3 a.

b. ok

7.4 a. ok

b. ok

c. ok

d. ok

7.5 ok

7.6. ok

7.7. ok

7.8 ok

7.9. ok

7.10 ok

7.11 ok

7.12 ok

7.13 ok

7.14 ok

7.15 ok

7.16.a. ok

b. ok

8.1 a.

b. ok

8.2 ok

8.3 ok

8.4 ok

8.5 ok

8.6 ok

8.7 ok

8.8 TCN in effect B, C, D

8.9 ok

8.10 a. ok

b. ok

c. ok

8.11. ok

8.12 ok

8.13 ~~Ok~~ a.

~~8.14~~. ok

~~8.15~~ ok

~~.98~~
~~.9~~ 6
~~.995~~

6.6. STOL Punctuation → not correct ?

8.3. An NPDES Permit. → check
(Appendix B) deleated.

8.10. b. accept Bldg location pin addition
To remote S.O. ie 322 Control
Tower

~~c. ?~~ O/C

Wilson

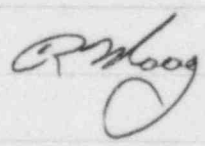
Section 8.0

8.1
8.2
8.3 Use NPDES permit
8.4
8.5
8.6
8.7
8.9
8.10
8.11
8.12
8.13
8.14
8.15

R Moog

Section 7.0

7.1
7.2
7.3
7.4
7.5
7.6
7.7
7.8
7.9
7.10
7.11
7.12
7.13
7.14
7.15
7.16



Section 6.0

6.1
6.2
6.3
6.4
6.5 prefered stm "LP extraction stm"
6.6 part b stop PB not operable
6.7 a Also possible for BTU limit to clear as Rx pwr ↑ which causes T_H ↑ ∴ FW would start increasing
~~6.8~~
~~6.9~~
~~6.10~~
~~6.11~~
6.8
6.9
6.10
6.11
6.12
6.13
6.14
6.15