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

EXAMINATION REPORT NO. 50-289/84-25

FACILITY DOCKET NO. 50-289

FACILITY LICENSE NO. DPR-50

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

FACILITY: Three Mile Island, Unit 1

DATES: August 27 - 30, 1984

CHIEF EXAMINER: Noel F Dudley 10-16-84
Noel Dudley Date
Reactor Engineer

APPROVED BY: RW Hall 10/16/84
Chief, Project Section 1D Date

SUMMARY: One written Senior Reactor Operator examination of six hour duration was administered and evaluated as a pass. An inspection, consisting of eight hours of on-site inspection effort, evaluated the administration of the licensed operator requalification program as adequate to meet regulatory requirements. The program was well organized and well documented. Instructor qualifications, the Manager of Training's Direct Observation of Training/Test Program, and the examination collusion check program were found to be acceptable.

REPORT DETAILS

TYPE OF EXAMS: Initial ___ Replacement __X__ Requalification _____

EXAM RESULTS:

	RO Pass/Fail	SRO Pass/Fail	Inst. Cert Pass/Fail	Fuel Handler Pass/Fail
Written Exam	/	/	1/0	/
Oral Exam	/	/	/	/
Simulator Exam	/	/	/	/
Overall	/	/	1/0	/

CHIEF EXAMINER AT SITE: Noel Dudley

PERSON EXAMINED

D. L. Wilt - IC

1. Summary of generic strengths or deficiencies noted on oral exams:

   N/A

2. Summary of generic strengths or deficiencies noted from grading of written exams:

   N/A

3. Comments on availability and candidate familiarization with plant reference material:

   N/A

4. Comments on availability and candidate familiarization with plant design, procedure, T. S. changes and LERs:

   N/A

5. Comments on interface effectiveness with plant training staff and plant operations staff during exam period.

   Plant staff was extremely cooperative in providing all records requested and making licensed operators and instructors available for interviews.

6. Improvements noted in training programs as a result of prior operator licensing examinations/suggestions, etc:

   N/A

7. Personnel Present at Exit Meeting:

   NRC Personnel

   N. Dudley, Reactor Engineer

   Facility Personnel

   S. Newton, Training Manager

8. Summary of NRC Comments made at exit interview:

TMI-1 has an adequate requalification program which is functioning in accordance with TMI-1 training departmental instructions.

9. Summary of facility comments and commitments made at exit interview:

None.

10. CHANGES MADE TO WRITTEN EXAM

Answer No.	Change	Reason
5.03(a)	Include"(accounts for instrument error)"	Provides additional information.
5.03(b)	Add, "decreases due to reduced heat transfer areas".	Provides completeness to answer.
5.03(b) question	No change	Even though it is recognized that TMI-1 performance data indicates that steam temperature does not begin to decrease until 90% power, the actual power level does not effect the answer to the question.
5.05(a)	Change "50 hrs" to "40 hr.".	Corrects answer to correspond with referenced training material.
5.05(a) reference	Add "Chap 3, Sec VI, Para 116"	Provides reference for length of xenon transients.
5.06(b)	Include "(OTSG may reach low level limit)"	Provides additional information.
5.10(a)	Include "(Graph acceptable with explanation)"	Provides additional information.

Answer No.	Change	Reason
6.01(c)	Include "(Low Speed Stop)".	Provides additional information.
6.02	Delete last sentence.	Information is not required by the question.
6.04(a) question	Delete (a) reweight to 0.75 points.	"De-energizing detector channels" is an undefined statement.
6.04 reference	Add "Drawing No. 55-209-481".	Provides justification for deleting part (a).
6.05(e)	Change "Shift from fast to" to "Trips and restarts on".	More accurate description of Rx Building Fan response to an ES signal.
6.06(b)&(c)	Add "Closes on ESAS".	Provides completeness to answer.
6.06 reference	Add "Makeup and Purification Lesson Plan 11.2.01.69 p 23".	Justifies additions to answer.
6.07(a)	Change "Once withdrawn Safety Rods are placed on" to "Normal power to the Safety Rods is".	Clarifies answer.
6.10(c)	Expand description of a possible way to isolate tank A.	Tank A cannot be totally isolated since it is required to be available by T.S.
7.04	No change.	The caution warning about going further in the procedure does not need to be included for full credit.
7.06(b)	Change "Yes" to "Maybe throttled".	Recognizes that HPI maybe but is not required to be throttled in this situation.

Answer No.	Change	Reason
7.07	Include "(includes group 8 or 9 on emergency power supply)".	Provides additional information.
7.09	Replace answer with "Bypass Low Press Injection [0.7] Shut Core flood tank valve [0.7] Open and tag power supply [0.6]" reweight to 2.0 points.	Correct answer for actions required between 1000 to 700 psig vise 2000 to 1700 psig.
7.09 reference	Change "p 13,14" to "p 15".	Provides justification to answer.
7.10 (1 and 3)	Change "300 mrem/qt" to 1.25 rem/qt" and "125 mrem/lt" to 500 mrem/pregnancy".	Provides limit specific to TMI-1.
7.10 reference	Add "Rad Controls Proc. 1641 p.7".	Justifies changes to answer.
8.03(a)	Change "tests within" to "tests are not within".	Corrects answer for situation in question.
8.06 question	Change "NI-2 3X E 2 cpm" to "NI-2 3X E 3 cpm"	Provide consistence with statement of situation.
8.08 question	Change "Mode 3" to "cold shutdown"	State problem in terms of TMI-1 Technical Specification (TS) vise standard T.S.
8.11 question	Change "Refueling water tank" to "Borated water storage tank".	Use nomenclature specific to TMI-1.
8.11(a)	Change "outside design basis" to "in an un-analyzed condition".	Reflects wording of TMI-1 procedure.
8.11(c)	Change to "No report [035] T.S. required >350,000 gal. [0.4]."	400,000 gal. is greater than required T.S. value.
8.11 reference	Add "T.S. p. 3-21" and "PROC 1044 p. 13".	Justifies changes to answers.

11. Licensed Operator Requalification Program - Unit 1

A. Scope

This inspection was conducted to ascertain the conformance of the licensed operator requalification program to regulatory requirements. The inspection was conducted in parallel with an inspection (I.R. 50-289/84-19) which evaluated specific requalification topics identified by the Operational Readiness Evaluation conducted on February 8 and 9, 1984 (I.R. 50-289/84-05). Special attention was given to qualifications of instructors (order item 82-BC-77), the Manager of Training's Direct Observation of Training/Test Program (order item 82-BC-78), and the licensee's review of exam results for evidence of collusion (order item 82-BC-79).

B. Documents Reviewed

---Requalification training attendance records
---Weekly requalification quizzes
---Annual requalification examinations
---Lesson plans and objectives
---Lecture schedules (past and future)
---Babcock and Wilcox simulator training records
---Operational training memos
---Instructor evaluations
---Instructor qualifications

C. Persons Interviewed

Mr. E. Fredricks, Instructor (SRO Unit 2)
Mr. D. Wilt, Instructor (RO)
Mr. D. Boltz, Instructor (SRO)
Mr. R. Maag, Instructor (SRO)
Mr. S. Brantley, Senior Reactor Operator (SRO)
Mr. J. Masters, Reactor Operator (RO)
Ms. D. Gallently, Administrative Assistant

D. Findings

The annual written requalification examination is given on three separate days. The examination concentrated on subject areas presented by the requalification program during the previous year, yet was broad in scope. The quality of questions can be improved so that a majority are of the analyse and/or explain type. Examination security was maintained by insuring 50% new questions on each examination.

Each licensed operator was also given an oral examination. The Operations and Maintenance Supervisor, Mr. M. Ross, evaluated each senior reactor operator and assigned shift supervisor to evaluate the reactor operators. Documentation of the oral examination indicated they were comprehensive and detailed.

There were three operators who failed portions of the written or oral examinations and were removed from licensed duties. These operators were provided accelerated training, re-examined, and were returned to licensed duty.

Operators who scored between 70% and 80% on a section of the written examination were identified and required to attend lectures in the identified areas. Generic weaknesses identified by the written and oral annual examinations are used to modify the long range training schedule.

The content of the requalification lesson plans are of sufficient depth and quality to adequately cover the lesson objectives. Retention and understanding of lecture presentations is verified by quizzes given at the end of each training cycle. Each training cycle includes an Industrial Experience Review which incorporates changes in plant procedure, equipment modifications, training on LER's and other industry wide concerns.

Operators completed required reactivity manipulations at the B&W Simulator or during walkthroughs at TMI. On site training using the Basic Principle Trainer (BPT) has just begun. After an introductory training session experienced operators feel there is significant training value to the BPT.

Instructor evaluations are being routinely conducted by the Training Manager and Operator Training Supervisor. More frequent evaluations, made by experience instructors, are documented and included in the evaluation records but are not used to meet the requirements of the Manager of Training's Direct Observation of Training/Test Program.

Three of the five requalification instructors hold SRO or IC licenses. A fourth instructor, who holds an RO license, will be issued an IC license. All integrated plant requalification lectures were taught by SRO or IC licensed instructors.

Each written examination or quiz is evaluated by at least two instructors for evidence of collusion. In one case, review of an auxiliary operator exam identified two persons who had written identical answers to a question. A complete internal investigation was conducted and sufficient evidence was collected to convince management that no collusion had taken place. NRC will review the final report, when it is issued, for proper administration of the collusion check program.

E. Conclusions

TMI-1 has an adequate requalification program which is well organized and documented. The quality of examination questions can be improved. The program identifies individual weakness and ensures operators are qualified to perform licensed duties. The instructor certification and evaluation program and the examination collusion check program are being actively administered.

Attachment:

Written Examination and Answer Key

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

FACILITY: TMI-1

REACTOR TYPE: PWR-B&W177

DATE ADMINISTERED: 84/08/06

EXAMINER: DUDLEY,N.

APPLICANT: _____

INSTRUCTIONS TO APPLICANT:

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	APPLICANT'S SCORE	% OF CATEGORY VALUE	CATEGORY
25.00	25.58			5. THEORY OF NUCLEAR POWER PLANT OPERATION, FLUIDS, AND THERMODYNAMICS
24.25	24.81			6. PLANT SYSTEMS DESIGN, CONTROL, AND INSTRUMENTATION
23.50	24.04			7. PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL
25.00	25.58			8. ADMINISTRATIVE PROCEDURES, CONDITIONS, AND LIMITATIONS
97.75	100.00			TOTALS

FINAL GRADE _____%

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

_____
APPLICANT'S SIGNATURE

QUESTION 5.01 (2.00)

After criticality is achieved, the startup procedure requires the operator to level power at 10 -8 amps to record critical data. The operator quickly establishes a ZERO DPM SUR and verifies that the intermediate range N.I.'s are steady with no rod motion. One minute later, the operator notices that power is increasing. Explain why.

QUESTION 5.02 (1.50)

a. What does reactive load (KVARS) measure and HOW does the amount of reactive load effect turbine generator operations? (1.0)

b. How is reactance adjusted? (0.5)

QUESTION 5.03 (2.00)

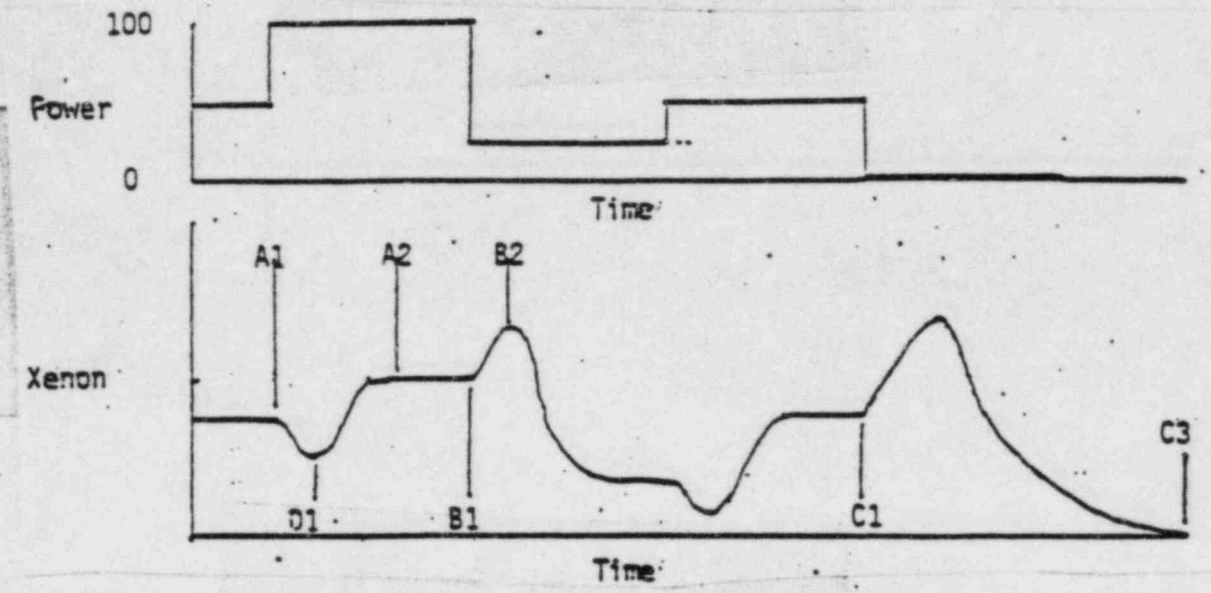
a. Why must the RCS be maintained 25 F subcooled following a reactor trip?

b. Why does the OTSG steam temperature decrease 10 F between 50% and 100% power?

QUESTION 5.04 (2.00)

When the reactor is at a stable 15% power and it is discovered that Tave is not in the programmed band, an I&C Technician is instructed to change the level setpoint on both OTSG's until Tave is returned to 579 F. HOW will this correct the problem?

QUESTION 5.05 (2.50)



Using the above figure answer the following questions:

A. What is the approximate time from A1 to A2 ? (0.75)

B. What is the approximate time from B1 to B2 ? (0.75)

C Why does Xe concntration decrease from A1 to D1 ? (1.0)

QUESTION 5.06 (3.50)

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 trainsient:

A. Hot leg temp, Cold leg tdmp, 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.

QUESTION 5.07 (3.00)

After calculating an Estimated Critical Position for startup it is necessary to dilute 200 ppm boron. Initially source range counts are 40 cps and 45 cps. After diluting 100 ppm boron source range counts indicate 85 cps and 70 cps. Should you as an SRO allow the continuation of the dilution? Explain.

QUESTION 5.08 (2.00)

The attached Figure 5.9 shows the response of RCS pressure and pressurizer level to a trip of one RCP at power. Which curve represents pressure assuming all automatic systems operate properly? JUSTIFY your answer.

QUESTION 5.09 (3.00)

State which rod has the greatest INTEGRATED rod worth and EXPLAIN why. Treat each comparison separately.

a. A rod at the center of the core compared to a similar rod at the edge of the core.

b. A rod dropped by itself compared to the same rod being dropped during a reactor trip.

c. An Axial Power Shaping Rod compared to a control rod.

QUESTION 5.10 (3.50)

a. Although the U238 resonance capture peaks broaden and flatten with increased fuel temperature, the area under the peak remains the same. Why then is there an increase in neutron capture as the fuel temperature is increased? (1.0)

b. Does the fuel temperature coefficient INCREASE or DECREASE fuel temperature is increased? (0.5)

c. HOW AND WHY does the moderator temperature coefficient (MTC) change (more or less negative) as temperature is increased at a constant boron concentration, in an undermoderated core? (1.0)

d. HOW AND WHY does the MTC change as boron concentration is increased at a constant temperature, in an undermoderated core? (1.0)

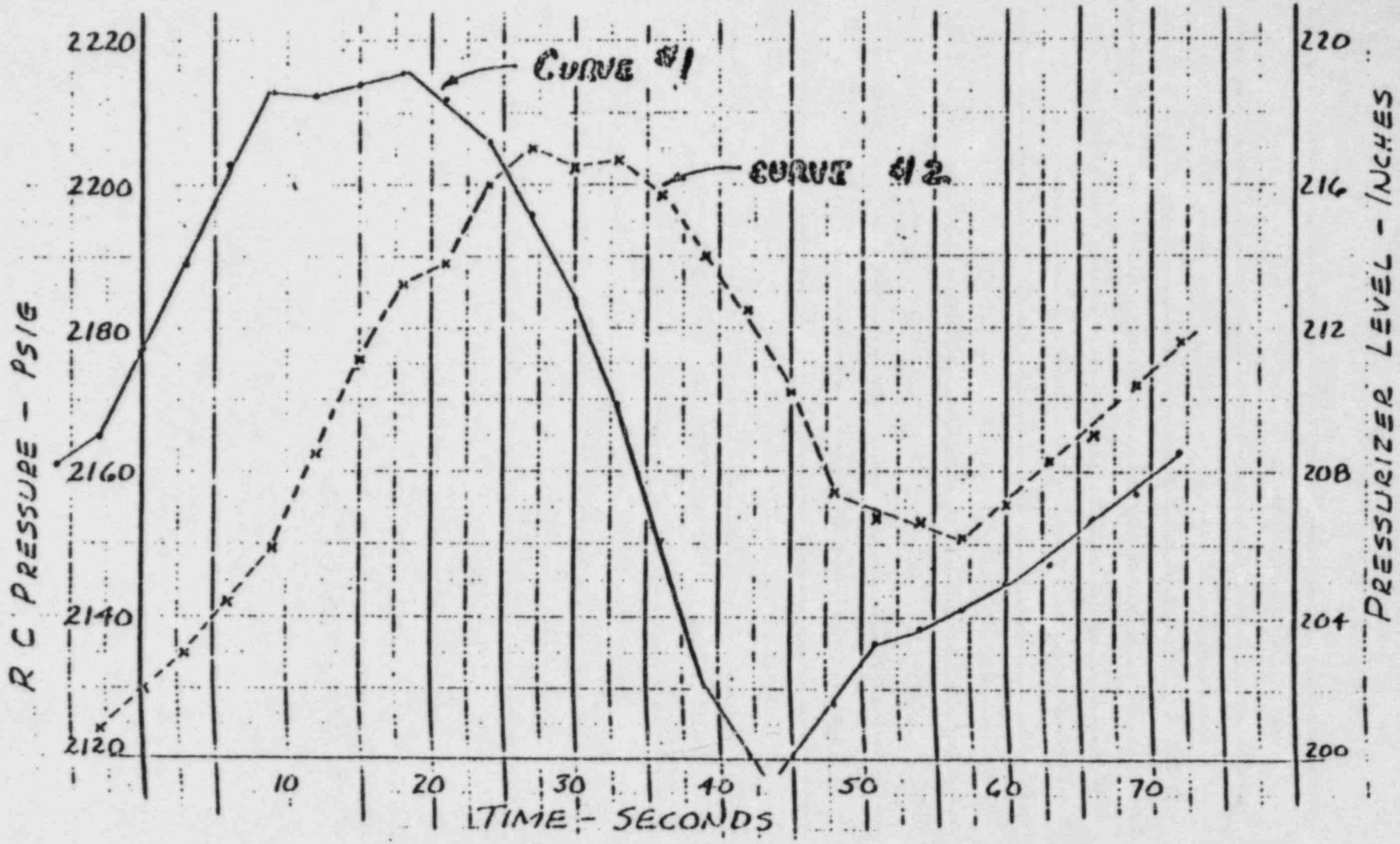

CURVE #1
CURVE #2
R C PRESSURE - PSIG
PRESSURIZER LEVEL - INCHES
TIME - SECONDS
2220
2200
2180
2160
2140
2120
220
216
212
208
204
200
10
20
30
40
50
60
70

FIGURE 5.9

QUESTION 6.01 (2.50)

Upon loss of ICS/NNI power

a. WHAT position will the Hand/Auto station indicators assume? (0.5)

b. What position will the main feedwater valves (FW-v17A/B) assume? (0.5)

c. HOW do the main feedwater pumps respond? (0.5)

d. What is the basis for the precaution to systematically restore ICS/NNI power? (1.0)

QUESTION 6.02 (2.00)

OTSG level is measured with differential pressure transmitters. Before the level signal is displayed, it is processed by a temperature compensating network. Explain why this is necessary.

QUESTION 6.03 (3.00)

During plant operation at 90% power with the ICS in automatic (integrated mode) you notice the following symptoms (alarm or deviation from normal reading):

1. OTSG A on BTU limits (alarm)
2. Selected Rx outlet Th decreases
3. Unit dT decreases
4. Selected loop A Th decreases
5. Steam pressure approximately 900 psig

A. Identify the problem with the plant.

B. What corrective action should be taken to correct the problem ?

QUESTION 6.04 (.75)

What effect, if any, would deenergizing the logic channels of the Engineered Safeguards system have on ES actuations?

QUESTION 6.05 (2.50)

What affect, if any, will an ES signal have on each of the following components?

a. Emergency Diesel Generators
b. The Decay Heat River Water Pumps
c. DH-V4A, 4B (DHR Discharge Header A,B valves)
d. DH-V7A, 7B (DHR discharge to suction of Makeup pumps)
e. The three Reactor Building Emergency Cooling System Fans

QUESTION 6.06 (3.00)

What interlocks are associated with each of the following valves in the Makeup and Purification System? (See simplified diagram)

a. MU-V1A, 1B (TWO required) (1.2)
b. MU-V3 (TWO required) (1.2)
c. MU-V2A, 2B (ONE required) (0.6)

QUESTION 6.07 (3.00)

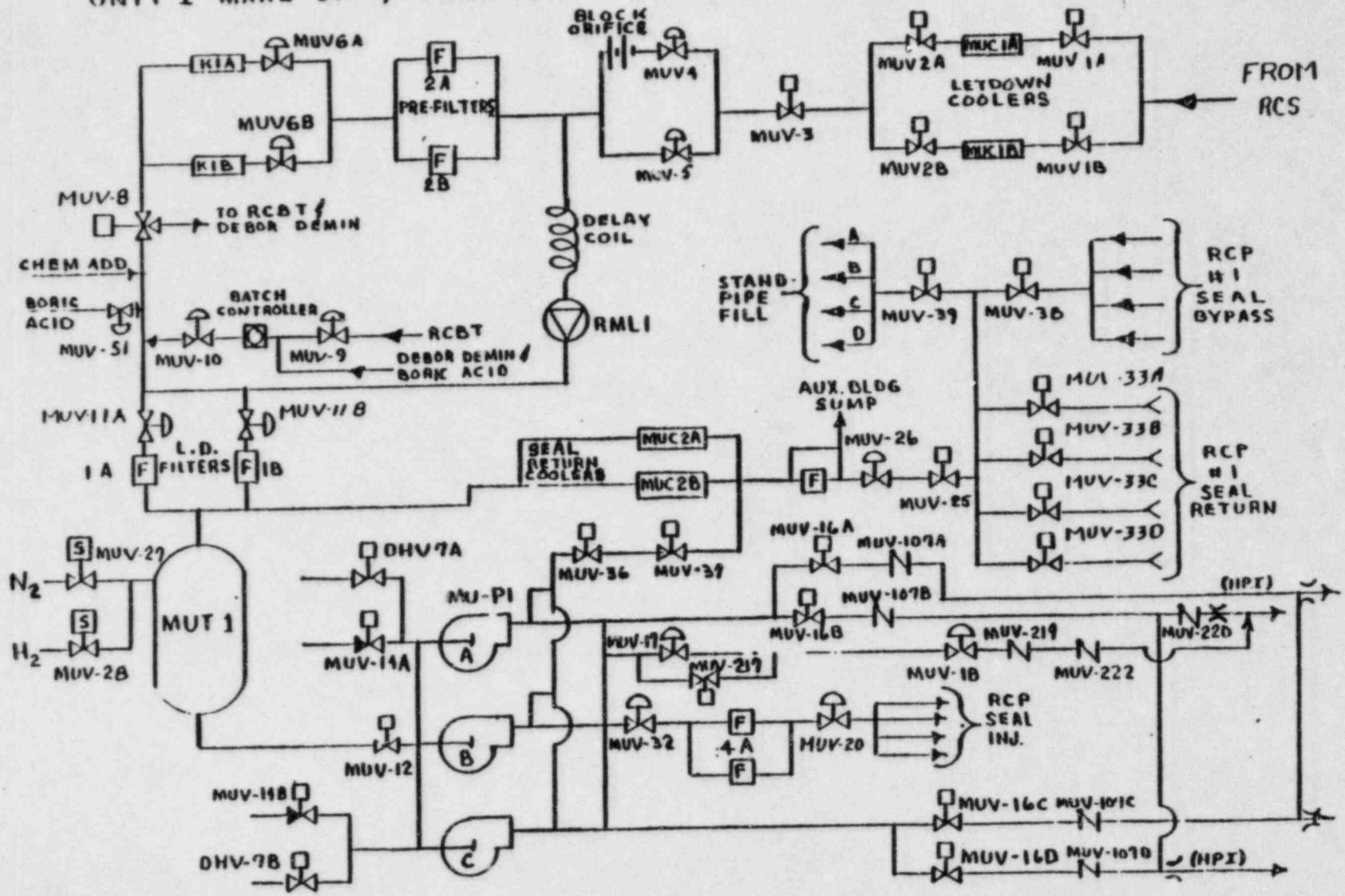
a. Why must safety rods be withdrawn using the auxiliary power supply while regulating rods can be withdrawn without using the auxiliary power supply?

b. Why is the relative rod position indication used instead of absolute rod position indication for monitoring sequence faults?

QUESTION 6.08 (2.00)

Explain HOW and WHY the internal vent valves would prevent a pressure imbalance during a loss of coolant accident in the cold leg of the reactor loop.

UNIT I MAKE-UP & PURIFICATION SYSTEM (SIMPLIFIED)



QUESTION 6.09 (3.00)

Explain how each of the following design criteria for the Nuclear Power Plant Protection System is accomplished. A detailed discussion of individual components and circuitry details is not required.

a. Single Failure
b. Redundancy
c. Electrical Independance and Separation

QUESTION 6.10 (2.50)

a. If Emergency Feedwater (EFW) pumps auto-start on loss of both feedwater pumps what level should be maintained automatically in the OTSGs? (0.5)

b. What is the preferred source of feedwater to the EFW pumps after the water in the condenser hotwell is expended? (0.7)

c. What system lineup, if any, can be established to assure prevention of cross contaminating condensate storage tanks if condensate storage tank A has high chlorides? (1.3)

QUESTION 7.01 (1.50)

If a steam leak occurred outside the containment which required shutting down the plant, what criteria should be used to determine whether to manually trip the reactor or to commence a load rejection at 10% per minute?

QUESTION 7.02 (2.00)

What FOUR conditions must be checked to verify natural circulation following a loss of coolant accident which results in an actuation of HPI system?

QUESTION 7.03 (2.00)

What immediate actions, if any, should be taken if following a reactor trip RCS temperature (average of 5 highest incore thermocouples) is 590 F, RCS pressure is 1650 psia, pressurizer level is being maintained at 115", makeup tank level is 90" and decreasing, and OTSG levels are at 30 " ?

QUESTION 7.04 (2.00)

What actions, if any, should be taken if reactor power is 12% after a manual trip of the reactor from 100% power?

QUESTION 7.05 (2.00)

In accordance with the guidelines provided in the Operations Department Memo 83-6, what actions should be taken following the loss of reactor coolant pump flow if reactor power was at 4% and had not been raised above 5% during restart?

QUESTION 7.06 (3.00)

Following a LOCA, should HPI be throttled in each of the following separate situations? Justify your answer.

a. Flow from HPI pumps A, B, and C read 510, 530, and 550 gpm respectively. RCS pressure is 800 psig and RCS temperature is 450 F.

b. Flow from each HPI pump is 480 gpm, RCS pressure is 500 psig, RCS temperature is 350 F, and PZR level is 15" 30 mimutes after a loss of coolant accident.

QUESTION 7.07 (3.00)

What FOUR objectives should be pursued after a loss of offsite power, if the plant was initially at 100% power and all immediate manual actions have been completed?

QUESTION 7.08 (3.00)

The RCS is being filled, PZR level is 300", the center CRDM has been filled within one foot of the top, the CRDM top closure has been reinstalled, and the hot leg and pressurizer vents are open. What MAJOR steps must be taken to complete filling the RCS and removing nitrogen and non-condensable gases from the pressurizer. (Discussion of venting RCP's and CRDM's and detailed procedural steps are not required.)

QUESTION 7.09 (2.00)

Outline the actions required during a normal cooldown when depressurizing the plant from 1000 psig to 700 psig. Shutdown is for refueling.

QUESTION 7.10 (3.00)

An entry into the containment is required while at 100% power and will result in an estimated whole body dose of 120 mrem. The following four candidates are equally qualified to perform the task. Which candidate may be allowed to perform the task in accordance with administrative procedures.

Explain your reasons for accepting of rejecting each candidate. No waivers can be obtained.

CANDIDATE	1	2	3	4
SEX	male	male	female	male
AGE	27	38	24	20
WK/EXPOSURE	200mrem	100mrem	0mrem	30mrem
QT/EXPOSURE	?	900mrem	20mrem	800mrem
ACCUM LIFE EXPOSURE	?	54000mrem	2200mrem	4000mrem
REMARKS	History unavail-able	None	3 months pregnant	None

QUESTION 8.01 (1.00)

During a plant transient, the Shift Technical Advisor gives you, the Shift Supervisor, some advice that is contrary to your judgement. What is your responsibility for following his advice? (1.0)

QUESTION 8.02 (1.50)

During a backshift work is being done to clear the drains around the fuel storage tank. The written procedure calls for pressurizing the drain lines to 10 psi with air, which is unsuccessful. The workers want to increase the pressure to 25 psi. What actions should the shift supervisor take? Explain your answer.

QUESTION 8.03 (4.50)

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

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 F and heating up at 1 F per minute, when a decay heat removal pump is found inoperable. (1.5)

c. The plant is at 100% power when it is determined that the discharge valves for two auxillary feedwater pumps are failed shut. (1.5)

QUESTION 8.04 (1.50)

What TWO steps must a CRO trainee take if he reproduces valve lineups for use in the plant for tracing systems?

QUESTION 8.05 (2.00)

Which of the following evolutions would the CRO be allowed to perform without direct reference to procedures?

a. Plant heat up to 525 F
b. Increasing Core Flood Tank nitrogen pressure
c. Transfering rod to auxiliary supply
d. Makeup to the RC-MU system

QUESTION 8.06 (1.50)

What actions, if any, should be taken if during a reactor startup NI-1 fails low? Prior to the failure all channels had been increasing with the exception of NI-2 which had been holding constant at 3X E 3 cpm. At the time of the failure the channels read:

NI-1	5X E 5 cpm
NI-2	3X E 3 cpm
NI-3	5X E -10 amps
NI-4	1X E -10 amps

JUSTIFY YOUR ANSWER.

QUESTION 8.07 (2.00)

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 from the MCR in two days. What actions, if any, should be taken? Justify your answer.

QUESTION 8.08 (2.00)

What action, if any, should the Shift Supervisor take if the manual discharge valve from the reactor building spray pump (BS-V41A) is found shut and should be locked opened? The plant is in cold shutdown.

QUESTION 8.09 (3.00)

a. Who's permission and/or concurrance, if any, is required prior to starting an LPI pump which bears a blue tag?

b. What other tags, if any, should be placed if a red tag is placed on the manual operator of the motor operated valve from the BWST to the makeup pumps (MU-v148)?

QUESTION 8.10 (3.00)

What action, if any, should be taken if the plant is at beginning of life, 80% power, Group 7 rods at 50%, four RCPs operating, and computer and/or console indications of:

Quadrant tilt:	Full incore detector system		+8.45%
	Power range channels	A	+8.32
		B	+8.25
		C	+8.30
		D	+8.15
	Minimum incore detector system		+7.95
Imbalance:	Channels	A	-15%
		B	-17
		C	-16
		D	-19

Explain the reasons for your actions. Portions of the Technical Specifications are provided.

QUESTION 8.11 (3.00)

For each of the following events explain briefly why the NRC SHOULD or SHOULD NOT be notified within 1 hr.

a. During instrument testing while at power, three pressurizer pressure safety channels are momentarily place in bypass.

b. While at power, Tave momentarily dips to 510 F and then returns to normal.

c. Borated water storage tank level falls below 400,000 gallons and cannot be restored.

d. During surveillance testing an expected actuation of LPIS train A occurs. (3.0)

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

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

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

$T = (\text{Beta} - \text{Rho})/\text{Rho} \times \text{Lambda}$

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

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

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

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 $ft\text{-}lbm/lbf\text{-}sec^2$

ANSWERS -- TMI-1 -84/08/06-DUDLEY,N.

ANSWER 5.01 (2.00)

When rods were inserted only prompt neutrons were affected and reactor power was stablized.[1.0] During the time that the operator was taking critical data, the delayed neutrons contributed to the overall neutron population [1.0] thus power increases. (2.0)

REFERENCE
Reactor Physics Sec. VI, Para. 24 and 25, p 34-36

ANSWER 5.02 (1.50)

a. Measures the difference in vector angle between current and and voltage. [0.25] Provides indication of circulating currents which affects heating of windings. [0.75]
(1.0)

b. Using generator voltage adjust (0.5)

REFERENCE
Basic Theory Review p 3-12,3-13

ANSWER 5.03 (2.00)

a. The 25 F subcooling limit insures that the core is fully covered and voiding is prevented. (accounts for instrument error)[1.0]

b. OTSG temperature decreases because the amount of superheat decreases due reduced heat transfer area and to greater steam steam flow. [1.0]

REFERENCE
OP 1101-1 p 149
RCS Lesson Plan p 32-36

ANSWER 5.04 (2.00)

If level increases there is more heat transfer area [0.75], therefore, more heat is transferred to the water [0.5] and Tave will decrease. [0.5] Decreasing level will have the opposite effect.[0.25]

ANSWERS -- TMI-1 -84/08/06-DUDLEY,N.

REFERENCE
Heat Transfer and Core Thermal Characteristics p 3-5
RCS Lesson Plan p 32-36

ANSWER 5.05 (2.50)

A. ~40 hours (0.75)

B. 2-6 hours (0.75)

C. Xenon burnout is greater than iodine decay to xenon. (1.0)

REFERENCE
Review of Reactor Theory Lesson Plan p 47-77
Reactor Theory Chap 3, Sec VI, Para 116

ANSWER 5.06 (3.50)

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 Tc's.[0.5]

REFERENCE
Operator Training Manual Vol III, Heat Exchanger Heat Transfer p 153

ANSWER 5.07 (3.00)

The dilution (and subsequent startup) should NOT be allowed [0.8]. Source range counts have doubled on one channel, this would infer that 1/2 of the amount of reactivity to go critical has been added.[1.2]To dilute by an additional 100 ppm would probably take the reactor critical. [1.0]

REFERENCE
Review of Reactor Theory Lesson Plan p 22

ANSWERS -- TMI-1 -84/08/06-DUDLEY,N.

ANSWER 5.08 (2.00)

Curve 1 is pressure. [0.5]

The PZR spray valve will stabalize the pressure increase eventhough level continues to raise. [0.75] Once level has stabilized the PZR spray will reduce pressure until the spray valve closes and heaters are energized. [0.75]

REFERENCE
B+W Operational Transient Lecture Notes R. Winters 6/80

ANSWER 5.09 (3.00)

a. Center of core [0.4] due to higher flux at center of core. [0.6]
b. Dropped by itself [0.4] due to reduced effectiveness (shadowing) caused by adjacent rods during a scram [0.6]
c. Control rod [0.4] since APSR poison section is only part of rod. [0.6]

REFERENCE
Reactor Physics p 137,140,141

ANSWER 5.10 (3.50)

a. The neutron sees a significant absorption cross section over a wider range of energies. (graph acceptable with explaination) (1.0)

b. Decrease. [less neagative] (0.5)

c. MTC becomes more negative [0.25] because the density change per degrees-F is greater at higher temperatures [0.75]. (1.0)

d. MTC becomes less negative (decreases) [0.25] because the number of boron atoms (poison) in the core decreases more per F change at higher boron concentrations. [0.75] (1.0)

REFERENCE
REACTOR PHYSICS Sec. V, para. 107, p 146, 149
para. 108, p 150-154

ANSWERS -- TMI-1 -84/08/06-DUDLEY,N.

ANSWER 6.01 (2.50)

a. Midscale [0.5]
b. Midstroke [0.5]
c. Running at ~2800 RPM (low speed stop) [0.5]
d. Upon restoration of HAND power, main and startup feedwater valves will stroke fully open. [0.5] Upon restoration of AUX power, emergency feedwater valves will stroke fully open.[0.5] (unless selected to the backup manual loader.)

REFERENCE
EP 1202-40

ANSWER 6.02 (2.00)

The temp. of a diff. press. ref. and var. legs must be considered because a change in temp. will result in a change in density and introduce an error in the measured dP. The temp. Comp. network will maintain the accuracy of the inst.

REFERENCE
Rancho-Seco Lesson Plan IC 2

(MXK145/0)

ANSWER 6.03 (3.00)

A. Most probable cause is a failure of the selected loop A Th RTD. (0.60)

B. 1. Places the ICS in TRACK (stablize plant)
2. Select alternate loop A Th RTD
3. Adjust plant parameters to normal
4. Return ICS to automatic

(4 @ 0.60 ea.)

REFERENCE
Rancho Seco Lesson Plan IC-2 & 3

(MXK144/0)

ANSWERS -- TMI-1 -84/08/06-DUDLEY,N.

ANSWER 6.04 (.75)

Initiates ES actuation [0.75]

REFERENCE
US NRC Reactor Training Center System Manual PWR B&W Design p 11.2-2
Drawing No. ss-209-481

ANSWER 6.05 (2.50)

a. Start (but do not load on bus)
b. Both pumps start
c. Open
d. No affect
e. Trip and restart on slow speed [0.5 each]

REFERENCE
Emergency DG and Auxiliaries p25
Decay Heat Removal p 12
Decay Heat River Water Systems p 10
Reactor Building Emergency Cooling System p 9

ANSWER 6.06 (3.00)

a. Closed until Intermediate Closed Cooling valves (IC-v1A,1B) are open [0.6]
   Closes on high CRD cooling temperature [0.6] (1.2)
b. Closes on Rx Trip Isolation Signal
   closes on 4 psig from ESAS
   Closes on high letdown temperature [2 at 0.6 each] (1.2)
c. Closes on RM-L-1
   Closes on ESAS signal [1 at 0.6] (0.6)

REFERENCE
Makeup and Purification System p 15
Makeup and Purification Lesson Plan 11.2.01.069, p 23

ANSWERS -- TMI-1 -84/08/06-DUDLEY,N.

ANSWER 6.07 (3.00)

a. Normal power to the safety rods is the hold bus which is two phase DC which cannot rotate the drive mechanism [0.75] Normal power to regulating rods is six phase which can rotate the drive mechanism. [0.75]

b. Relative position does not respond to a dropped rod. [0.75] Absolute indication responds to a dropped rod and would reset the rods to manual and prevent automatic runback. [0.75]

REFERENCE
Control Rod Drive System p CRD-12, CRD-30

ANSWER 6.08 (2.00)

Open to permit steam generated in the core to flow directly to the leak. [1.0] Allows ECCS to refill core and maintain the core covered/cooled. [1.0]

REFERENCE
RCS Lesson Plan p 29

ANSWER 6.09 (3.00)

a. No single failure will prevent a trip. [0.5]
No single failure will cause a trip. [0.5]

b. 4 channels (plus inputs and outputs are both electrically and physically) [0.5] separated and independent. [0.5]

c. Seperate power supplies for each channel. [0.5]
Outputs are electrically isolated at interconnecting points. [0.5]

REFERENCE
Reactor Protection System Lesson Plan p 8

ANSWER 6.10 (2.50)

a. 30 * on the startup range (0.5)
b. Million gal. demin weater tank (and River Water) (0.7)
c. Condensate tank B [0.4] to one motor driven EFW pump [0.3] and the turbine driven EFW pump; [0.3] shut crossconnect valves (CO-V111A+D and EF V-1A) to isolate tank A but leave it available to met T.S. requirements. [0.3] (1.3)

ANSWERS -- TMI-1 -84/08/06-DUDLEY,N.

REFERENCE
Emergency Feedwater System Lesson Plan p 7,11,32

ANSWERS -- TMI-1 -84/08/06-DUDLEY,N.

ANSWER 7.01 (1.50)

If continued operations will not pose a hazard to personnel [0.75] or equipment required for safe shutdown reduce load at 10% per minute, otherwise trip the reactor. [0.75] (1.5)

REFERENCE
OP 1203 p 2

ANSWER 7.02 (2.00)

RCS delta T between 30 F and 50 F and Th is less than 600 F
Incore Thermo-couples stabilized and tracking Th
Secondary side pressure at saturation pressure of Tc
Verify heat removal by steam flow and feed flow
[0.5 each] (2.0)

REFERENCE
OP 1210-10 p 9

ANSWER 7.03 (2.00)

Trip all RCP's
Initiate HPI
Initiate EFW
Raise OTSG level to 90-95%
Go to ATP 1210-2 (loss of subcooling)
[0.4 each] (2.0)

REFERENCE
OP 1210-1 p 3

ANSWER 7.04 (2.00)

Initiate HPI
Maximize letdown
Trip IG-02 and IL-02 (panel PR)
Maintain primary to secondary heat transfer
[0.5 each] (2.0)

ANSWERS -- TMI-1 -84/08/06-DUDLEY,N.

REFERENCE
OP 1210-1 p 1

ANSWER 7.05 (2.00)

Isolate steam to the turbine driven EFW pump and secure motor driven EFW pumps if auto initiation signal is present. [1.0] Use letdown and makeup system to remove decay heat and maintain PZR level. [0.7] Insure PZR heaters are energized. [0.3] (2.0)

REFERENCE
OP DEPT. MEMO 83-6

ANSWER 7.06 (3.00)

a. Yes [0.6] To prevent pump runout (do not throttle below 500 gpm) [0.9]

b. May be throttled [0.6] since greater than 25 F subcooling and PZR level greater than 0" [0.9]

REFERENCE
OP 1210-10 p 2

ANSWER 7.07 (3.00)

Preserve hot water in the pressurizer.
Establish natural circulation.
Borate the RCS to maintain subcriticality.
Cooldown to maintain subcooling.
Restore power to RCP's and PZR heaters. (includes group 8 or 9 on emergency power supply) [0.75 each for any four] (3.0)

REFERENCE
OP 1202-2 p 1,2

ANSWERS -- TMI-1 -84/08/06-DUDLEY,N.

ANSWER 7.08 (3.00)

Energize PZR heaters.
Close PZR vent.
Close hot leg vents when legs are filled (260 F and 20 psig).
Vent PZR to RC drain tank (293 F and 45 psig).
Reduce PZR level to between 90* and 110*.
Make up to RCS from bleed holdup tank using waste transfer pump.
[0.5 each] (3.0)

REFERENCE
OP 1103-2 p 15
OP 1103-5 p 11-13

ANSWER 7.09 (2.00)

Bypass low pressure injection [0.7]
Shut core flood tank valve [0.7]
Open and tag power supply [0.6] (2.0)

REFERENCE
OP 1102-11 p 15

ANSWER 7.10 (3.00)

1 No [0.35] because he has no history to calculate 1.25 rem/qt limit [0.4]
2 No [0.35] because he would exceed admin. limit of 1000 mrem/qt [0.4]
3 No [0.35] because she has limit of 500 mren/pregnancy [0.4]
4 Yes [0.35] exposure would be less than 1000 mrem/qt [0.4]

REFERENCE
Radiation Science fig. 1-1
Rad Controls Proc. 1641, p 7

ANSWERS -- TMI-1 -84/08/06-DUDLEY,N.

ANSWER 8.01 (1.00)

Any conflict the SS is responsible absolutely.

ANSWER 8.02 (1.50)

The shift supervisor should initiate a temporary change notice and route it to the appropriate Department Head. [0.75] The work should not be continued since there is an unreviewed safety issue and the intent of the procedure is changed. [0.75] (1.5)

REFERENCE
Admin Proc 1001A rev 4, p 27,29

ANSWER 8.03 (4.50)

a. Each test is within 25% of required time [0.35] and each three consecutive tests are not within 3.25 of reqired time [0.4]. Declare DG A inoperable. [0.25] Prove operability of DG B within 1 hr. [0.3] Conduct load test on DG A. [0.2] (1.5)

b. Decay heat removal pumps are not required until Rx is critical.[0.75] No action besides repair of pump is required. [0.75] (1.5)

c. Be subcritical within one hour. [0.7] Hot shutdown within next 6 hours. [0.4] Cold shutdown within following 6 hours. [0.4] (1.5)

REFERENCE
T.S., pp. 1-1, 3-21, 1-8, 3-43, 3-25

ANSWER 8.04 (1.50)

Must insure copy is marked 'Information Only' [0.75]
Must initial and date copy [0.75]

REFERENCE
Proc. 1001 G rev 1 p 5

ANSWERS -- TMI-1 -84/08/06-DUDLEY,N.

ANSWER 8.05 (2.00)

a. With
b. Without
c. *Without
d. *Without

REFERENCE
OP 1001 G rev 2 p 10, 11

ANSWER 8.06 (1.50)

No action. [0.5]
No SR required if one channel of I.R. is above E -10 amps [1.0]

REFERENCE
T.S. p 3-30
N.I. Lesson Plan figure NI-2

ANSWER 8.07 (2.00)

Verify PORV shut. [0.5]
Remove power from PORV. [0.75]
PORV may be taken out of service and isolated from the system if Tavg is above 320 F. [0.75]

REFERENCE
T.S. p 3-18c

ANSWER 8.08 (2.00)

Open valve and check system for operability. [0.75]
Log component, person reporting, and corrective action [0.5]
Investigate [0.25]
Fill out Plant Incident Report. [0.5]

REFERENCE
Proc. 1026 rev 12, p26

ANSWERS -- TMI-1 -84/08/06-DUDLEY,N.

ANSWER 8.09 (3.00)

a. Shift Supervisor/Forman [0.75]
Employee in charge of working party that has clearance [0.75]

b. Red tag on extension control on the control panel[0.75]
Red tag on associated power supply [0.75]

REFERENCE
Proc 1002 rev 25 p7
rev 24 p9

ANSWER 8.10 (3.00)

Full incore detector system is 5% above limit.[0.7]
Rod group withdrawal limits must be reduced 10%.[0.7]
Power must be reduced to 70% by boration to place plant in allowable operating region.[1.0]
Reduce imbalance limits by 10%.[0.4]
Borate to pull rods fully out. [0.2]

REFERENCE
T.S. p 90-91

ANSWER 8.11 (3.00)

a. Should report [0.35] plant is operated in an unanalyzed condition.[0.4]

b. No report [0.35] only needed when an action statement for LCO is entered [0.4]

c. No report [0.35] T.S. require greater then 350,000 gal [0.4]

d. No report [0.35] for ESF actuation during surveillance testing [0.4] (3.0)

REFERENCE
TS p 6-14
TS p 3-21
Proc 1044 p 13