June 1, 2007

Dr. Terrence Tehan, Director
Nuclear Science Center
Rhode Island Atomic Energy Commission
16 Reactor Road
Narragansett, RI 02882

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-193/OL-07-01, RHODE ISLAND ATOMIC ENERGY COMMISSION

Dear Dr. Tehan:

During the week of April 23, 2007, the NRC administered operator licensing examinations at your Rhode Island Atomic Energy Commission Reactor. The examination was conducted according to NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1. Examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report at the conclusion of the examination.

In accordance with 10 CFR 2.390 of the Commission's regulations, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at (the Public Electronic Reading Room) http://www.nrc.gov/reading-rm/adams.html. The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. Should you have any questions concerning this examination, please contact Mr. Kevin Witt at (301) 415-4075 or via internet e-mail kmw@nrc.gov.

Sincerely,

/RA/

Johnny Eads, Chief
Research and Test Reactors Branch B
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-193

Enclosures: 1. Initial Examination Report No. 50-193/OL-07-01
2. Facility comments with NRC resolution
3. Examination and answer key

cc w/encls:
Please see next page

Dr. Terrence Tehan, Director
Nuclear Science Center
Rhode Island Atomic Energy Commission
16 Reactor Road
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3. Examination and answer key updated with NRC resolutions

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Please see next page

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MMendonca Facility File (EBarnhill) O-6 F-2

ADAMS ACCESSION #: ML071450002 **TEMPLATE #:NRR-074**

OFFICE	PRTB:CE		IOLB:LA	E	PRTB:BC	
NAME	KWitt		EBarnhill/CHart		JEads	
DATE	06 /01 /2007		05/25/2007		06/01/2007	

OFFICIAL RECORD COPY

cc:

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Test, Research, and Training
Reactor Newsletter
University of Florida
202 Nuclear Sciences Center
Gainesville, FL 32611

U. S. NUCLEAR REGULATORY COMMISSION
OPERATOR LICENSING INITIAL EXAMINATION REPORT

REPORT NO.: 50-193/OL-07-01

FACILITY DOCKET NO.: 50-193

FACILITY LICENSE NO.: R-95

FACILITY: Rhode Island Atomic Energy Commission

EXAMINATION DATES: April 23-24, 2007

SUBMITTED BY: _____ _____
Kevin Witt, Chief Examiner Date

SUMMARY:

During the week of April 23, 2007, NRC administered Operator Licensing examinations to one Reactor Operator (RO) and one Senior Operator Upgrade (SROU) applicants. The RO candidate failed the written portion of the examination. The SROU applicant passed the examination.

REPORT DETAILS

1. Examiners:
   Kevin Witt, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	0/1	0/0	0/1
Operating Tests	1/0	1/0	2/0
Overall	0/1	1/0	1/1

3. Exit Meeting:
   K. Witt, NRC, Examiner
   J. Davis, Rhode Island Nuclear Science Center (RINSC), Reactor Supervisor
   M. Middleton, RINSC, Assistant Director for Reactor Operations
   T. Tehan, RINSC, Director

   The examiner discussed generic comments identified during the facility operating tests and thanked the facility for their support of the examinations. The facility supplied comments to the written examination via email on May 04, 2007, the comments along with NRC resolution are Enclosure 2 to this letter. The examiner also identified a discrepancy on the NRC form 396s (Certification of Medical Examination by Facility Licensee) submitted with the applications. Neither form was checked for the guidance used to perform the medical. The facility licensee has been informed that licenses will not be issued until proper forms are received and approved by the NRC.

Reactor Operator License Exam Question Issues
for Exam Issued Week of April 23, 2007

Section B

Question 4 D:

The question asks whether verification of the –80 second period after shutdown is a channel check, test, or calibration.

Technical Specification 1.5.3 defines a Channel Calibration as "an adjustment of the channel such that its output corresponds with acceptable accuracy to known values of the parameter which the channel measures. Calibration shall encompass the entire channel, including equipment actuation, alarm, or trip and shall be deemed to include a channel test".

During shutdown, the reactor period settles at –80 seconds after five minutes. If it were practical to do a verification of the –80 second period, this would constitute a Channel Calibration because:

A. This action is verifying that the channel output corresponds with acceptable accuracy to a known value that the parameter which the channel measures, in this case period, and
B. The channel response encompasses the entire channel including equipment actuation, alarm, or trip.

The correct answer should be: Channel Calibration

NRC Resolution: Disagree with comment.

As noted in the comment, "an adjustment of the channel such that its output corresponds with acceptable accuracy to known values of the parameter which the channel measures. Calibration shall encompass the entire channel, including equipment actuation, alarm, or trip and shall be deemed to include a channel test".

Nowhere in the question does it imply that you are going to adjust the channel. Also, a negative 80 second period does **NOT** check any alarm or trip. However, it could be interpreted that you are testing channel accuracy by the insertion of a test signal (in this case -80 seconds due to reactor physics). Therefore the answer key has been modified to add a second correct answer test.

Question 5:

The question asks that the four reactor scrams associated with the Technical Specification Safety Limits for the forced convection mode of operation be chosen. The possible options include:

A. Reactor Thermal Power
B. Reactor Short Period
C. Reactor Coolant Flow Rate
D. Reactor Pool Temperature
E. Reactor Coolant Outlet Temperature
F. Height of the Water Above the Core
G. Primary Coolant System Operable
H. Reactor Coolant Inlet Temperature

The answer comes straight out of Technical Specification 2.1.1, which says that the answer is:

A. Reactor Thermal Power
B. Reactor Coolant Flow Rate
C. Reactor Coolant Outlet Temperature
D. Height of the Water Above the Core

I can see where a candidate might interpret this question as asking which of these parameters have reactor scrams that are associated specifically with forced convection operation, versus natural convection operation, versus both modes of operation. Technical Specification Tables 3.1 and 3.2 list all of the scram and alarms that are required, and which cooling mode(s) the alarm/scram is required. If the candidate is thinking about this question from the standpoint of Technical Specification Tables 3.1 and 3.2 rather than Technical Specification 2.1.1, they should consider that:

A. Reactor Thermal Power – Both Cooling Modes
B. Reactor Short Period - Both Cooling Modes
C. Reactor Coolant Flow Rate – Forced Convection
D. Reactor Pool Temperature – Natural Convection
E. Reactor Coolant Outlet Temperature - Forced Convection
F. Height of the Water Above the Core – Both Cooling Modes
G. Primary Coolant System Operable – Not Listed
H. Reactor Coolant Inlet Temperature – Alarm Only

Based on this, scrams that are specifically associated with forced cooling convection are:

A. Reactor Coolant Flow Rate – Forced Convection
B. Reactor Coolant Outlet Temperature - Forced Convection

NRC Resolution: Agree with comment.
The question will be reworded for future use as follows:

Which one of the following choices lists four scrams which must be available per the Technical Specifications when operating in the ***forced convection mode***?

Question 7:
The question asks where the ESC is located. The Emergency Plan has been revised, and the Emergency Plan Implementing Procedures are in the process of being revised to reflect the fact that the ESC has been re-located to the Coastal Institute Building.

NRC Resolution: Agree with comment.
Question has been deleted from this examination. Question will be modified to incorporate new ESC location before its next use.

Question 8:
1. The exam had four spaces for five answers.

2. This question is a matching question in which the candidate is supposed to match the action that should occur under the following circumstances:

   A. Pottermeter and primary dT readings abnormal for operating conditions.
      1. Exam Answer - Manual Scram
      2. My Answer - Manual Scram (Operating Procedure Appendix AC § V.1)

B. Reactor power unexpectedly drops from 95% to 92%.
   1. Exam Answer - Maintain Reactor at Power
   2. My Answer - Shutdown Only (Operating Procedure § 8.2.1)

C. The alarm for the high Neutron Flux on one of the ion chamber safety channels becomes inoperable due to a faulty relay.
   1. Exam Answer - Shutdown Only
   2. My Answer - Maintain Reactor Power (Technical Specification Table 3.1)

   Tech Specs require that the two power level channels have over power scrams, but not alarms. If the faulty relay only affects the alarm, then we should be able to continue operation.

D. Loss of one stack monitor. Repair parts expected to arrive in 12 hours.
   1. Exam Answer - Shutdown Only
   2. My Answer - Maintain Reactor Power for six hours, then Shutdown Only (Operating Procedure Appendix AC § V.7.C)

E. Emergency Generator fails to start.
   1. Exam Answer - Shutdown Only
   2. My Answer - Shutdown Only (Technical Specifications § 3.4, 3.5, 3.6)

NRC Resolution: Agree with comments.
Parts A and E, facility and NRC agree. Part B, agree with comment, answer key changed to show 1 as correct answer. Part C agree with comment answer key changed to show 2 as correct answer. This choice will be modified to replace alarm with scram. Part D, answer key changed to accept a second correct answer "2".

Question 11:
The question asks the candidate to pick which of the following statements is a correct Technical Specification limit concerning experiments:

A. Regarding explosive materials:
   1. Answer is incorrect because Technical Specification § 3.8.4 forbids explosives in experiments.

B. Regarding the maximum reactivity worth of a moveable experiment being 0.6% dK/K:
   1. Answer is incorrect because Technical Specification § 3.1.4 says that the limit is 0.08% dK/K.

C. Regarding highly water reactive materials:
   1. Answer is incorrect because Technical Specification § 3.8.8 forbids highly water reactive materials in experiments.

D. Regarding the maximum total reactivity worth of experiments being 3.0% dK/K:
   1. Answer is incorrect because Technical Specification § 3.1.3 says that the limit is 0.6% dK/K.

Consequently, there are no correct answers.

NRC Resolution: Agree with comment.
This question has been deleted from this examination. Unfortunately, the examiner incorrectly put the work "moveable" in choice b. Choice b should have the word "moveable" replaced with the word "fixed" to make choice b correct.

Section C

Question 6:
The question asks the candidate to pick the statement that correctly describes a signal in the automatic power level channel.

A. Answer A is a correct answer because a period of less than 20 seconds will prohibit automatic regulating rod control. Operating Procedure Appendix W § 3.B shows the steps taken to ensure that this interlock is triggered when a period of 30 seconds or less is reached.

NRC Resolution: Agree with comment.
Answer key modified to show second correct answer “a”.

Question 7:

This question asks the candidate to pick which of the listed scenarios would explain high conductivity at the "inlet of the demineralizer". While failure of the cooling water heat exchanger is the best answer of the given answers, the candidate's experience will tell them that:

A. There are two sets of demineralizers: the make-up system demineralizers and the clean-up demineralizer. Heat exchanger failure will have no impact on the inlet of the make-up system demineralizers.

B. Water temperature has an effect on conductivity measurement.

C. Based on past history, whenever conductivity begins to approach our limit, we solve the problem by changing the demineralizer resin.

D. Operating Procedure Appendix H § II Discussion explains that we do a weekly analysis of secondary water to look for the presence of Na-24, and that the purpose of this is to indicate whether or not we have a heat exchanger failure.

NRC Resolution: Comment noted.
No change to this examination. Before the question is next used it will be modified to specify clean-up demineralizer.

Question 9:
Note that High Primary Conductivity no longer has an alarm associated with it.

NRC Resolution: Agree with Comment.
Part c of question answer key changed to recognize 4 as correct answer.

Question 11:
Operating Procedure Appendix AC § V.7 says that if only one of the monitors fail, we can operate up to six hours if we use alternative monitoring.

NRC Resolution: Agree with Comment.
Question deleted.

Question 13:

The question asks why we have a pool level set point.

The exam answer is C - To assure that adequate pool volume is available to provide cooling of the core in the event of a loss of coolant accident.

The correct answer is B - to prevent incipient boiling in the event that the power reaches the thermal power trip limit. RINSC SAR § B shows that cladding temperatures remain well below the 530 ºC limit until the onset of nucleate boiling occurs. Factors that impact the onset of nucleate boiling are

reactor thermal power level,
primary coolant flow rate,
height of the pool water above the core, and
primary coolant temperature.

RINSC Technical Specification 2.1 sets the safety limits for each of these parameters for both forced convection, and natural convection modes of cooling in order to ensure that the onset of nucleate boiling is not reached. See the bases to Technical Specifications 2.1.1 and 2.1.2.

NRC Resolution: Partially agree with comment.

Although the facility argument is correct that the bases to Technical Specifications 2.1.1 and 2.1.2 show that the correct answer is B, the bases for Technical Specification 2.2.1 - ... "This depth was used in the SAR Loss of Coolant Analysis (part B of the SAR). The safety system settings chosen provide acceptable safety margins to the maximum fuel cladding temperature. Therefore the answer key has been modified to show either choice B or C as correct.

Question 19:

The question asks the candidate to pick the electrical load that is not available if we are running on generator power.

The sump pump does not run on generator power.

NRC Resolution: Agree with comment.

Answer key changed to add choice "b" as a 2nd correct answer.

OPERATOR LICENSING EXAMINATION

With Answer Key

RHODE ISLAND NUCLEAR SCIENCE CENTER

Week of April 23, 2007

Enclosure 3

QUESTION A.01 [1.0 point]
Which alteration or change to the core will most strongly affect the thermal utilization factor.

a. Build up of fission products in fuel.

b. Removal of moderator.

c. Addition of U^{238}

d. Removal of a control rod.

QUESTION A.02 [1.0 point]
Following a significant reactor power increase, the moderator temperature coefficient becomes increasingly more negative. This is because:

a. as moderator density decreases, less thermal neutrons are absorbed by the moderator than by the fuel.

b. the change in the thermal utilization factor dominates the change in the resonance escape probability.

c. a greater density change per degree F occurs at higher reactor coolant temperatures.

d. the core transitions from an under-moderated condition to an over-moderated condition.

QUESTION A.03 [1.0 point]
Which one of the following conditions would ***INCREASE*** the shutdown margin of a reactor?

a. Inserting an experiment adding positive reactivity.

b. Lowering moderator temperature if the moderator temperature coefficient is negative.

c. Depletion of a burnable poison.

d. Depletion of uranium fuel.

QUESTION A.04 [1.0 point]
The term "***Prompt Critical***" refers to:

a. the instantaneous jump in power due to a rod withdrawal

b. a reactor which is supercritical using only prompt neutrons

c. a reactor which is critical using both prompt and delayed neutrons

d. a reactivity insertion which is less than $ß_{eff}$

QUESTION A.05 [1.0 point]
Which one of the following factors is the most significant in determining the differential worth of a control rod?

a. The rod speed.

b. Reactor power.

c. The flux shape.

d. The amount of fuel in the core.

QUESTION A.06 [1.0 point]

Which one of the following is the principal source of heat in the reactor after a shutdown from extended operation at 100 KW?

a. Production of delayed neutrons

b. Subcritical reaction of photo-neutrons

c. Spontaneous fission of U^{238}

d. Decay of fission fragments

QUESTION A.07 [1.0 point]

A reactor has a shutdown margin of 0.0526 ΔK/K. Adding a reactor experiment increases the indicated count rate from 10 cps to 20 cps. Which one of the following is the new K_{eff} of the reactor?

a. 0.53

b. 0.90

c. 0.975

d. 1.02

QUESTION A.08 [1.0 point]

Which one of the following statements concerning reactivity values of equilibrium (at power) xenon and peak (after shutdown) xenon is correct? Equilibrium xenon is _____ of power level; peak xenon is _____ of power level.

a. **INDEPENDENT INDEPENDENT**

b. **INDEPENDENT DEPENDENT**

c. **DEPENDENT INDEPENDENT**

d. **DEPENDENT DEPENDENT**

QUESTION A.09 [1.0 point]

A reactor contains three safety rods and a control rod. Which one of the following would result in a determination of the excess reactivity of this reactor?

a. The reactor is critical at a low power level, with all safety rods full out and the control rod at some position. The reactivity remaining in the control rod (i.e. its rod worth from its present position to full out) is the excess reactivity.

b. The reactor is shutdown. Two safety rods are withdrawn until the reactor becomes critical. The total rod worth withdrawn is the excess reactivity.

c. The reactor is at full power. The total worth of all rods withdrawn is the excess reactivity.

d. The reactor is at full power. The total worth remaining in all the safety rods and the control rod (i.e. their worth from their present positions to full out) is the excess reactivity.

QUESTION A.10 [1.0 point]

Which one of the following statements describes why installed neutron sources are used in reactor cores?

a. To increase the count rate by an amount equal to the source contribution.

b. To increase the count rate by 1/M (M = Subcritical Multiplication Factor).

c. To provide neutrons to initiate the chain reaction.

d. To provide a neutron level high enough to be monitored by instrumentation.

QUESTION A.11 [1.0 point]

Which one of the following is true concerning the differences between prompt and delayed neutrons?

a. Prompt neutrons account for less than one percent of the neutron population while delayed neutrons account for approximately ninety-nine percent of the neutron population

b. Prompt neutrons are released during fast fissions while delayed neutrons are released during thermal fissions

c. Prompt neutrons are released during the fission process while delayed neutrons are released during the decay process

d. Prompt neutrons are the dominating factor in determining the reactor period while delayed neutrons have little effect on the reactor period

QUESTION A.12 [1.0 point]

Which one of the following describes the response of the subcritical reactor to equal insertions of positive reactivity as the reactor approaches criticality at low power? Each reactivity insertion causes a …

a. **SMALLER** increase in the neutron flux, resulting in a **LONGER** time to reach equilibrium.

b. **LARGER** increase in the neutron flux, resulting in a **LONGER** time to reach equilibrium.

c. **SMALLER** increase in the neutron flux, resulting in a **SHORTER** time to reach equilibrium.

d. **LARGER** increase in the neutron flux, resulting in a **SHORTER** time to reach equilibrium.

QUESTION A.13 [1.0 point]

Several processes occur during the neutron cycle which increase or decrease the number of neutrons. Which ONE of the following describes a process which INCREASES the number of neutrons?

a. Fast Non-Leakage probability ($\mathscr{L}_f$)

b. Resonance Escape Probability (p)

c. Thermal Utilization Factor (f)

d. Reproduction Factor (η)

QUESTION A.14 [1.0 point]
Which ONE of the following is the reason for the -80 second period following a reactor scram?

a. The negative reactivity added during a scram is greater than K_{eff}.

b. The half-life of the longest-lived group of delayed neutron precursors is approximately 55 seconds.

c. The fuel temperature coefficient adds positive reactivity as the fuel cools down, thus retarding the rate at which power drops.

d. The amount of negative reactivity added is greater than the Shutdown Margin.

QUESTION A.15 [1.0 point]
An experimenter makes an error loading a rabbit sample. Injection of the sample results in a 100 millisecond period. If the scram setpoint is 125 kW and the scram delay time is 0.1 seconds, WHICH ONE of the following is the peak power of the reactor at shutdown.

a. 125 kW

b. 250 kW

c. 340 kW

d. 125 kW

QUESTION A.16 [1.0 point]
Regulating rod worth for a reactor is 0.001 ΔK/K/inch. The moderator temperature coefficient (α_{Tmod}) for the same reactor is 0.0005 ΔK/K/°F. If moderator temperature increases by 9°F. By how much, and in which direction must the regulating rod move to compensate?

a. 4½ inches, outward

b. 9 inches, outward

c. 4½ inches, inward

d. 9 inches, inward

QUESTION A.17 [1.0 point]
During a startup you increase reactor power from 50 watts to 1000 watts in 100 seconds. What is reactor period?

a. 25

b. 33

c. 41

d. 50

QUESTION A.18 [1.0 point]
INELASTIC SCATTERING is the process by which a neutron collides with a nucleus and …

a. recoils with the same kinetic energy it had prior to the collision.

b. is absorbed, with the nucleus emitting a gamma ray, and the neutron with a lower kinetic energy.

c. is absorbed, with the nucleus emitting a gamma ray.

d. recoils with a higher kinetic energy than it had prior to the collision with the nucleus emitting a gamma ray

Question A.19 [1.0 point]
The neutron microscopic cross-section for absorption (σ_a) of an isotope generally …

a. increases as neutron energy increases

b. decreases as neutron energy increases

c. increases as target nucleus mass increases

d. decreases as target nucleus mass increases

Question A.20 [1.0 point]
Given the data in the table to the right, which ONE of the following is the closest to the half-life of the material?

a. 11 minutes

b. 22 minutes

c. 44 minutes

d. 51 minutes

TIME	ACTIVITY
0 minutes	2400 cps
10 minutes	1757 cps
20 minutes	1286 cps
30 minutes	941 cps

QUESTION B.01 [1.0 point]

Based on the Requalification Plan for operators, each licensed operator must complete a minimum of _____ reactivity manipulations during each 2 year cycle.

a. 4

b. 10

c. 20

d. 28

QUESTION B.02 [1.0 point]

What is the best type of shielding material to protect from a thermal neutron beam?

a. Lead

b. Heavy clothing

c. Rubber

d. $Boron^{10}$

QUESTION B.03 [1.0 point]

Which one of the following is the definition of Committed Dose Equivalent?

a. The sum of the deep dose equivalent and the committed effective dose equivalent.

b. The dose equivalent that the whole body receives from sources outside the body.

c. The sum of the external deep dose equivalent and the organ dose equivalent.

d. The 50 year dose equivalent to an organ or tissue resulting from an intake of radioactive material.

QUESTION B.04 [2.0 points, ½ each]

Identify each of the actions listed below as either a Channel ***CHECK***, Channel ***TEST***, or Channel ***CAL***ibration.

a. Verifying overlap between Nuclear Instrumentation meters.

b. Replacing an RTD with a precision resistance decade box, to verify proper channel output for a given resistance.

c. Performing a calorimetric (heat balance) calculation on the primary system, then adjusting Nuclear Instrumentation to agree.

d. During shutdown you verify that the period meter reads -80 seconds.

QUESTION B.05 [1.0 point]
Which one of the following lists the four reactor scrams associated the Technical Specification Safety Limits for the ***forced convection mode*** of operation?

a. Reactor thermal power. Reactor short period. Reactor coolant flow rate. Reactor pool temperature.

b. Reactor thermal power. Reactor coolant flow rate. Reactor coolant outlet temperature. Height of water above the top of the core.

c. Reactor short period. Reactor coolant outlet temperature. Primary coolant system operable. Reactor pool temperature.

d. Reactor coolant inlet temperature. Reactor coolant outlet temperature. Primary coolant system operable. Height of water above the centerline of the core.

QUESTION B.06 [1.0 point]
Which one of the following is **NOT** a guidance/recommendation under "Planned Occupational Exposure under Emergency Conditions" for Life Saving Actions?

a. Planned whole body dose not to exceed 100 rems.

b. Persons receiving exposures under the planned actions should avoid procreation for a few months.

c. Planned dose to hands and forearms not to exceed 300 rems.

d. The younger volunteers should perform the rescue.

~~**QUESTION B.07 [1.0 point]**~~ [Question deleted per facility comment]
~~At the RINSC the Emergency Support Center (ESC) is ...~~

~~a. the control room.~~

~~b. located at the South County Hospital in Wakefield, RI.~~

~~c. the geographical area within the site boundary where the Emergency Coordinator has direct authority over all activities.~~

~~d. in the reactor building and the basement area outside the EPZ.~~

QUESTION B.08 [2.0 points, 0.4 each]

Match the abnormal condition listed in Column A with the appropriate action from Column B.

COLUMN A	COLUMN B
a. Pottermeter and primary ΔT readings abnormal for operating conditions.	1. Shutdown only
b. Reactor power unexpectedly drops from 95% to 92%.	2. Maintain Rx at power
c. The alarm for the high Neutron flux on one of the ion chamber safety channels becomes inoperable due to a faulty relay.	3. Automatic Scram
d. Loss of one stack monitor. Repair parts expected to arrive in 12 hours.	4. Manual Scram
e. Emergency Generator fails to start	

QUESTION B.09 [1.0 point]

Which one of the following is an Emergency Action Level for an Alert condition at the RINSC?

a. Radiation levels at the site boundary is 75 mrem deep dose equivalent over 24 hours.

b. Building air monitor reading 10 times higher than normal.

c. Radiation levels at the site boundary is 100 mrem/hr for one (1) hour deep dose equivalent.

d. Loss of city water while the reactor is operating.

QUESTION B.10 [1.0 point]

Calculate the T.S. Shutdown Margin. Assume the following worths:

	worth %ΔK/K		worth %ΔK/K
Blade #1:	2.38	Blade #2:	2.56
Blade #3:	2.40	Blade #4:	2.37
Regulating Blade:	0.084	Excess Reactivity:	1.64
Experiments	(Max Worth)		

a. 4.83%

b. 4.91%

c 7.39%

d. 8.07%

~~QUESTION B.11 [1.0 point]~~ [Question deleted per facility comment]

~~Which one of the following statements is a correct Technical Specification limit concerning experiments?~~

~~a. Containers for experiments containing explosive materials shall be designed and tested for a pressure exceeding the maximum expected by a factor of 2.~~

~~b. The maximum reactivity worth of a ***MOVABLE*** experiment is 0.6% ΔK/K.~~

~~c. Experiments containing highly water reactive materials shall be doubly encapsulated.~~

~~d. The total reactivity worth of all experiments shall NOT exceed 3.0% ΔK/K.~~

QUESTION B.12 [1.0 point]
Which one of the following does NOT require NRC approval for changes?

a. License

b. Requalification plan

c. Emergency Implementation Procedures

d. Emergency Plan

QUESTION B.13 [1.0 point]
According to the ALARA program, any radiation exposure during one monitoring period in excess of _____ must be brought to the attention of the RSO and, following investigation, the Nuclear and Radiation Safety Committee.

a. 5 mrem

b. 100 mrem

c. 500 mrem

d. 5000 mrem

QUESTION B.14 [1.0 point]
Which one of the followings correctly describes the 10 CFR 20 term “ALI”?

a. The sum of the products of the dose equivalent to the organ and the weighing factors applicable to each of the body organs that are irradiated.

b. The smaller value of intake of a given radionuclide in a year by a reference man that would result in a committed dose equivalent of 5 rem.

c. A unit of measurement of radioactivity.

d. The limit on concentration of certain radionuclides listed in 10 CFR 20 that could result in an annual dose in excess of 5 rem.

QUESTION B.15 [1.0 point]
Limiting Safety System Settings (LSSS) are …

a. limits on very important process variables which are found to be necessary to reasonably protect the integrity of certain physical barriers which guard against the uncontrolled release of radioactivity.

b. settings for automatic protective devices related to those variables having significant safety functions that are chosen so that automatic actions will prevent exceeding a safety limit.

c. settings for ANSI 15.8 suggested reactor scrams and/or alarms which form the protective system for the reactor or provide information which requires manual protective action to be initiated.

d. the lowest functional capability or performance levels of equipment required for safe operation of the reactor.

QUESTION B.16 [1.0 point]

Two point sources have the **SAME CURIE STRENGTH**. Source A emits 1 MeV gammas whereas Source B emits 2 MeV gammas. You obtain a reading from the same Geiger counter 10 feet from each source. Concerning the two readings, which one of the following statements is correct?

a. The reading from Source B is four times that of Source A.

b. The reading from Source B is twice that of Source A.

c. Both readings are the same.

d. The reading from Source B is half that of Source A.

QUESTION B.17 [1.0 point]

You are giving a tour to twelve students. The students are divided into three groups of four; each group led by a staff member. How many pocket dosimeters must be issued?

a. None, since they won't get any dose.

b. Fifteen, one for each staff member and student.

c. Twelve, one for each student.

d. Three, one for each group.

QUESTION B.18 [1.0 point]

An individual receives 100 Mrem of Beta, 25 Mrem of Gamma, and 5 Mrem of neutrons. What is his total dose?

a. 275 Mrem

b. 205 Mrem

c. 175 Mrem

d. 130 Mrem

QUESTION C.01 [1.0 point]
While operating in the Natural Convection Flow Mode which one of the following will result in a reactor scram?

a. Primary Coolant Flow = 40 gpm

b. Coolant Outlet Temperature = 123°F

c. Log N amplifier high voltage at 40 volts

d. Reactor Power = 110 kw

QUESTION C.02 [1.0 point]
Which of the following choices is NOT an interlock prohibiting withdrawal of safety blades during startup? Assume all scram conditions are cleared.

a. NI read less than ***3 cps***

b. Startup counter drive ***off***

c. Master switch is in ***test***

d. Mode switch is in ***rundown***

QUESTION C.03 [1.0 point]
The thermal column design prevents radiation streaming by:

a. a movable lead shutter that is normally closed.

b. installation of portable shielding around the experiment.

c. alternately stacked graphite logs and a stepped closure door.

d. concrete filler plugs.

QUESTION C.04 [1.0 point]
Which one of the following actions should **NOT** automatically occur when the evacuation button is depressed?

a. The air conditioning and normal ventilation fans turn off.

b. All dampers on ventilating ducts leading outside close.

c. The building cleanup system air scrubber and fresh air blower turn off.

d. The off-gas blower and rabbit system blower turn off.

QUESTION C.05 [1.0 point]
Which one of the listed tanks is the normal collection point for non-sanitary liquid waste from the reactor building?

a. Delay Tank

b. Radiation Waste Tank

c. Retention Tank

d. Resin Tank

QUESTION C.06 [1.0 point]

Which ONE of the following CORRECTLY describes a signal in the automatic power level channel?

a. A reactor period signal is supplied to the circuit which prohibits automatic control if reactor period is less than 20 seconds.

b. The servo amplifier provides a gain function signal which varies directly with reactor power.

c. The servo amplifier supplies a reference voltage used as the system power demand.

d. The servo amplifier receives a signal from the Rod Position system which is used to slow the motor when approaching the upper or lower rod limit.

QUESTION C.07 [1.0 point]

Which ONE of the following conditions will cause a HIGH CONDUCTIVITY reading at the INLET of the demineralizer?

a. Failure of the cooling water heat exchanger.

b. Pool water temperature low.

c. Reactor water system pressure greater than secondary water pressure.

d. High reactor water pump flow.

QUESTION C.08 [1.0 point]

Which one of the following conditions will generate an alarm when the Power Level Selector switch is in the “0.1 MW” position?

a. Thermal Column flow sensor reads zero.

b. Bridge movement is detected by sensor.

c. Secondary coolant flow rate is 750 gpm

d. Core outlet temperature is 122 °F

QUESTION C.09 [2.0 points, ½ each]

For each of the parameters listed in column a, list the correct plant response from column b.

COLUMN A	COLUMN B
a. Bridge movement	1. Alarm only
b. One safety blade disengaged from magnet	2. Scram only
c. High conductivity (primary)	3. Alarm and Scram
d. High Voltage failure	4. No response

QUESTION C.10 [1.0 point]
Which one of the following statements is TRUE?

a. Inverting an irradiated fuel element would have no effect on core reactivity or differential control rod worth.

b. The RINSC fully reflected reactor will NOT go critical even if the entire 7 x 9 grid of the core were filled with fuel elements.

c. The volume of water transferred from the pool into the primary is controlled primarily by flow paths in the control blade shrouds.

d. Full flow through the fuel elements will probably not be turbulent at lower temperatures

~~**QUESTION C.11 [1.0 point]**~~ [Question deleted per NRC resolution of facility comments]
~~Which ONE of the following ABNORMAL conditions requires either a reactor shut down or a reactor scram.~~

~~a. regulating blade sticks~~

~~b. startup counter sticks~~

~~c. high conductivity alarm on delay tank~~

~~d. stack monitor reading low~~

QUESTION C.12 [1.0 point]
Which one of the following actions may stop a leak from a beam port vent line ?

a. Installing the cover flange on the tube end.

b. Plugging the outer tube instrument leads hole.

c. Installing the outer tube concrete filled plugs.

d. Closing the beam port shutter.

QUESTION C.13 [1.0 point]
Which one of the following is the reason for the pool level scram setpoint?

a. To assure that an acceptable pool volume is available to provide cooling in the Natural Convection Mode.

b. To prevent incipient boiling event if transient power rises to the thermal power trip limit.

c. To assure that an adequate pool volume is available to provide cooling of the core in the event of a loss of coolant accident.

d. To maintain an adequate pool level for the dash-pot action of the control blades in the event of a scam.

QUESTION C.14 [1.0 point]

The Delay Tank is vented ...

a. into the suction line of the reactor room exhaust blower

b. into the suction of the off-gas blower

c. into the suction of the dilution air blower

d. directly to the base of the stack

QUESTION C.15 [1.0 point]

Loss of which ONE of the services listed below requires the operator to shutdown and secure the reactor?

a. City water supply.

b. Demineralized water.

c. Building heating system.

d. Building telephones.

QUESTION C.16 [1.0 point]

Which one of the following is **NOT** a function built into the Primary Makeup Water system?

a. A check valve prevents primary water from back flowing through the makeup system

b. A drop in the water level of one inch opens a solenoid valve to allow water flow into the pool.

c. A control room alarm is generated at -1.5 inches to warn of decreasing pool levels.

d. A low level alarm is sent to a security company off campus.

QUESTION C.17 [1.0 point]

Which ONE of the following correctly describes how a compensated ion chamber detects neutrons. A neutron interacts with the …

a. U^{235} lining of the tube.

b. B^{10} lining of the tube.

c. BF_3 gas which fills the tube

d. N_2 gas which fills the tube.

QUESTION C.18 [1.0 point]

Which ONE of the following correctly describes the operation of the RTD (temperature detector used for the temperature recorder).

a. A bimetallic strip which because of differing thermal expansion coefficients causes the strip to bend proportional to temperature.

b. A bimetallic junction, which generates a potential (micro-volt range) proportional to temperature.

c. A precision wound resistor, which changes resistance proportional to temperature.

d. A precision wound inductor, which changes inductance proportional to temperature.

QUESTION C.19 [1.0 point]

The facility loses power, the propane gas generator starts and the Automatic transfer switch operates as is should. Which ONE of the following electrical loads is **NOT** available?

a. Emergency lights

b. Sump Pump

c. Demineralizer Pump

d. Reactor Safety Systems

A.01 d
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume 2, Module 3, Enabling Objective 1.2, p. 04.

A.02 c
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume 2, Module 3, Enabling Objective 2.4, p. 26.

A.03 d
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume 2, Module 4, Enabling Objective 3.6 p. 28.

A.04 b
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume 2, Module 4, Enabling Objective 2.8, p. 15.

A.05 c
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume 2, Module 3, Enabling Objective 5.4, p. 51.

A.06 d.
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume 1, Module 1, Enabling Objective 4.9, p. 61.

A.07 c
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume 2, Module 4, Enabling Objective 3.6, p. 28.
$SDM = 1-K_{eff}/K_{eff} \rightarrow K_{eff} = 1/SDM + 1 \rightarrow K_{eff} = 1/0.0526 + 1 \rightarrow K_{eff} = .95$
$CR_1/CR_2 = (1 - K_{eff2}) / (1 - K_{eff1}) \rightarrow 10/20 = (1 - K_{eff2}) / (1 - 0.95)$
$(0.5) \times (0.05) = (1 - K_{eff2}) \rightarrow K_{eff2} = 1 - (0.5)(0.05) = 0.975$

A.08 d
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume 2, Module 3, Enabling Objective 4.1, p. 34.

A.09 a
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume x, Module x, Enabling Objective x.x, p. xx.

A.10 d
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume 1, Module 2, Enabling Objective 1.1, p. 01.

A.11 c
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume 1, Module 2, Enabling Objective 3.1, pp. 30–32.

A.12 b
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume x, Module x, Enabling Objective x.x, p. xx.

A.13 d
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume x, Module x, Enabling Objective x.x, p. xx.

A.14 b
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume x, Module x, Enabling Objective x.x, p. xx.

A.15 c
REF: $P = P_0 e^{t/\tau}$, $P = 125 \text{ kwatt} \times e^{0.1/0.1} = 125 \times e = 339.79$ DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume x, Module x, Enabling Objective x.x, p. xx.

A.16 a
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume x, Module x, Enabling Objective x.x, p. xx.
A 9°F HEATUP, will add 9°F × -0.0005 ΔK/K/°F = -0.0045 ΔK/K. To compensate, the regulating rod must add 0.0045 positive reactivity, which implies move out. +0.0045 ΔK/K ÷ 0.001 ΔK/K/inch = 4.5 inches

A.17 b
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume x, Module x, Enabling Objective x.x, p. xx. $P = P_0 e^{t/\tau}$
$\ln(P/P_0) = t/\tau \quad \tau = t/(\ln(P/P_0) \quad \tau = 100/\ln(20) = 33.381$

A.18 b
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume x, Module x, Enabling Objective x.x, p. xx.

A.19 b
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume x, Module x, Enabling Objective x.x, p. xx.

A.20 b
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume x, Module x, Enabling Objective x.x, p. xx.

B.01 b
REF: Requalification Plan

B.02 d
REF: Nuclear Power Plant Health Physics and Radiation Protection, Ch. 9

B.03 d
REF: 10CFR20.1003

B.04 a Check, b Test, c CAL, d Check or Test [2nd answer added per NRC resolution of facility comment.]
REF: RINSC Tech. Specs, Definitions pg. 2

B.05 b
REF: RINSC T.S. 2.1

B.06 d
REF: Emergency Plan §7.5.1 Life Saving Actions

~~B.07 d~~ [Question deleted per NRC resolution of facility comments]
~~REF: E-Plan pages 2 and 19~~

B.08 a, 4; b, ~~2~~ 1; c, ~~1~~ 2; d, 1 or 2; e, 1 [Answer key changed per NRC resolution of facility comments]
REF: Abnormal Procedures

B.09 a
REF: E-Plan; Emergency Classification System Section 4.0

B.10 b
REF: 1997 NRC Exam: SDM = SDM (cold/clean) - Max worth blade - Reg Blade - Max Experiment
$SDM_{(cold/clean)}$ = Total Blade worth - K_{excess} = 9.794% - 1.64% = 8.154% / SDM = 8.154% - 2.56% - 0.084% - 0.60% = 4.91%

~~B.11 b~~ [Question deleted per NRC resolution of facility comments]
~~REF: T.S. 3.1 and 3.8.~~

B.12 c
REF: 10 CFR 50.54 (q); 10 CFR 50.59; 10 CFR 55.59

B.13 b
REF: RINSC Radiation Safety Guide pg. 3

B.14 b
REF: RINSC Radiation Safety Guide pg. 58

B.15 b
REF: Tech. Specs, Definitions 1.7

B.16 c
REF: GM is not sensitive to energy.

B.17 d
REF: RINSC Radiation Safety Guide, pg. 38

B.18 d
REF: 10CFR20 rem = rem

C.01 c
REF: T.S. Table 2.1.2g. 22

C.02 b
REF: Facility provided question

C.03 c
REF: SAR

C.04 c
REF: Facility provided question

C.05 c
REF: 1993 NRC Exam

C.06 c or a [2nd answer added per NRC resolution of facility comment.]
REF: General Electric Operation Manual

C.07 a
REF: General Electric Operation Manual

C.08 b
REF: SAR (HEU - LEU) Table F

C.09 a, 3; b, 1; c, ~~1~~ 4; d, 3 [Answer key changed per NRC resolution of facility comments]
REF: Facility supplied question

C.10 a
REF: SAR

~~C.11 d~~ [Question deleted per NRC resolution of facility comments]
~~REF: Rewrite of NRC examination administered October 1987. Also: Abnormal Procedures, Nos. 11, 5, 6, 15 and 3~~

C.12 d
REF: SAR LEU Conversion - Beamport Description

C.13 c or b [2nd answer added per NRC resolution of facility comment.]
REF: T.S. 2.2 Bases

C.14 a
REF: SAR System Description

C.15 a
REF: RINSC, Emergency Plan Implementing Procedures, § 3.3 Utilities Failure

C.16 c
REF: SAR sect. 5.5 & SOP App. W “Alarm, Scram, and Interlock Checks”

C.17 b
REF: Standard NRC Question

C.18 c
REF: SAR § 4.4.17.5

C.19 c or b [2nd answer added per NRC resolution of facility comment.]
REF: Rewrite of NRC Examination Question administered April 1985.