UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 3, 2018

Mr. Matt Feyrer, Site Manager
General Electric-Hitachi Vallecitos Nuclear Center
6705 Vallecitos Road
Sunol, CA 94586

SUBJECT: EXAMINATION REPORT NO. 50-073/OL-18-01, GENERAL ELECTRIC-HITACHI VALLECITOS NUCLEAR CENTER

Dear Mr. Feyrer:

During the week of February 12, 2018, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your General Electric-Hitachi Nuclear Test Reactor (GEH NTR). The examinations were conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. 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 Title 10 of the *Code of Federal Regulations* Section 2.390, a copy of this letter and the enclosure 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 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 Mrs. Paulette Torres at (301) 415-5656 or via e-mail Paulette.Torres@nrc.gov.

Sincerely,

***/RA/***

Anthony J. Mendiola, Chief
Research and Test Reactors Oversight Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Docket No. 50-073

Enclosures:
1. Examination Report No. 50-073/OL-18-01
2. Facility Comments with NRC Resolution
3. Written examination with facility comments incorporated

cc: w/o enclosure: See next page

SUBJECT: EXAMINATION REPORT NO. 50-073/OL-18-01, GENERAL ELECTRIC HITACHI VALLECITOS NUCLEAR CENTER DATED MAY 3, 2018

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**ADAMS Accession No. ML18100A264** **NRR-074**

| OFFICE | NRR/DLP/PROB* | NRR/DLP/PROB | NRR/DLP/PROB/BC |
|---|---|---|---|
| NAME | PTorres | AFerguson | AMendiola |
| DATE | 03/22/2018 | 04/23/2018 | 05/03/2018 |

**OFFICIAL RECORD COPY**

cc:

Mark Leik, Manager
Regulatory Compliance
GE Hitachi Nuclear Energy
Vallecitos Nuclear Center
6705 Vallecitos Road
Sunol, CA 94586

Thomas McConnell, Manager
Nuclear Test Reactor
GE Hitachi Nuclear Energy
Vallecitos Nuclear Center
6705 Vallecitos Road
Sunol, CA 94586

Scott Murray, Manager
Facility Licensing
GE Hitachi Nuclear Energy
3901 Castle Hayne Road
Wilmington, NC 28401

Commissioner
California Energy Commission
1516 Ninth Street, MS-34
Sacramento, CA 95814

California Department of Health
ATTN: Chief
Radiologic Health Branch
P.O. Box 997414, MS 7610
Sacramento, CA 95899-7414

Test, Research and Training
Reactor Newsletter
P.O. Box 118300
University of Florida
Gainesville, FL 32611-8300

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

REPORT NO.: 50-073/OL-18-01

FACILITY DOCKET NO.: 50-073

FACILITY LICENSE NO.: R-33

FACILITY: General Electric-Hitachi Vallecitos Nuclear Center

EXAMINATION DATE: Febreaury 13-14, 2018

SUBMITTED BY: ***/RA/*** ***03/22/2018***
Paulette Torres, Chief Examiner Date

SUMMARY:

During the week of Febryary 12, 2018, the NRC administered licensing examinations to one Reactor Operator (RO) candidate and two Senior Reactor Operator instant (SRO-I) candidates. The one RO candidate failed the written portion of the examination and passed the operating portion of the examination. The two SRO-I candidates passed all applicable portions of the examinations.

## REPORT DETAILS

1. Examiner: Paulette Torres, Chief Examiner, NRC

2. Results:

| | RO PASS/FAIL | SRO PASS/FAIL | TOTAL PASS/FAIL |
|---|---|---|---|
| Written | 0/1 | 2/0 | 2/1 |
| Operating Tests | 1/0 | 2/0 | 3/0 |
| Overall | 0/1 | 2/0 | 2/1 |

3. Exit Meeting:
Paulette Torres, Chief Examiner, NRC
Thomas McConnell, NTR Manager, GEH NTR

The facility licensee agreed to email their comments on the written examination that were incorporated in the examination report (see Enclosure 2).

FACILITY COMMENTS ON THE WRITTEN EXAM WITH NRC RESOLUTION

**QUESTION C.18 [1.0 point]**
The Technical Specification limit for the Beta-Gamma radioactive material discharged through the reactor cell exhaust system is:

a. 8.7 mCi/wk

b. 180 mCi/wk

c. 870 mCi/wk

d. 18 Ci/wk

Answer: c
REF: TS Table 3.3, pg. 3-11
SOP 5.2, Section 3.6, pg. 2 of 12

Facility Recommendation: Question C.18 not having an option with the correct answer – units issue. Please consider throwing this question out in your final grading of the written exams.

**NRC Resolution:** The NRC agrees with the facility comment and question C.18 will be deleted from the examination.

U. S. NUCLEAR REGULATORY COMMISSION
NON-POWER REACTOR LICENSE EXAMINATION

FACILITY: GEH-NTR

REACTOR TYPE: Test Reactor

DATE ADMINISTERED: 02/13/2018

CANDIDATE: _____

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the Answer sheet provided. Attach all Answer sheets to the examination. Point values are indicated in parentheses for each question. A 70% in each category is required to pass the examination. Examinations will be picked up three (3) hours after the examination starts.

| CATEGORY VALUE | % OF TOTAL | CANDIDATE'S SCORE | % OF CATEGORY VALUE | CATEGORY |
|---|---|---|---|---|
| 20.00 | 33.3 | _____ | _____ | A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS |
| 20.00 | 33.3 | _____ | _____ | B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS |
| 19.00<br>~~20.00~~ | 33.3 | _____ | _____ | C. FACILITY AND RADIATION MONITORING SYSTEMS |
| 59.00<br>~~60.00~~ | | _____<br>FINAL GRADE | _____ | % TOTALS |

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

_____
Candidate's Signature

A. Reactor Theory, Thermohydraulics & Facility Operating Characteristics

**A N S W E R  S H E E T**

Multiple Choice (Circle or X your choice)
If you change your Answer, write your selection in the blank.

A01 a ___ b ___ c ___ d ___

A02 a b c d ___

A03 a b c d ___

A04 a b c d ___

A05 a b c d ___

A06 a b c d ___

A07 a b c d ___

A08 a b c d ___

A09 a b c d ___

A10 a b c d ___

A11 a b c d ___

A12 a b c d ___

A13 a b c d ___

A14 a b c d ___

A15 a b c d ___

A16 a b c d ___

A17 a b c d ___

A18 a ___ b ___ c ___ d ___

A19 a b c d ___

A20 a b c d ___

(***** END OF SECTION A *****)

B. Normal/Emergency Procedures and Radiological Controls

**A N S W E R  S H E E T**

Multiple Choice (Circle or X your choice)
If you change your Answer, write your selection in the blank.

B01 a b c d ___

B02 a b c d ___

B03 a b c d ___

B04 a b c d ___

B05 a b c d ___

B06 a b c d ___

B07 a b c d ___

B08 a b c d ___

B09 a ___ b ___ c ___ d ___

B10 a b c d ___

B11 a b c d ___

B12 a b c d ___

B13 a b c d ___

B14 a b c d ___

B15 a b c d ___

B16 a b c d ___

B17 a b c d ___

B18 a b c d ___

B19 a b c d ___

B20 a b c d ___

(***** END OF SECTION B *****)

C. Facility and Radiation Monitoring Systems

**A N S W E R  S H E E T**

Multiple Choice (Circle or X your choice)
If you change your Answer, write your selection in the blank.

C01 a ___ b ___ c ___ d ___

C02 a b c d ___

C03 a b c d ___

C04 a b c d ___

C05 a b c d ___

C06 a b c d ___

C07 a b c d ___

C08 a b c d ___

C09 a b c d ___

C10 a b c d ___

C11 a b c d ___

C12 a b c d ___

C13 a b c d ___

C14 a b c d ___

C15 a b c d ___

C16 a ___ b ___ c ___ d ___

C17 a b c d ___

~~C18 a b c d ___~~ Deleted per facility comment

C19 a b c d ___

C20 a b c d ___

(***** END OF SECTION C *****)
(********** END OF EXAMINATION **********)

# NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

1. Cheating on the examination means an automatic denial of your application and could result in more severe penalties.

2. After the examination has been completed, you must sign the statement on the cover sheet indicating that the work is your own and you have neither received nor given assistance in completing the examination. This must be done after you complete the examination.

3. Restroom trips are to be limited and only one candidate at a time may leave. You must avoid all contacts with anyone outside the examination room to avoid even the appearance or possibility of cheating.

4. Use black ink or dark pencil only to facilitate legible reproductions.

5. Print your name in the blank provided in the upper right-hand corner of the examination cover sheet and each Answer sheet.

6. Mark your Answers on the Answer sheet provided. USE ONLY THE PAPER PROVIDED AND DO NOT WRITE ON THE BACK SIDE OF THE PAGE.

7. The point value for each question is indicated in [brackets] after the question.

8. If the intent of a question is unclear, ask questions of the examiner only.

9. When turning in your examination, assemble the completed examination with examination questions, examination aids and Answer sheets. In addition turn in all scrap paper.

10. Ensure all information you wish to have evaluated as part of your Answer is on your Answer sheet. Scrap paper will be disposed of immediately following the examination.

11. To pass the examination you must achieve a grade of 70 percent or greater in each category.

12. There is a time limit of three (3) hours for completion of the examination.

EQUATION SHEET

$$\dot{Q} = \dot{m} c_P \Delta T = \dot{m} \Delta H = UA\Delta T$$

$$P_{\max} = \frac{(\beta - \rho)^2}{(2\alpha\lambda)}$$

$$\lambda_{eff} = 0.1 \sec^{-1}$$

$$P = P_0 \, e^{t/T}$$

$$SCR = \frac{S}{-\rho} \cong \frac{S}{1 - K_{eff}}$$

$$\lambda^* = 1 \times 10^{-4} \text{ sec}$$

$$SUR = 26.06 \left[ \frac{\lambda_{eff} \rho + \dot{\rho}}{\bar{\beta} - \rho} \right]$$

$$CR_1 (1 - K_{eff_1}) = CR_2 (1 - K_{eff_2})$$

$$CR_1 (-\rho_1) = CR_2 (-\rho_2)$$

$$P = \frac{\beta(1-\rho)}{\beta - \rho} P_0$$

$$M = \frac{1}{1 - K_{eff}} = \frac{CR_2}{CR_1}$$

$$P = P_0 \, 10^{SUR(t)}$$

$$M = \frac{1 - K_{eff_1}}{1 - K_{eff\,2}}$$

$$SDM = \frac{1 - K_{eff}}{K_{eff}}$$

$$T = \frac{\lambda^*}{\rho - \bar{\beta}}$$

$$T = \frac{\lambda^*}{\rho} + \left[ \frac{\bar{\beta} - \rho}{\lambda_{eff} \rho + \dot{\rho}} \right]$$

$$T_{\frac{1}{2}} = \frac{0.693}{\lambda} \qquad \Delta\rho = \frac{K_{eff_2} - K_{eff_1}}{K_{eff_1} K_{eff_2}}$$

$$\rho = \frac{K_{eff} - 1}{K_{eff}}$$

$$DR = DR_0 \, e^{-\lambda t}$$

$$DR_1 \, d_1^{\,2} = DR_2 d_2^{\,2}$$

$$DR = \frac{6 Ci \, E(n)}{R^2}$$

$$\frac{(\rho_2 - \beta)^2}{Peak_2} = \frac{(\rho_1 - \beta)^2}{Peak_1}$$

DR – Rem, Ci – curies, E – Mev, R – feet

**1 Curie = 3.7 x $10^{10}$ dis/sec**

**1 kg = 2.21 lbm**

**1 Horsepower = 2.54 x $10^3$ BTU/hr**

**1 Mw = 3.41 x $10^6$ BTU/hr**

**1 BTU = 778 ft-lbf**

**°F = 9/5 °C + 32**

**1 gal ($H_2O$) ≈ 8 lbm**

**°C = 5/9 (°F - 32)**

**$c_P$ = 1.0 BTU/hr/lbm/°F**

**$c_p$ = 1 cal/sec/gm/°C**


# General Electric- Hitachi Nuclear Test Reactor

# Operator Licensing Examination

## Week of February 12, 2018

**QUESTION A.01 [1.0 point, 0.25 each]**
Match the following neutron interactions with its net result. Answers can be used more than once.

| Column A | Column B |
|---|---|
| a. Elastic Scattering | 1. γ – Rays |
| b. Inelastic Scattering | 2. Positive Ions |
| c. Nuclear Reactions | 3. Protons |
| d. Capture | |

**QUESTION A.02 [1.0 point]**
Which ONE of the following factors has a long term effect on $K_{eff}$ but is of no consequence during short term and transient operation?

a. Fuel burnup

b. Increase in fuel temperature

c. Increase in moderator temperature

d. Xenon and Samarium fission products

**QUESTION A.03 [1.0 point]**
Shutdown Margin is defined as:

a. The negative reactivity inserted by an increase in moderator temperature within the core when the reactor is brought from zero to full power.

b. Provides a measure of excess reactivity available to overcome fission product buildup, fuel burnup, and power defect.

c. The amount of negative reactivity that would be added to a core if the rods in a critical, cold, clean reactor were fully inserted.

d. The amount of reactivity available above what is required to keep the reactor critical.

**QUESTION A.04 [1.0 point]**
The count rate is 100 cps. An experimenter inserts an experiment into the core, and the count rate decreases to 60 cps. Given the initial $K_{eff}$ of the reactor was 0.92, what is the worth of the experiment?

a. $\Delta\rho = - 0.07$

b. $\Delta\rho = + 0.07$

c. $\Delta\rho = - 0.02$

d. $\Delta\rho = + 0.02$

**QUESTION A.05 [1.0 point]**
Xenon-135 is formed directly by decay of _____.

a. Antimony-135

b. Cesium -135

c. Iodine-135

d. Tellurium-135

**QUESTION A.06 [1.0 point]**
What happens to the mass number and the atomic number of an element when it undergoes beta decay?

a. The mass number decreases by 4 and the atomic number decreases by 2.

b. The mass number does not change and the atomic number decreases by 2.

c. The mass number increases by 2 and the atomic number increases by 1.

d. The mass number does not change and the atomic number increases by 1.

**QUESTION A.07 [1.0 point]**
The reactor is critical at 5 watts. Which ONE of the following correctly describes the reactor behavior when a reactivity worth of 0.50 % ΔK/K is IMMEDIATELY inserted to the reactor core?

a. Subcritical

b. Critical

c. Supercritical

d. Delayed Critical

**QUESTION A.08 [1.0 point]**
Which ONE of the following statements correctly describes the term neutron lifetime?

a. The mean time required for fission neutrons to slow down to thermal energies.

b. The average time that thermal neutrons diffuse before being lost in some way.

c. The time between succeeding neutron generations and is the sum of fission time, slowing down time, and diffusion time.

d. The average time between the release of a neutron in a fission reaction and its loss from the system by absorption or escape.

**QUESTION A.09 [1.0 point]**
Most text books list β for a $U^{235}$ fueled reactor as 0.0065 ΔK/K and $\beta_{eff}$ as being 0.0075 ΔK/K. Why is $\beta_{eff}$ larger than β?

a. Delayed neutrons are born at lower energies than prompt neutrons resulting in a less loss due to leakage for these neutrons.

b. Delayed neutrons are born at higher energies than prompt neutrons resulting in a greater worth for these neutrons.

c. The fuel includes $U^{238}$ which has a relatively large for fast fission.

d. Some $U^{238}$ in the core becomes $Pu^{239}$ (by neutron absorption) which has a larger for fission.

**QUESTION A.10 [1.0 point]**
The neutron microscopic cross-section for absorption $\sigma_a$ generally:

a. Increases as neutron energy increases.

b. Decreases as neutron energy increases.

c. Increases as the mass of the target nucleus increases.

d. Decreases as the mass of the target nucleus increases.

**QUESTION A.11 [1.0 point]**
Which ONE is true about "subcritical multiplication"? As the reactor approaches criticality, the parameter:

a. $k_{eff}$ approaches zero.

b. 1/M approaches zero.

c. M approaches one.

d. $\rho$ approaches infinity.

**QUESTION A.12 [1.0 point]**
Which ONE defines an integral rod worth curve?

a. Conforms to an axial flux shape.

b. Any point on the curve represents the amount of reactivity that one inch of rod motion would insert at that position in the core.

c. Represents the cumulative area under the differential curve starting from the bottom of the core.

d. Reactivity is highest at the top of the core and lowest at bottom of the core.

**QUESTION A.13 [1.0 point]**
Which ONE of the following is the correct reason for the 80 second negative period following a reactor scram?

a. The fuel temperature coefficient adding positive reactivity due to the fuel temperature decrease following a scram.

b. The ability of U-235 to fission with source neutrons.

c. The decay constant for the longest lived precursor.

d. The amount of negative reactivity added on a scram being greater that the shutdown margin.

**QUESTION A.14 [1.0 point]**
A reactor is operating at a power of 10 W. If there is a reactivity insertion of $\rho = 0.00065$, how long is it before the reactor power reaches 10 kW? (Assume $\beta_{eff} = 0.0065$, $\lambda = 0.07\ sec^{-1}$ and $T = 129$ sec)

a. 2 min

b. 10 min

c. 15 min

d. 20 min

**QUESTION A.15 [1.0 point]**
The term _____ defines the condition where no delay neutrons are required.

a. Prompt Jump

b. Prompt Drop

c. Asymptotic Period

d. Prompt Critical

**QUESTION A.16 [1.0 point]**
A subcritical reactor is being started up. A control blade is raised in four equal steps. Which ONE of the following statement most accurately describes the expected reactor response?

a. Power increases by the same amount for each withdrawal.

b. Each withdrawal will add the same amount of reactivity.

c. The time for power to stabilize after each successive withdrawal increases.

d. A lower critical rod height is attained by decreasing the time intervals between withdrawals.

**QUESTION A.17 [1.0 point]**
Which ONE of the following describes the characteristics of a good moderator?

a. Large scattering cross section and small absorption cross section.

b. Small scattering cross section and large absorption cross section.

c. Small scattering cross section and small absorption cross section.

d. Large scattering cross section and large absorption cross section.

**QUESTION A.18 [1.0 point, 0.25 each]**
The six factor formula is stated as $k_{eff} = \epsilon L_f p L_t f \eta$.
Match with the correct answer:

| Column A | Column B |
|---|---|
| a. Thermal utilization factor (f) | 1. Change as fertile material is converted to fissile material. |
| b. f and p factors | 2. Can be changed, by inserting movable control rods in and out. |
| c. f, p, Reproduction (η) factors | 3. Changes reactor power. |
| d. Resonance escape probability (p) | 4. Change as fuel is burned. |

**QUESTION A.19 [1.0 point]**
Reactor period is defined as _____.

a. The time required for a reactor to change by a factor of *e.*

b. The time required for the reactor power to double.

c. The number of factors of ten that reactor power changes in one minute.

d. The fraction of all neutrons that are born as delayed neutrons.

**QUESTION A.20 [1.0 point]**
Which ONE of the following is the best approximation of the amount of energy released by the fission of one atom of U-235?

a. 5 - 10 MeV

b. 50 - 70 MeV

c. 100 - 120 MeV

d. 180 - 210 MeV

********** End of Section A **********

**QUESTION B.01 [1.0 point]**
The _____ allows for a total weight of explosives in pounds of equivalent TNT of ≤ 25 lbs.

a. South Cell

b. North room (without Modular Stone Monument)

c. North Room (with Modular Stone Monument)

d. Setup Room

**QUESTION B.02 [1.0 point]**
The _____ interrupts safety system and de-energizes the safety rod electromagnets.

a. Drive-Out Limit Switch

b. Drive-In Limit Switch

c. Safety Rod-In Position Switch

d. Separate Switch

**QUESTION B.03 [1.0 point]**
“The reactor configuration shall be controlled to ensure that the potential excess reactivity shall be 0.76$.” This is an example of a:

a. Safety Limit.

b. Limiting Safety System Setting.

c. Limiting Condition of Operation.

d. Surveillance Requirement.

**QUESTION B.04 [1.0 point]**
The nominal specifications of the fuel assemblies shall include:

a. 76.5% enriched uranium clad with stainless steel.

b. 7% enriched uranium clad with aluminum.

c. 93% enriched uranium clad with aluminum.

d. 23.5% enriched uranium clad with stainless steel.

**QUESTION B.05 [1.0 point]**
Per Technical Specifications, the safety rod scram time (inflight time) shall be measured:

a. Daily

b. Monthly

c. Semiannually

d. Annually

**QUESTION B.06 [1.0 point]**
In accordance with 10 CFR Part 50.47(b)(11), under what conditions a member of the emergency response team can have a maximum projected exposure (or dose commitment) to be received under any condition of 75 Whole Body Dose (Rem)?

a. During any emergency.

b. In an emergency situation, to perform assessment actions.

c. In an emergency situation, to perform personnel decontamination.

d. In an emergency situation, to undertake corrective actions.

**QUESTION B.07 [1.0 point]**
Reactor Operator works in a high radiation area for eight (8) hours a day. The dose rate in the area is 100 mR/hour. Which ONE of the following is the MAXIMUM number of days in which
Reactor Operator may perform his duties WITHOUT exceeding 10 CFR 20 limits?

a. 5 days

b. 6 days

c. 7 days

d. 12 days

**QUESTION B.08 [1.0 point]**
Per Site Emergency Procedure No. A-5, if an emergency event is in progress and has been classified as an Alert or higher, which ONE of the following agencies VNC is required to notify?

a. Nuclear Regulatory Commission (USNRC)

b. Alameda County Office of Emergency Services (OES)

c. State Department of Health Services (DOHS)

d. All of the above

**QUESTION B.09 [1.0 point, 0.25 each]**
Match the 10 CFR 55 requirements for maintaining an active operator license in column A with the corresponding time period from column B (answers can be used more than once).

| Column A | | Column B |
|---|---|---|
| a. | Medical Exam | 1. 1 year |
| b. | Pass Requalification Operating Test | 2. 2 years |
| c. | Renewal Application of Existing License | 3. 4 years |
| d. | Pass Requalification Written Examination | 4. 6 years |

**QUESTION B.10 [1.0 point]**
Which ONE of the following terms defines the actions taken to mitigate the consequences of an emergency?

a. Assessment Actions

b. Corrective Actions

c. Protective Actions

d. Recovery Actions

**QUESTION B.11 [1.0 point]**
The on-duty _____, is the Initial Response Emergency Operations Coordinator (EOC) for all emergencies.

a. Radiation Monitoring Technician, Facilities Protection (RMT-FP)

b. Building Emergency Coordinator (BEC)

c. Emergency Preparedness Advisor

d. Incident Commander

**QUESTION B.12 [1.0 point]**
Which ONE of the following emergency situations may lead to an ALERT?

a. Actuation of an accidental criticality alarm at a VNC facility.

b. Report or observation of a severe natural phenomenon affecting the reactor site.

c. High-level release of airborne radioactive material indicated by stack instrumentation.

d. Actual or projected radiation levels at the site boundary of 1.0 mSv/hr deep dose equivalent for 1 hour or 5.0 mSv to the thyroid.

**QUESTION B.13 [1.0 point]**
Which ONE of the following is the 10 CFR 20 definition of Total Effective Dose Equivalent (TEDE)?

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

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

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

d. The dose to a specific organ or tissue resulting from an intake of radioactive material.

**QUESTION B.14 [1.0 point]**
If a gamma source measures 425 mR/hr at one foot, what will it measure at three feet?

a. 0.021 mR/hr

b. 47 mR/hr

c. 142 mR/hr

d. 207 mR/hr

**QUESTION B.15 [1.0 point]**
The minimum staffing when the reactor is not secured shall be composed of:

a. Two licensed operators, where one must be in the control room.

b. One Reactor Operator, one knowledgeable person and one Senior Reactor Operator on call.

c. One Senior Reactor Operator and one Reactor Operator.

d. One licensed operator and the Reactor Manager.

**QUESTION B.16 [1.0 point]**
The Manual Poison Sheets consist of:

a. Cadmium

b. Boron-Polyurethane

c. Graphite

d. Boron-Carbide

**QUESTION B.17 [1.0 point]**
What kind of detector feeds the Picoammeter Channels?

a. Fission Chamber

b. Compensated Ion Chamber

c. Uncompensated Ion Chamber

d. Scintillation

**QUESTION B.18 [1.0 point]**
Which ONE of the following relays de-energize upon a High Temperature Scram?

a. R-11

b. R-19

c. R-20

d. R-49

**QUESTION B.19 [1.0 point]**
Which ONE of the following general inspections of the Daily Surveillance Check Sheet is only required to be measured on the first work day of the week?

a. Conductivity

b. Rx Cell Negative Pressure

c. Primary Pump Off and Vented

d. Demineralizer Radiation Level

**QUESTION B.20 [1.0 point]**
Which ONE of following types of radiation is the HIGHEST Quality Factor specified in 10 CFR 20?

a. Alpha

b. Beta

c. Gamma

d. Neutron (unknown energy)

********** End of Section B **********

**QUESTION C.01 [1.0 point, 0.25 each]**
Match the components of the safety rod mechanical drive in Column A with its function in Column B.

| Column A | Column B |
|---|---|
| a. A rod follower | 1. To protect the mechanical components upon a scram. |
| b. An anvil on the rod follower | 2. Which is pinned to the poison section. |
| c. An electromagnet attached to the drive nut | 3. To provide a rod stop and a connection to the electromagnet. |
| d. An air dash pot shock absorber | 4. To release the poison section upon de-energizing. |

**QUESTION C.02 [1.0 point]**
The control rods were calibrated using the rising period technique, with the rods in an essentially unshadowed condition. The results indicate the total worth of all the rods is approximately _____.

a. 0.7$

b. 1.0$

c. 2.3$

d. 3.0$

**QUESTION C.03 [1.0 point]**
The start-up source used in the NTR reactor is a _____ source.

a. Am-Be

b. Ra-Be

c. Sb-Be

d. Pu-Be

**QUESTION C.04 [1.0 point]**
Per SAR, the typical cooling system conditions for reactor power of 100 kW (full power) for primary water is_____ Flow Rate.

a. 15 gpm

b. 20 gpm

c. 25 gpm

d. 35 gpm

**QUESTION C.05 [1.0 point]**
Which ONE of the following isotopes would give an annual average concentration of 20% at the site boundary from NTR stack releases?

a. N-16

b. Ar-41

c. I-131

d. Np-237

**QUESTION C.06 [1.0 point]**
Which ONE of the following is an example of an existing experiment service penetration?

a. One 1.5-inch deionized water supply line

b. One 0.75-inch compressed air supply line

c. Twelve 3-inch electrical conduits for wiring between the cell and control room

d. Stepped hole (6-8 inches in diameter) through the east wall approximately 10 feet above the cell floor.

**QUESTION C.07 [1.0 point]**
Which ONE of the following Radiation Monitors has a setpoint of 5 mR/hr?

a. Control room high level

b. North room high level

c. South cell high level

d. Reactor cell high level (reactor shutdown)

**QUESTION C.08 [1.0 point]**
All of the following scrams causes the control rod drives to run to their fully inserted positions EXCEPT:

a. Manual

b. Log N

c. Electrical Power

d. Linear

**QUESTION C.09 [1.0 point]**
The exact location selected for a particular compensated ion chamber in the reactor is determined by all of the following EXCEPT:

a. Intended use of the reactor

b. Sensitivity of the system

c. Desired meter reading

d. Resilience of the detector

**QUESTION C.10 [1.0 point]**
The _____ Power Supply is a regulated, constant voltage/constant current DC Hewlett Packard Model 4633A. The ranges are 0-150 VDC and 0-3 amps.

a. Safety Rod Magnet

b. Safety System

c. Log N

d. Picoammeter

**QUESTION C.11 [1.0 point]**
Which ONE of the following experimental facilities is considered an “Incore” facility?

a. Thermal Column

b. Horizontal Facility

c. CHRIS

d. Fuel Loading Chute

**QUESTION C.12 [1.0 point]**
Which ONE of the following radiation monitoring equipment at the NTR, its corresponding function is “Exposure Monitoring”?

a. Personal Dosimetry

b. Remote Area Monitors

c. Continuous Air Monitor

d. Portable Survey Instruments

**QUESTION C.13 [1.0 point]**
In support of ALARA, the maximum annual dose equivalent VNC goal for the typical radiation worker is established as the total effective dose equivalent equal to:

a. 2% of the NRC limit

b. 10% of the NRC limit

c. 20% of the NRC limit

d. Not applicable. Same as the NRC limit

**QUESTION C.14 [1.0 point]**
In accordance with Technical Specifications, the Reactor is SECURE when all of the following conditions exist EXCEPT:

a. The console key is in proper custody.

b. Power is unavailable to the control rod drive mechanism electromagnets.

c. No work is in progress involving in-core components, installed rods drives, or experiments.

d. The core contains insufficient fissile material to attain criticality under optimum conditions of moderation and reflection.

**QUESTION C.15 [1.0 point]**
An example of a record to be retained for the lifetime of the reactor facility is:

a. Reportable occurrences.

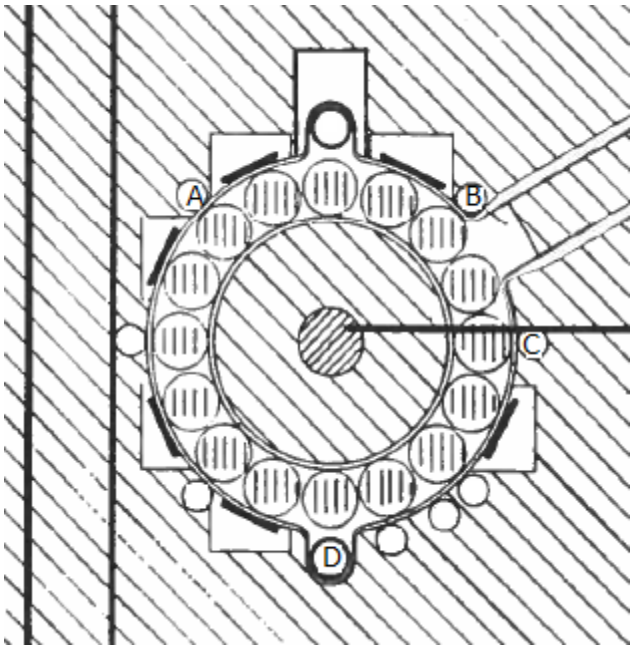
b. Experiments performed with the reactor.

c. Fuel inventories, receipts, and shipments.

d. Gaseous and liquid radioactive effluents released to the environs.

**QUESTION C.16 [1.0 point, 0.25 each]**
The figure below shows a simplified drawing of the Vertical Section Through the NTR. Match the corresponding regions in Column A with the reactor components in Column B.

Column A




Column B

1. Water Inlet
2. Water Outlet
3. Safety Rod
4. Fine Control Rod
5. Coarse Control Rod
6. Sample Tube
7. Fuel Disk
8. Source Rod

**QUESTION C.17 [1.0 point]**
Technical Specifications require the stack discharge to be approximately _____ above the Building 105 grade level.

a. 8 feet

b. 14 feet

c. 18 feet

d. 45 feet

~~**QUESTION C.18 [1.0 point]**~~ **Deleted per facility comment**

~~The Technical Specification limit for the Beta-Gamma radioactive material discharged through the reactor cell exhaust system is:~~

~~a. 8.7 mCi/wk~~

~~b. 180 mCi/wk~~

~~c. 870 mCi/wk~~

~~d. 18 Ci/wk~~

**QUESTION C.19 [1.0 point]**

The temperature coefficient of reactivity of the reactor primary coolant shall be negative above a primary coolant temperature of _____.

a. 222°F

b. 140°F

c. 124°F

d. 90°F

**QUESTION C.20 [1.0 point]**

All of the following initiates an alarm at the Central Alarm Station (CAS) EXCEPT:

a. Sump Level

b. Fuel Tank High and Low Level

c. Stack Activity

d. Low Reactor Cell Pressure

********** End of Section C **********
********** End of the Exam **********

**A.01**
Answer: a,3 b,1 c,2 d,1
REF: Denaro and Jayson, Fundamentals of Radiation Chemistry, pg. 51

**A.02**
Answer: a
REF: Burns, Session 3.3.2, pg. 3-18

**A.03**
Answer: c
REF: Burns, example 6.2.3 (a), pg. 6-4

**A.04**
Answer: a
REF: $CR_1 / CR_2 = (1 - K_{eff2}) / (1 - K_{eff1})$
$100 / 60 = (1 - K_{eff2}) / (1 - 0.92)$
Therefore $K_{eff2} = 0.867$
$\Delta\rho = (K_{eff2} - K_{eff1}) / (K_{eff2} * K_{eff1})$
$\Delta\rho = (0.867 - 0.92) / (0.867 * 0.92)$
$\Delta\rho = - 0.0664$

**A.05**
Answer: c
REF: Burns, Figure 8.1, pg. 8-6

**A.06**
Answer: d
REF: DOE Handbook volume 1, NP-01, pg. 24, β decay = $ZX^A \rightarrow Z+1Y^A + e + v$,
A = atomic mass = proton + neutrons
Z = # protons

**A.07**
Answer: c
REF: Burn, Section 4.2, Figure 4-1, pg. 4-2
0.5 % $\Delta K/K = 0.005$ $\Delta K/K = \rho$, $\rho > 0$
$\rho = (k_{eff} - 1) / k_{eff}$, then $k_{eff} = 1.005$
When $k > 1$, $\rho > 0$ and reactor is supercritical

**A.08**
Answer: d
REF: Burns, section 3.3.5, pg. 3-23

**A.09**
Answer: a
REF: Burns, Section 3.2.4, pg. 3-12

**A.10**
Answer: b
REF: Foster & Wright, "Basic Nuclear Engineering" 4th ed., Figure 8.3, pg. 202

**A.11**
Answer: b
REF: Burns, Table 5.5, pg. 5-15

**A.12**
Answer: c
REF: Burns, Section 7.3, pg. 7-5 to 7-7

**A.13**
Answer: c
REF: Lamarsh, 3rd ed., pg. 345

**A.14**
Answer: c
REF: Reactor power: $P(t) = P(0) \exp(t/T)$
Solving for t, we find $t = T \ln [P(t)/P(0)] = 129 \ln (10{,}000/10) = 891$ s = 14.9 min
Also,
$\rho = 0.00065$, then
$T = (\beta_{eff} - \rho)/(\rho \lambda) = (0.0065 - 0.00065)/(0.07)(0.00065) =$ 129 seconds

**A.15**
Answer: d
REF: Knief, Nuclear Engineering, 2nd ed., pg. 142

**A.16**
Answer: c
REF: Burns, Section 5.3, pg. 5-7

**A.17**
Answer: a
REF: DOE Handbook part 2, module 2, pg. 24

**A.18**
Answer: a,2 b,4 c,1 d,3
REF: DOE Handbook part 2, module 3, pg. 10, 15

**A.19**
Answer: a
REF: DOE Handbook part 2, module 4, pg. 21

**A.20**

Answer: d

REF: Lamarsh, Table 3.6, pg. 88
Foster and Wright, Basic Nuclear Engineering, 4th ed., table 4.2, pg. 76, "The energy release per fission is approximately 200 MeV."

**B.01**
Answer: d
REF: TS 3.5.3.2, pg. 3-13

**B.02**
Answer: d
REF: SOP 3.2, Section 3.3.4, pg. 3 of 13
SAR 4.2.2, pg. 4-7

**B.03**
Answer: c
REF: TS, Section 3.1.3.1, pg. 3-1

**B.04**
Answer: c
REF: TS 5.3, pg. 5-2

**B.05**
Answer: c
REF: TS 4.2.3.5, pg. 4-3

**B.06**
Answer: d
REF: VNC Radiological Emergency Plan, Section 7.4.5, Table 1, pg. 7-3

**B.07**
Answer: b
REF: 10 CFR 20.1201(a)(1)

$$5000mR * \frac{1hr}{100mR} * \frac{1day}{8hr} = 6.25days$$

**B.08**
Answer: d
REF: Site Emergency Procedure No. A-5, Section 6.2.1, pg. 9 of 17

**B.09**
Answer: a, 2 b, 1 c, 4 d, 2
REF: 10 CFR 55.53 “Conditions of Operator Licenses”
10 CFR 55.55 “Expiration”
10 CFR 55.59 “Requalification”

**B.10**
Answer: c
REF: VNC Radiological Emergency Plan, Section 2.4, pg. 3-1

**B.11**
Answer: a
REF: VNC Radiological Emergency Plan, Section 3.1.2 and Section 3.1.3

**B.12**
Answer: c
REF: VNC Radiological Emergency Plan, Section 4.2, pg. 4-2

**B.13**
Answer: a
REF: 10 CFR 20.1003, Definitions

**B.14**
Answer: b
REF: Given $DR_1(d_1)^2 = DR_2\ (d_2)^2$

Then $DR_2 = \frac{DR_1}{(d_2/d_1)^2}$

$DR_2 = \frac{425\ mR}{(3/1)^2}$

$DR_2 = 47.2$ mR/hr

**B.15**
Answer: b
REF: TS 6.1.3.1, pg. 6-4
SAR 12.1.3, pg. 12-4
SOP 6.1, Section 5.1, pg. 2 of 4

**B.16**
Answer: a
REF: SOP 3.1, Section 4.1, pg. 1 of 5
SAR 4.2.2, pg. 4-9

**B.17**
Answer: b
REF: SOP 2.4, Section 3, pg. 1 of 12

**B.18**
Answer: d
REF: SOP 2.1, Figure 2, pg. 8 of 10
SOP 2.7, Section 4.4.1, pg. 3 of 8 and Figure 4, pg. 7 of 8

**B.19**
Answer: d
REF: SOP 6.4, Section 6.2, pg. 3 of 11 and Daily Surveillance Check Sheet

**B.20**
Answer: a
REF: 10 CFR 20.1004

**C.01**
Answer: a,2 b,3 c,4 d,1
REF: SOP 3.2, Section 3.2, pg. 2 of 13

**C.02**
Answer: c
REF: SAR 4.2.2, pg. 4-9
SAR Table 4-1, pg. 4-18

**C.03**
Answer: b
REF: SAR 4.2.4, pg. 4-10
SAR 7.7, pg. 7-15/7-16
SOP 3.6, Section 1, pg. 1 of 3

**C.04**
Answer: b
REF: SAR 5.1, pg. 5-1
SAR 5.2, pg. 5-4

**C.05**
Answer: b
REF: SAR 6.4, pg. 6-6

**C.06**
Answer: d
REF: SAR 6.2, pg. 6-5

**C.07**
Answer: a
REF: SAR Table 7-2, pg. 7-11
SOP 6.4, Section 6.3, pg. 4 of 11

**C.08**
Answer: c
REF: SAR 7.1, pg. 7-1/7-2

**C.09**
Answer: d
REF: SAR 7.3.3, pg. 7-8

**C.10**
Answer: a
REF: SAR 8.1, pg. 8-1

**C.11**
Answer: b
REF: SAR 10.1, pg. 10-1

**C.12**
Answer: a
REF: SAR 11.1.4, pg. 11-9
VNC 5.2.1

**C.13**
Answer: c
REF: VSS 5.2, section 3.1, pg. 3 of 9

**C.14**
Answer: b
REF: TS 1.2.20, pg. 1-4
SOP 6.1, Section 4.3, pg. 1 of 4

**C.15**
Answer: d
REF: TS 6.7.3, pg. 6-12
SAR 12.6, pg. 12-15

**C.16**
Answer: a,5 b,3 c,4 d,1
REF: SOP 3.2, Figure 1, pg. 12 of 13
SOP 3.3, Figure 1, pg. 5 of 7
SOP 3.4, Figure 1, pg. 5 of 7
SAR 4.2, Figure 4-1, pg. 4-2

**C.17**
Answer: d
REF: TS 5.1.5, pg. 5-1
SOP 5.1, Section 3.2.4, pg. 2 of 4

~~**C.18**~~ **Deleted per facility comment**
~~Answer: c~~
~~REF: TS Table 3.3, pg. 3-11~~
~~SOP 5.2, Section 3.6, pg. 2 of 12~~

**C.19**
Answer: b
REF: SOP 1.1, Section 5.4, pg. 3 of 10
SAR 5.2, pg. 5-5
TS 4.1.3.5, pg. 4-2

**C.20**
Answer: d
REF: SOP 6.5, Section 6.2, pg. 2 of 9 and Monthly Surveillance Check Sheet