February 2, 2017

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

SUBJECT: EXAMINATION REPORT NO. 50-073/OL-17-01, GENERAL ELECTRIC-HITACHI VALLECITOS NUCLEAR CENTER

Dear Mr. Feyrer:

During the week of October 3, 2016, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination 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 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 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 Ms. Michele DeSouza at (301) 415-0747 or via internet e-mail Michele.DeSouza@nrc.gov.

Sincerely,

/RA/

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

Docket No. 50-073

Enclosures:
1. Examination Report No. 50-073/OL-17-01
2. Written Examination

cc: w/o enclosures: See next page

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DISTRIBUTION w/ encls.:
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ADAMS ACCESSION #: ML17018A104 **TEMPLATE #:NRR-079**

OFFICE	NRR/DPR/PROB:CE	NRR/DPR PROB: RI	NRR/DPR IOLB:OLA	NRR/DPR PROB:BC
NAME	MDeSouza	OFont	ABaxter	AMendiola
DATE	01/06/2017	01/31/2017	01/18/2017	02/02/2017

OFFICIAL RECORD COPY

cc:

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California Department of Health
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Radiologic Health Branch
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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-17-01

FACILITY DOCKET NO.: 50-073

FACILITY LICENSE NO.: R-33

FACILITY: GEH NTR

EXAMINATION DATES: October 3 - 6, 2016

SUBMITTED BY: **/RA/** 01/26/2017
Michele DeSouza, Chief Examiner Date

SUMMARY:
During the week of October 3, 2016, the NRC administered an operator licensing examination to one Senior Reactor Operator (RO) candidate and one Reactor Operator candidate. The Senior Reactor Operator candidate failed Category B of the operating test. One Reactor Operator candidate failed Category A of the written examination and Category B of the operating test.

REPORT DETAILS

1. Examiner: Michele DeSouza, Chief Examiner, NRC

2. Results:

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

3. Exit Meeting:
Michele C. DeSouza, Chief Examiner, NRC
Osvaldo Font, Inspector, NRC
Thomas Caine, Former Director, GEH Vallecitos Nuclear Center
Daniel Thomas, Director, GEH NTR
Mark Leik, Manager, Environmental Health and Safety, Vallecitos Nuclear Center

Per discussion with the facility, prior to administration of the examination, adjustments were accepted. Upon completion of the examination, the NRC Examiner met with facility staff representatives to discuss the results. At the conclusion of the meeting, the NRC examiner thanked the facility for their support in the administration of the examination.

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

FACILITY: GEH NTR

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 10/04/2016

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
20.00	33.3	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
60.00		_____ FINAL GRADE	_____ %	TOTALS

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

_____
Candidate's Signature

Category A – Reactor Theory, Thermodynamics, & 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 ___ (0.25 each)

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 CATEGORY A *****)

Category B – Normal/Emergency Operating 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 ____ (0.25 each)

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 ___ (0.33 each)

B19 a b c d ___

B20 a b c d ___

(***** END OF CATEGORY B *****)

Category 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 ___ (0.33 each)

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 ___ (0.25 each)

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 ___

C19 a b c d ___

C20 a b c d ___

(***** END OF CATEGORY 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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1 kg = 2.21 lb

1 Horsepower = 2.54 x 10^3 BTU/hr

1 Mw = 3.41 x 10^6 BTU/hr

1 BTU = 778 ft-lb

°F = 9/5 °C + 32

1 gal (H_2O) ≈ 8 lb

°C = 5/9 (°F - 32)

c_P = 1.0 BTU/hr/lb/°F

c_p = 1 cal/sec/gm/°C

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

QUESTION A.01 [1.0 point]
What is β_{eff}?

a. The fractional change in neutron population per generation

b. The fraction of all fission neutrons that are born as delayed neutrons

c. The time required for the reactor to change by power by a factor of e

d. The fraction of all delayed neutrons that reach thermal energy

QUESTION A.02 [1.0 point]
Which ONE of the following isotopes will absorb neutrons quickly when it interacts with neutrons?

a. Hydrogen-1

b. Carbon-14

c. Boron-10

d. Uranium-235

QUESTION A.03 [1.0 point, 0.25 each]
Match the following Neutron Interactions (each used only once)

a. Fission	1. Neutron enters nucleus, forms a compound nucleus, then decays by gamma emission
b. Radiative capture	2. Particle enters nucleus, forms a compound nucleus and is excited enough to eject a new particle with incident neutron remaining in nucleus
c. Scattering	3. Nucleus absorbs neutron and splits into two similarly sized parts
d. Particle ejection	4. Nucleus is struck by a neutron and emits a single neutron

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

QUESTION A.04 [1.0 point]
Which ONE of the following is a correct statement of how delayed neutrons enhance the ability to control reactor power?

a. Prompt neutrons can cause fissions in both U-235 and U-238 and delayed neutrons can only cause fissions in U-235

b. Delayed neutrons are born at higher energy levels than prompt neutrons

c. The average number of delayed neutrons produced per fission is higher than the average number of prompt neutrons

d. Delayed neutrons increase the average neutron lifetime that allows a reactor to be controlled

QUESTION A.05 [1.0 point]
The following shows part of a decay chain for the radioactive element Pa-234:
$_{91}Pa^{234} \rightarrow {}_{92}U^{234}$
This decay chain is an example of _____ decay.

a. Alpha

b. Beta

c. Gamma

d. Neutron

QUESTION A.06 [1.0 point]
Assume that the worth's of the Shim rod is $3.50, Safety rod is $4.50, and Reg rod is $2.25. The reactor is critical at 15 W after WITHDRAWING the following control rod worths: Shim $2.20, Safety $3.40, and Reg $1.50. What is the CORE EXCESS?

a. $2.85

b. $3.15

c. $5.50

d. $7.10

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

QUESTION A.07 [1.0 point]
Which ONE of the following is the **MAJOR** source of energy released during fission?
a. Fission fragments

b. Fission product decay

c. Prompt gamma rays

d. Fission neutrons (kinetic energy)

QUESTION A.08 [1.0 point]
Which one of the following statements describes the difference between differential rod worth (DRW) and integral rod worth (IRW) curves?

a. DRW relates the time rate of reactivity change to rod position. IRW relates the total reactivity in the core to the time rate of reactivity change

b. IRW relates the worth of the rod per increment of movement to rod position. DRW relates the total reactivity added by the rod to the rod position

c. IRW is the slope of the DRW at a given rod position

d. DRW relates the worth of the rod per increment of movement to rod position. IRW relates the total reactivity added by the rod to the rod position

QUESTION A.09 [1.0 point]
Which ONE of the following best describes the difference between reflectors and moderators?

a. Reflectors decrease thermal leakage while moderators decrease fast leakage

b. Reflectors thermalize neutrons while moderators decrease core leakage

c. Reflectors decrease core leakage while moderators thermalize neutrons

d. Reflectors shield against neutrons while moderators decrease core leakage

QUESTION A.10 [1.0 point]
What is the condition of the reactor when $k = \frac{1}{1-\beta}$?

a. Subcritical

b. Critical

c. Super critical

d. Prompt critical

QUESTION A.11 [1.0 point]
A subcritical reactor, k_{eff} is increased from 0.914 to 0.965. Which ONE of the following is the amount of reactivity that was added to the core?

a. 3.64%Δk/k

b. 4.38%Δk/k

c. 5.78%Δk/k

d. 6.57%Δk/k

QUESTION A.12 [1.0 point]
Which ONE of the following parameters is MOST significant in determining the differential rod worth of a control rod?

a. Fuel temperature

b. Flux shape

c. Reactor power

d. Rod speed

QUESTION A.13 [1.0 point]
During the time following a reactor scram, reactor power decreases on an 80 second period, which corresponds to the half-life of the longest-lived delayed neutron precursors, which is approximately _____.

a. 20 seconds

b. 40 seconds

c. 55 seconds

d. 80 seconds

QUESTION A.14 [1.0 point]
Which factors of the six factor formula are affected by an INCREASE in core temperature and how are they affected?

a. ↓Lf, ↓p, ↑f

b. ↑ ε, ↑L_f, ↓L_t, ↑p

c. ↑ε , ↓Lf, ↓L_t, ↓p, ↑η, ↑f

d. ↑ε, ↑L_f, ↓L_t, ↓p, ↑η, ↑f

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

QUESTION A.15 [1.0 point]
The reactor is on a CONSTANT positive period. Which ONE of the following power changes will take the SHORTEST time to complete?

a. From 100 kW to 150 kW

b. From 10 kW to 20 kW

c. From 10 W to 30 W

d. From 1 W to 5 W

QUESTION A.16 [1.0 point]
Which ONE of the following is the reason for an installed neutron source within the reactor core?

a. Without it, a reactor startup is impossible as no neutrons would be available

b. Power can be compensated for by adjusting the compensating voltage on the source range detector

c. Could result in a very short period due to the reactor going critical before the neutron population is built up high enough to be read on nuclear instrumentation

d. Would be very slow due to the long time to build up the neutron population from such a low level

QUESTION A.17 [1.0 point]
How high will the reactor power get given the lowest of the reactor high power scrams set point is 110%, the scram delay time is 0.5 seconds, the reactor is operating at 100% power prior to the scram, and the reactor period is positive 20 second?

a. 113%

b. 115%

c. 120%

d. 220%

QUESTION A.18 [1.0 point]
Reactor is critical. What would be the corresponding k_{eff} when removing 0.05 $\Delta k/k$ from its criticality?

a. 0.9951

b. 0.9524

c. 0.9750

d. 1.0526

QUESTION A.19 [1.0 point]
Given a source strength of 150 neutrons per second (N/sec) and a multiplication factor of 0.7, which ONE of the following is the expected stable neutron count rate?

a. 150 N/sec

b. 250 N/sec

c. 400 N/sec

d. 500 N/sec

QUESTION A.20 [1.0 point]
Two common FISSION PRODUCTS that have especially large neutron cross sections and play a significant role in reactor physics are Xe-135 and _____.

a. Nitrogen-16

b. Argon-41

c. Iodine-131

d. Samarium-149

(***** END OF CATEGORY A *****)

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.01 [1.0 point]
Which ONE of the following conditions is a violation of General Electric Hitachi Nuclear Test Reactor Technical Specifications, reactor primary coolant water?

a. Conductivity of the primary coolant water is 10umhos/cm

b. Primary coolant temperature is 200^{o}F during reactor operation

c. Primary coolant flow is 20gpm while reactor power is 10 kW

d. Primary coolant water pH is 5.4

QUESTION B.02 [1.0 point]
In accordance with Vallecitos Nuclear Center site emergency procedures, “a fire that could prevent a safety system from performing its intended function”, is an example of what type of classification?

a. General area emergency

b. Site area emergency

c. Alert

d. Notification of Unusual event

QUESTION B.03 [1.0 point]
Which ONE of the following is the definition for “Annual Limit on Intake”?

a. The concentration of a radionuclide in air which, if inhaled by an adult worker for a year, results in a total effective dose equivalent of 100 mrem

b. The effluent concentration of a radionuclide in air which, if inhaled continuously over a year, would result in a total effective dose equivalent of 50 mrem for noble gases

c. 10CFR20 derived limit, based on a Committed Effective Dose Equivalent of 5 rem whole body or 50 rems to any individual organ, for the amount of radioactive material inhaled or ingested in a year by an adult worker

d. Projected dose commitment to individuals that warrant protective action following a release of radioactive material

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.04 [1.0 point]
Which ONE of the following is **NOT** a responsibility of the SRO and RO?

a. Review and audit of safety aspects of reactor facility operations

b. Insertion and removal of experiments

c. Participation in requalification program

d. Preparation of logs and records of reactor operations

QUESTION B.05 [1.0 point]
Per GEH NTR Technical Specifications, what is the MINIMUM level of management who may direct any experiment or facility change with a reactivity worth greater than one dollar?

a. Reactor Director

b. Operations Supervisor

c. SRO at the facility

d. SRO on call

QUESTION B.06 [1.0 point]
Which ONE of the following situations requires an immediate shutdown?

a. Unexplained reactivity change of $0.05

b. Reactivity change greater than $0.25

c. Excess reactivity is greater than $0.76

d. An instrument indicating an oscillation of more than 10% peak to peak

QUESTION B.07 [1.0 point]
How long will it take a 50 Curie source, with a half-life of 5.26 years, to decay to 2 Curie?

a. 10.5 Years

b. 15.5 Years

c. 24.5 Years

d. 35.5 Years

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.08 [1.0 point]
Which ONE of the following is NOT required to prepare a Radiation Work Permit (RWP)?

a. Start and expiration date

b. ALARA plan

c. NRC permission

d. Description of work and instruction for radiological work

QUESTION B.09 [1.0 point, 0.25 each]
Identify each of the following surveillances as a channel check (CHECK), a channel test (TEST), or a channel calibration (CAL). Write the correct answer on your answer sheet next to the space given for each example listed below

a. During performance of the daily checklist, you compare the prestart readings of the radiation area monitors to the previous day readings

b. During performance of the daily checklist, you press the scram button to verify a scram on the safety system channel

c. Adjustment of the wide range linear channel in accordance with recent data collected during a reactor power calibration

d. You expose a 2 mCi check source to the stack particulate monitor detector to verify that it alarms at 10,000 cpm

QUESTION B.10 [1.0 point]
10 CFR 20 limits the annual occupational exposure to the WHOLE BODY of an individual to:

a. 5 rem

b. 15 rem

c. 50 rem

d. 100 rem

QUESTION B.11 [1.0 point]
"Under steady-state conditions, the maximum power level shall be no greater than 190 kW." This is an example of:

a. Safety Limit

b. Limiting Safety System Setting

c. Limiting Conditions for Operation

d. Safety Operational Limit

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.12 [1.0 point]
Calculate an individual's total whole body dose given the individual received the following doses: 5 mrad of alpha, 10 mrad of gamma, and 10mrad of neutron (unknown energy)

a. 190 mrem

b. 200 mrem

c. 210 mrem

d. 220 mrem

QUESTION B.13 [1.0 point]
What is your dose rate at 9 feet away from the source, if you are receiving 250 mR/hr at 3 feet away from the source?

a. 24 mR/hr

b. 28 mR/hr

c. 32 mR/hr

d. 36 mR/hr

QUESTION B.14 [1.0 point]
Based on the GEH NTR Requalification Plan, each operator must perform the functions of a licensed operator to maintain an "active" operator's license a MINIMUM of _____.

a. 24 hours per year

b. 8 hours per quarter

c. 4 hours per month

d. 4 hours per quarter

QUESTION B. 15 [1.0 point]
In accordance with procedures which ONE of the following individuals receives, reviews, and transmits reportable incidents to the Nuclear Regulatory Commission?

a. Reactor Operator

b. Senior Reactor Operator

c. Manager, Nuclear Test Reactor

d. Manager, Regulatory Compliance

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.16 [1.0 point]
10CFR55 states in order to maintain your active operator licensure you must receive a medical examination conducted in accordance with ANSI 15.4. What is the medical examination maximum required frequency?

a. One year

b. Two years

c. Four years

d. Six years

QUESTION B.17 [1.0 point]
Radiation from an unshielded Co-60 source is 600 mrem/hr. What thickness of lead shielding will be needed to lower the radiation level to 5 mrem/hr? Assume: half-value layer of lead is 6.5mm

a. 27 mm

b. 34 mm

c. 39 mm

d. 45 mm

QUESTION B.18 [1.0 point, 0.33 each]
Match the appropriate emergency classification in Column A with the stack gas or particulate monitor release reading (radioactive effluent concentration in excess of alarm set point (if applicable)) in Column B.

Column A	Column B
a. Notification of Unusual Event	1. 1750 times alarm set point for 30 minutes
b. Alert	2. 3000 times alarm set point for 10 minutes
c. Site Area Emergency	3. 500 times alarm set point for 15 minutes

QUESTION B.19 [1.0 point]
Which ONE of the following is the radiation dose limit for the public in an unrestricted area?

a. No limit

b. 2 rem in a year

c. 2 rem in any one hour

d. 2 mrem in any one hour

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.20 [1.0 point]
A two curie source emits a 2MeV gamma 100% of the time. The source will be placed in the reactor storage building. How far from the source should a high radiation area sign be posted?

a. Not required

b. 10.5 feet

c. 12.5 feet

d. 15.5 feet

(***** End of Category B *****)

Category C: Facility and Radiation Monitoring Systems

QUESTION C.01 [1.0 point, 0.33 each]
Match the facility radiation detector in Column A with the type of radiological problem it detects in Column B.

Column A	Column B
a. RAM	1. Gases Only
b. Stack Monitor	2. Radiation Level
c. CAM	3. Particulates Only
	4. Gases and Particulates

QUESTION C.02 [1.0 point]
What is the primary coolant water flow path starting at the reactor outlet?

a. Flow orifice, hold-up tank, primary pump, heat exchanger, reactor inlet

b. Flow orifice, heat exchanger, air trap, primary pump, reactor inlet

c. Primary pump, heat exchanger, flow orifice, air trap, reactor inlet

d. Hold-up tank, air trap, flow orifice, primary pump, reactor inlet

QUESTION C.03 [1.0 point]
Which ONE of the following is the GEH NTR definition utilized for a High Radiation Area?

a. Reactor cell and the south cell

b. Dose in excess of 5 mrem in 1 hour at 30 cm

c. Dose in excess of 100 mrem in 1 hour at 30 cm

d. Inner fenced area at the Vallecitos Nuclear Center

QUESTION C.04 [1.0 point]
Which ONE of the following is an accurate description of how thermal power is determined?

a. Measurement of the rise and fall of the core temperature averaged over the previous year

b. Overall measurements of coolant temperatures through the primary and secondary

c. Heat balance measurement using coolant flow through the core and differential temperature across the core

d. Ambient temperature measurements throughout the year and measured against the core configured temperature differentials

Category C: Facility and Radiation Monitoring Systems

QUESTION C.05 [1.0 point]
GEH NTR Technical Specifications requires fuel elements be stored in a safe array where the k_{eff} is less than _____.

a. 0.6

b. 0.7

c. 0.8

d. 0.9

QUESTION C.06 [1.0 point]
The control rod poison section is contained in which ONE of the following materials?

a. Aluminum

b. Stainless steel

c. Cadmium

d. Graphite

QUESTION C.07 [1.0 point]
Which ONE of the following will cause a HIGH conductivity reading at the inlet of the demineralizer?

a. Primary coolant water temperature low

b. High reactor water pump flow

c. Reactor water system pressure greater than secondary water pressure

d. Failure of fuel elements

QUESTION C.08 [1.0 point]
Which ONE of the following SCRAM indications is NOT associated with the log N channel?

a. High reactor power

b. Short reactor period

c. Loss of positive high voltage to ion chambers

d. Amplifier mode switch in operate

Category C: Facility and Radiation Monitoring Systems

QUESTION C.09 [1.0 point]
Which ONE of the following conditions will activate the 'low differential pressure' safety system?

a. Stack to CAM pressure increase

b. Primary to secondary pressure drop

c. Secondary to primary pressure increase

d. Reactor cell pressure drop

QUESTION C.10 [1.0 point, 0.25 each]
Match the control rod drive mechanism from Column A with the correct function in Column B.

Column A	Column B
a. Drive out	1. Interrupts voltage and deenergizes safety rod electromagnets
b. Drive in	2. Provide indication of rod stroke fully out
c. Safety rod in	3. Provide indication of rod stroke fully inserted
d. Separation switch	4. Works with circuit to provide rod fully inserted position

QUESTION C.11 [1.0 point]
What indication would result from a heat exchanger leak?

a. Reduction of primary coolant flow

b. Reduction of secondary coolant flow

c. High level alarm in the fuel loading tank

d. High level alarm in the core tank

QUESTION C.12 [1.0 point]
Which ONE of the following is NOT a reason for performance of control rod calibration?

a. After a change in reactor core configuration

b. Reactor control systems are altered

c. Fresh fuel has been added to the reactor core

d. Shutdown margin increase of $0.20

Category C: Facility and Radiation Monitoring Systems

QUESTION C.13 [1.0 point]
Which ONE of the following correctly describes the operation of a thermocouple?

a. Junction of two dissimilar metals, generating a potential (voltage proportional to temperature changes

b. Bi-metalic strip that winds or unwinds dependent on the different thermal expansion constants for the two metals, moves a lever proportional to the temperature changes

c. Precision wound resistor, inside a bridge device, resistance varies proportionally to the temperature changes

d. Liquid filled container, expands or contracts proportional to temperature changes, external wires report readings to a lever

QUESTION C.14 [1.0 point]
When the reactor is operating above a power level of _____ no experimental objects will be placed in the core tank.

a. 0.1 W

b. 50 W

c. 100 W

d. 0.1 kW

QUESTION C.15 [1.0 point]
Which region of the pulse size versus applied voltage characteristic curve do the power channel detectors operate?

a. Proportional

b. Ion Chamber

c. Geiger-Mueller

d. Limited Proportional

QUESTION C.16 [1.0 point]
Per GEH NTR Primary Coolant System SOP 1-1, what material is the plug that is placed in the loading chute (when not in use)?

a. Aluminum clad graphite

b. Stainless steel clad graphite

c. Cadmium lined boron

d. Lead lined air filled

Category C: Facility and Radiation Monitoring Systems

QUESTION C.17 [1.0 point]
When a 'downscale alarm' is indicated, it is wired to a _____ and which of the following will occur?

a. Loss of power to all rods, and a SCRAM will occur

b. Low power annunciator, and control and safety rods automatically withdraw to compensate for the power demand

c. Rod block annunciator, and control and safety rods cannot be withdrawn

d. Control rod annunciator, and control rods cannot be withdrawn but safety rods can be withdrawn to compensate for the power demand difference

QUESTION C.18 [1.0 point]
Which ONE of the following conditions will NOT cause the operating reactor to automatically scram?

a. Reactor period = 6 seconds

b. Loss of high voltage to two of the power channels

c. Primary coolant temperature = 220^{o}F

d. Low power indication on linear power channel

QUESTION C.19 [1.0 point]
Which ONE of the following is the neutron absorber in the GEH NTR reactor control rods?

a. Graphite

b. Zirconium hydride

c. Boron carbide

d. Aluminum oxide

Category C: Facility and Radiation Monitoring Systems

QUESTION C.20 [1.0 point]
Where is the majority of the facility's Ar-41 produced?

a. Horizontal facility

b. Vertical facility

c. Fuel loading chute

d. Thermal column

(***** END OF CATEGORY C *****)
((***** END OF EXAM *****))

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

A.01
Answer: b
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory*, Volume 2, Module 2

A.02
Answer: c
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 2.5.1, Pages 2-38-43

A.03
Answer: a 3 b 1 c 4 d 2
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory*, Volume 1, Module 1, Page 43-46

A.04
Answer: d
Reference: Burn, *Introduction to Nuclear Reactor Operations,* Section 3.3.2, Page 3-7

A.05
Answer: b
Reference: Chart of the Nuclides

A.06
Answer: b
Reference: Total Worth = \$3.50+\$4.50+\$2.25=\$10.25
Reactivity at 15 W=\$2.20+\$3.40+\$1.50 = \$7.10
Core Excess = Total Worth – Reactivity@15 W = \$10.25-\$7.10= \$3.15

A.07
Answer: b
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Table 3.2, Page 3-5

A.08
Answer: d
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory*, Volume 2, Module 1

A.09
Answer: c
Reference: Burn, *Introduction to Nuclear Reactor Operations,* Section 5.4

A.10
Answer: c
Reference: LaMarsh, *Introduction to Nuclear Engineering*, Page 340-341
(1-B)k=1 manipulated reads k=1/(1-B)

A.11
Answer: c
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 3.3.4, Page 3-20&21
$\Delta\rho=(k_{eff2}-k_{eff1})/(k_{eff1}*k_{eff2})$ = (0.965-0.914)/(0.965*0.914) = 0.0578Δk/k=5.78%Δk/k

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

A.12
Answer: b
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 7.2

A.13
Answer: c
Reference: LaMarsh, *Introduction to Nuclear Engineering*, Page 88
Group 1 is longest lived neutron precursor for thermal fission in U-235 with a half-life of 55.72 seconds

A.14
Answer: a
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory*, Volume 2, Module 1

A.15
Answer: a
Reference: $P=P_o e^{t/T} \rightarrow t=T*\ln(P/P_o)$ assume constant period=1
The smallest ratio of P/P_o is the shortest time to complete

A.16
Answer: c
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 5.2.2, Pages 5-2 - 5-4

A.17
Answer: a
Reference: P/P_o = 110%, T = 20 seconds, t = 0.5, P/P_o = 110 e^0.5/20 = 112.78%

A.18
Answer: b
Reference: $\rho=(k-1)/k-0.05 \rightarrow 1=k-(-0.05k)=k(1+0.05) \rightarrow k=1/1.05 =0.9524$

A.19
Answer: d
Reference: $CR=S/(1-k) \rightarrow 150/(1-0.7)$ = 500 N/sec

A.20
Answer: d
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 8.1, Page 8-1

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.1
Answer: b
Reference: GEH NTR TS 3.3.3.3, 3.3.4, and Table 3-1

B.2
Answer: c
Reference: GEH NTR, Site Emergency Procedures C-5, 4.2

B.3
Answer: c
Reference: 10CFR20.1003

B.4
Answer: a
Reference: GEH NTR TS 6.1.4, 6.2.1, and 6.2.3

B.5
Answer: c
Reference: GEH NTR TS 6.1.3.2

B.6
Answer: c
Reference: GEH NTR EP 8-3

B.7
Answer: c
Reference: $T\ A = A_{\circ} * e^{-\lambda t}$
$2Ci = 50Ci * e^{-\lambda(t)}$
Ln(2/50) = -ln2/5.27 yr*(t) --> -3.2189/-0.1315 →
solve for t: 24.47 years

B.8
Answer: c
Reference: GEH NTR Radiological Safety SOP 7.9

B.9
Answer: a (check), b (test), c (cal) , d (test)
Reference: GEH NTR TS definitions

B.10
Answer: a
Reference: 10 CFR 20.1201

B.11
Answer: a
Reference: GEH NTR TS 2.1.4

B.12
Answer: c
Reference: 5mrad Alpha x 20=100mrem, 10mrad Gamma x 1=10mrem, 10mrad neutron x 10 = 100mrem →100mrem+10mrem+100mrem= 210mrem

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.13
Answer: b
Reference: $I_1D_1^2=I_2D_2^2 \rightarrow$ 250mR/hr@$(3ft)^2=I_2$@$(9ft)^2 \rightarrow$28mR/hr

B.14
Answer: d
Reference: 10CFR55.59, GEH NTR Administrative Procedures, Chapter 9.0, Procedure 9.13, Section 9.1

B.15
Answer: d
Reference: GEH NTR Administrative Procedures, Chapter 9.0, Procedure 9.11, Section 4.1

B.16
Answer: b
Reference: 10CFR55; ANSI 15.4, 1988

B.17
Answer: d
Reference: $DR=DR_oe^{\wedge -ux}$, HVL =6.5mm $1=2e^{\wedge -u*6.5}$ so u=0.10664,
5mrem/hr = 600mrem/hr $e^{\wedge -0.10664*X}$, X = 44.89mm

B.18
Answer: a (3), b (1), c (2)
Reference: GEH NTR Site Emergency Procedure E-5, Table 1

B.19
Answer: d
Reference: 10CFR20.1301(a)(2)

B.20
Answer: d
Reference: I=6CEn=R/hr@ft.$\rightarrow$2Ci x 2Mev x 100% = 24 R/hr@ $(1ft)^2$ =
24 R/hr = 0.1 R/hr@ $D^2 = \sqrt{240}$ R/hr = 15.5 ft.

Category C: Facility and Radiation Monitoring Systems

C.01
Answer: a (2), b (4), c (3)
Reference: GEH NTR SAR Section 11.1.4, and Radiation Protection Procedures 10, Radiation Safety Procedure 7.0, Remote Area Monitor 7.2, Section 3.0, and Continuous Air Monitor 7.12, Section 3.0

C.02
Answer: b
Reference: GEH NTR SAR 5-2

C.03
Answer: c
Reference: GEH NTR Radiation Protection Procedure 10, Radiological Safety 7.0, Radiation Zone Classification 7.7

C.04
Answer: c
Reference: GEH NTR SAR 7.3.3

C.05
Answer: d
Reference: GEH NTR TS 5.4

C.06
Answer: b
Reference: GEH NTR SAR 4.2.2, page 4-8

C.07
Answer: d
Reference: Standard NRC question

C.08
Answer: d
Reference: GEH NTR SAR Table 7-1

C.09
Answer: d
Reference: GEH NTR SAR 3.5

C.10
Answer: a (2), b (3), c (4), d (1)
Reference: GEH NTR SAR 4.2.2(1), (2), and (4)

C.11
Answer: c
Reference: GEH NTR System Operating Procedures 13, Reactor Coolant Systems Chapter 1.0, Secondary Cooling System Procedure 1.5, Section 7.2

C.12
Answer: d
Reference: GEH NTR System Operating Procedures 13.0, Reactor Control 3.0, Control Rod Calibrations 3.7

Category C: Facility and Radiation Monitoring Systems

C.13
Answer: a
Reference: GEH NTR Previous Exam 2010

C.14
Answer: d
Reference: GEH NTR SAR 10.3, A, 4

C.15
Answer: b
Reference: GEH NTR System Operating Procedures 13, Reactor Instrumentation 2.0, Startup Channel 2.2, Section 1.0 and NRC standard question

C.16
Answer: a
Reference: GEH NTR System Operating Procedures 13, Reactor Coolant Systems 1.0, Primary Coolant Systems 1.1, Section 3.6

C.17
Answer: c
Reference: GEH NTR System Operating Procedures 13, Reactor Instrumentation 2.0, Pico-ammeter Channels 2.4, Section 3.5.1

C.18
Answer: d
Reference: GEH NTR TS Table 3-1 & 3-2

C.19
Answer: c
Reference: GEH NTR SAR 4.2.2

C.20
Answer: d
Reference: GEH NTR SAR 10.2