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

February 28, 2019

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

SUBJECT: EXAMINATION REPORT NO. 50-073/OL-19-01, GENERAL ELECTRIC – HITACHI, VALLECITOS NUCLEAR CENTER

Dear Mr. Feyrer:

On February 13, 2019, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your General Electric-Hitachi, Vallecitos Nuclear Center. 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 Licensing Projects
Office of Nuclear Reactor Regulation

Docket No. 50-073

Enclosures:
1. Examination Report No. 50-073/OL-19-01
2. Written examination

cc: w/o enclosures: See next page

SUBJECT: EXAMINATION REPORT NO. 50-073/OL-19-01, GENERAL ELECTRIC-HITACHI, VALLECITOS NUCLEAR CENTER DATED FEBRUARY 28, 2019

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ADAMS Accession No. ML19058A188 **NRR-079**

OFFICE	NRR/DLP/PROB/CE	NRR/DLP/IOLB/OLA	NRR/DLP/PROB/BC
NAME	MDeSouza	QLChen	AMendiola
DATE	02/13/2019	02/28/2019	02/28/2019

OFFICIAL RECORD COPY

cc:

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Test, Research and Training
Reactor Newsletter
Attention: Amber Johnson
Dept of Materials Science and Engineering
University of Maryland
4418 Stadium Drive
College Park, MD 20742-2115

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

REPORT NO.: 50-073/OL-19-01

FACILITY DOCKET NO.: 50-073

FACILITY LICENSE NO.: R-33

FACILITY: GE-H, V Nuclear Test Reactor

EXAMINATION DATES: February 13, 2019

SUBMITTED BY: Michele DeSouza 02/13/2019
Michele DeSouza, Chief Examiner Date

SUMMARY:
On February 13, 2019, the NRC administered an operator licensing examination retake to one Reactor Operator (RO) candidate. The RO candidate passed all applicable portions of the examination(s).

REPORT DETAILS

1. Examiner: Michele DeSouza, Chief Examiner, NRC

2. Results:

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

3. Exit Meeting:
Michele C. DeSouza, Chief Examiner, NRC
Thomas McConnell, Manager, GE-H, VNTR

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.

ENCLOSURE 1

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

FACILITY:	General Electric-Hitachi, Vallecitos
REACTOR TYPE:	Nuclear Test Reactor
DATE ADMINISTERED:	02/13/2019
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
NA	NA	________	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
NA	NA	________	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
20.00		________ FINAL GRADE	_____ %	TOTALS

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

____
Candidate's Signature

ENCLOSURE 2

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 *****)
(********** 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 <u>only</u> 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.

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

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

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

$$P = P_0 \; e^{t/\tau}$$

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

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

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

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

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

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

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

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

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

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

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

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

$$T_{\frac{1}{2}} = \frac{0.693}{\lambda}$$

$$\Delta\rho = \frac{K_{eff_2} - K_{eff_1}}{K_{eff_1} K_{eff_2}}$$

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

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

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

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

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

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

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

1 Horsepower = 2.54 x 10^3 BTU/hr

1 BTU = 778 ft-lb

1 gal (H_2O) ≈ 8 lb

c_P = 1.0 BTU/hr/lb/°F

1 kg = 2.21 lb

1 Mw = 3.41 x 10^6 BTU/hr

°F = 9/5 °C + 32

°C = 5/9 (°F - 32)

c_p = 1 cal/sec/gm/°C

QUESTION A.01 [1.0 point]
Which ONE of the following is the stable reactor period which will result in a power rise from 50% to 100% power in 5 seconds?

a. 5 seconds

b. 7 seconds

c. 9 seconds

d. 10 seconds

QUESTION A.02 [1.0 point]
What effect does Doppler Broadening for U-238 have on neutrons in a critical core?

a. More Scattering

b. More Absorption

c. Increase the Reproduction Factor

d. Increase the Resonance Escape Probability

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 C: Facility and Radiation Monitoring Systems

QUESTION A.04 [1.0 point]
Which ONE of the following most accurately describes the reason that fission products such as Xenon-135 and Samarium-19 have the most substantial impact in reactor design and operation?

a. Xenon-135 and Samarium-19 causes excess positive reactivity in the core

b. Xenon-135 and Samarium-19 burn up causes an increase in the thermal flux

c. Xenon-135 and Samarium-19 have large absorption cross sections resulting in a large removal of neutrons from the reactor

d. Xenon-135 and Samarium-19 produce fast fission neutrons, resulting in the net increase in the fast neutron population of the reactor core

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]
What is the result in a potential elastic scattering reaction between a neutron and a target nucleus?

a. Energy is transferred into nuclear excitation, and then emitted via a gamma emissions

b. Neutron is absorbed by the target nucleus and then emitted with lower kinetic energy

c. Neutron conserves its initial kinetic energy if the target nucleus is large

d. Target nucleus gains the amount of kinetic energy that the neutron loses

Category C: Facility and Radiation Monitoring Systems

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 parameters is MOST significant in determining the differential rod worth of a control rod?

a. Rod speed

b. Reactor power

c. Flux shape

d. Fuel temperature

QUESTION A.09 [1.0 point]
Which ONE of the following best defines the reactor excess reactivity?

a. Measure of the additional fuel loaded to overcome fission product poisoning

b. Measure of remaining control rod worth when the reactor is exactly critical

c. Measure of remaining control rod worth when the reactor is sub-critical

d. Combined control rod negative reactivity worth required to keep the reactor shutdown

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

Category C: Facility and Radiation Monitoring Systems

QUESTION A.11 [1.0 point]
Given a source strength of 150 neutrons per second (N/sec) and a multiplication factor of 0.85, which ONE of the following is the expected stable neutron count rate?

a. 500 N/sec

b. 750 N/sec

c. 1000 N/sec

d. 1250 N/sec

QUESTION A.12 [1.0 point]
Which ONE of the following is the definition of the effective neutron multiplication factor (k-eff)?

a. Absorption / (Production + Leakage)

b. (Production + Leakage) / Absorption

c. Production / (Absorption + Leakage)

d. (Absorption + Leakage) / Production

QUESTION A.13 [1.0 point]
What is the average number of neutrons produced from every fission of Uranium-235 with thermal neutrons?

a. 2.42 neutrons

b. 2.66 neutrons

c. 2.81 neutrons

d. 2.93 neutrons

QUESTION A.14 [1.0 point]
Which ONE of the following conditions would INCREASE the shutdown margin of a reactor?

a. Depletion of Uranium Fuel

b. Depletion of a burnable poison

c. Inserting an experiment adding positive reactivity

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

Category C: Facility and Radiation Monitoring Systems

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 statements best describes the effects of an increase in moderator temperature on neutron multiplication?

a. Reactor period doubles

b. An increase in the moderator temperature has negligible effect on neutron multiplication

c. An immediate decrease in the prompt neutron fraction due to leakage, absorption and reduction in the fission rate

d. Mean free path between scattering collisions increases causing the average neutron to travel further and rod worth increases

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

Category C: Facility and Radiation Monitoring Systems

QUESTION A.19 [1.0 point]
Which ONE of the following is defined as the balance between production of neutrons and their absorption in the core for which core leakage can be neglected?

a. Utilization Factor

b. Reproduction Factor

c. Infinite Multiplication Factor

d. Effective Multiplication Factor

QUESTION A.20 [1.0 point]
Delayed neutrons contribute more to reactor stability than prompt neutrons because they ________ the average neutron generation time and are born at a ________ kinetic energy.

a. Increase, lower

b. Decrease, lower

c. Increase, higher

d. Decrease, higher

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

Category C: Facility and Radiation Monitoring Systems

A.01
Answer: b
Reference: $P=P_oe^{t/T}$ $T = t/\ln(P/P_o)$; $T = 5 / \ln(100/50)$; T = 7.2 seconds

A.02
Answer: b
Reference: DOE Fundamentals Handbook, *Nuclear Physics and Reactor Theory*, Volume 2, NP-03, page 26

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: c
Reference: DOE Fundamentals Handbook, *Nuclear Physics and Reactor Theory*, Volume 2, NP-03, page 34

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

A.06
Answer: d
Reference: DOE Fundamentals Handbook, *Nuclear Physics and Reactor Theory*, Volume 1, NP-01, page 43

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

A.08
Answer: c
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 7, page 7-4

A.09
Answer: b
Reference: DOE Fundamentals Handbook, *Nuclear Physics and Reactor Theory*, Volume 2, NP-03, page 50

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: $CR=S/(1-k)$; $150/(1-0.85) = 1000$N/sec

Category C: Facility and Radiation Monitoring Systems

A.12
Answer: c
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory*, Volume 2, NP-03, page 8

A.13
Answer: a
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory*, Volume 2, NP-03, Table 1, page 7

A.14
Answer: a
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 6.2.3, page 6-4

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: d
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory*, Volume 2, NP-03, page 26

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: c
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory*, Volume 2, NP-03, page 9

A.20
Answer: a
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 3.2.4, page 3-12 and Section 3.4.4, page 3-33