June 21, 2016

Dr. Sean McDeavitt, Director
Texas A&M University
Texas A&M Engineering Experiment
Station
Nuclear Science Center
1095 Nuclear Science Road, M/S 3575
College Station, TX 77843-3575

SUBJECT: EXAMINATION REPORT NO. 50-059/OL-16-01, TEXAS A&M UNIVERSITY AGN-201

Dear Dr. McDeavitt:

During the week of May 9, 2016, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your Texas A&M University AGN-201M Reactor. 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 Mr. Jerry Newhouse, Reactor Manager, 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 Mr. Gary “Mike” Morlang, at (301) 415-4092 or via e-mail at Gary.Morlang@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. 50-059

Enclosures: 1. Examination Report No. 50-059/OL-16-01
2. Written examination

cc: w/o enclosures: See next page

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DISTRIBUTION w/ enclosures.:
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ADAMS Accession No.: ML16161A004

OFFICE	NRR/DPR/PROB/CE	NRR/DPR/PROB/OLA	NRR/DPR/PROB/BC
NAME	MMorlang	CRevelle	AMendiola
DATE	05/25/2016	06/07/2016	06/21/2016

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

REPORT NO.: 50-059/OL-16-01

FACILITY DOCKET NO.: 50-059

FACILITY LICENSE NO.: R-23

FACILITY: TAMU AGN Reactor

EXAMINATION DATE: May 10, 2016

SUBMITTED BY: __/RA/__ 05/25/2016
Mike Morlang, Chief Examiner Date

SUMMARY:

During the week of May 9, 2016 the NRC administered a licensing examination to one Limited Senior Reactor Operator (LSRO) candidate. The candidate passed all applicable portions of the examination.

REPORT DETAILS

1. Examiner: Mike Morlang, Chief Examiner, NRC

2. Results:

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

3. Exit Meeting:

Mike Morlang, Chief Examiner, NRC
Jerry Newhouse, Reactor Manager

cc:

Mayor, City of College Station
P.O. Box Drawer 9960
College Station, TX 77840-3575

Governor's Budget and
Planning Office
P.O. Box 13561
Austin, TX 78711

Radiation Program Officer
Bureau of Radiation Control
Dept. Of State Health Services
Division for Regulatory Services
1100 West 49th Street, MC 2828
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Office of Permitting, Remediation & Registration
Texas Commission on Environmental Quality
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Austin, TX 78711-3087

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

OPERATOR LICENSING EXAMINATION

UNITED STATES NUCLEAR REGULATORY COMMISSION

TEXAS A&M UNIVERSITY AGN-201M

Week of May 9, 2016

Enclosure 2

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

FACILITY: Texas A&M University AGN-201M Reactor

REACTOR TYPE: AGN-201M

DATE ADMINISTERED: 5/10/2016

CANDIDATE: ________Jeremy Osborn______________

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the answer sheet provided. Attach the answer sheets to the examination. Points for each question are indicated in brackets for each question. A 70% in each section is required to pass the examination. Examinations will be picked up three (3) hours after the examination starts.

Category Value	% of Total	% of Candidates Score	Category Value	Category
22.00	100			Reactor Theory, Thermodynamics and Facility Operating Characteristics, Normal and Emergency Operating Procedures, Facility and Radiation Monitoring Systems
22.00	100			TOTALS

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

____
Candidate's Signature

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.

13. When you have completed and turned in you examination, leave the examination area. If you are observed in this area while the examination is still in progress, your license may be denied or revoked.

EQUATION SHEET

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1 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

Limited Senior Reactor Operator (Fuel Handling Only)

01	a b c d ___	12	a b c d ___
02	a b c d ___	13	a b c d ___
03	a b c d ___	14	a b c d ___
04	a b c d ___	15	a b c d ___
05	a b c d ___	16	a b c d ___
06	a b c d ___	17	a b c d ___
07	a b c d ___	18	a b c d ___
08	a b c d ___	19	a b c d ___
09	a b c d ___	20	a b c d ___
10	a b c d ___	21	a b c d ___
11	a b c d ___	22	a b c d ___

CANDIDATE'S SIGNATURE___________________

Question 001 [1.0 point]

Which ONE of the following describes the difference between a moderator and reflector?

a. A reflector increases the neutron production factor and a moderator increases the fast fission factor.

b. A reflector decreases the thermal utilization factor and a moderator increases the fast fission factor.

c. A reflector decreases the neutron production factor and a moderator decreases the fast non-leakage factor.

d. A reflector increases the fast non-leakage factor and a moderator increases the thermal utilization factor.

Question 002 [1.0 point]

The delayed neutron fraction changes over core life primarily due to the:

a. buildup of Pu-241 which increases the delayed neutron fraction.
b. buildup of Pu-239 which decreases the delayed neutron fraction.
c. depletion of U-235 which decreases the delayed neutron fraction.
d. depletion of U-238 which increases the delayed neutron fraction.

Question 003 [1.0 point]

Select the answer that describes the inherent **safety feature** provided by the temperature coefficient of reactivity.

a. Its negative value causes reactivity to increase as moderator temperature increases.
b. Its negative value causes reactivity to decrease as moderator temperature increases.
c. Its positive value causes reactivity to increase as moderator temperature increases.
d. Its positive value causes reactivity to decrease as moderator temperature increases.

Question 004 [1.0 point]

Which one of the following is the correct reason that delayed neutrons allow human control of the reactor?

a. Fewer prompt neutrons are produced than delayed neutrons.
b. Delayed neutrons increase the mean neutron lifetime.
c. Delayed neutrons take longer to thermalize than prompt neutrons.
d. Delayed neutrons are born at higher energies than prompt neutrons.

Question 005 [1.0 point]

Which ONE of the following is the type of neutron source that is used at the Texas A&M University AGN-201?

a. Radium - Beryllium
b. Plutonium - Beryllium
c. Americium - Plutonium
d. Neptunium – Beryllium

Question 006 [1.0 point]

Excess reactivity is the amount of reactivity:

a. associated with experiments.
b. needed to achieve prompt criticality.
c. available above that which is required to keep the reactor critical.
d. available above that which is required to make the reactor subcritical.

Question 007 [1.0 point]

In the AGN - 201, the largest thermal neutron microscopic cross section is:

a. Xenon-135 capture.
b. Uranium-235 fission.
c. Uranium-238 fission.
d. Plutonium-240 absorption.

Question 008 [1.0 point]

Inelastic scattering is the process whereby a neutron collides with a nucleus and:

a. recoils with the same kinetic energy it had prior to the collision.
b. recoils with a lower kinetic energy, with the nucleus emitting a gamma ray.
c. is absorbed by the nucleus, with the nucleus emitting a beta ray.
d. recoils with a higher kinetic energy, with the nucleus emitting a gamma ray.

Question 009 [1.0 point]

The AGN-201 is designed to produce a fission rate within the thermal fuse that is approximately twice the average of the core. Which ONE of the following describes how this higher reaction rate is accomplished?

a. The non-uniform fuel loading in the upper fuel disc increases the thermal flux in fuse area.

b. The polystyrene media used in the thermal fuse is a better moderator, raising the thermal flux in the fuse area.

c. The fuel density used in the thermal fuse is twice that of the balance of the core resulting in a higher fission rate in the fuse area.

d. The fuel enrichment used in the thermal fuse is twice that of the balance of the core resulting in a higher fission rate in the fuse area.

Question 010 [1.0 point]

Of the approximately 200 MeV of energy released per fission event, the largest amount appears in the form of:

a. Alpha radiation
b. Gamma radiation
c. Prompt and delayed neutrons
d. Kinetic energy of the fission fragments

Question 011 [1 point]

Temporary procedures which do NOT change the intent of the original procedure or involve an un-reviewed safety question may be approved as a MINIMUM by the:

a. Reactor Operator.

b. Reactor Supervisor.

c. Reactor Safety Committee.

d. Dean of the College of Engineering.

.

Question 012 [1 point]

The Technical Specification basis for the MAXIMUM core temperature limit is to prevent:

a. breakdown of the graphite reflector.

b. instrument inaccuracies.

c. release of fission products.

d. boiling of the shield water.

.

Question 013 [1 point]

According to Technical Specifications the reactor is considered Shutdown when:

a. the reactor is subcritical.

b. the reactor console key switch is in the "OFF" position.

c. no experiments worth more than 25¢ are being moved or serviced

d. all safety and control rods are withdrawn and the key is removed from the console with the key switch in "OFF

Question 014 [1 point]

Which ONE of the following would satisfy the MINIMUM Technical Specification staffing requirements whenever the reactor is NOT Shutdown?

a. One authorized operator at the reactor console, a licensed RO in the reactor room.

b. One licensed RO in the reactor control room and an authorized operator in the reactor room.

c. One authorized operator at the reactor console, a licensed RO in the reactor control room and a licensed SRO on call.

d. One licensed RO in the control room, a certified observer in the reactor control room and a licensed SRO on call one half hour away.

;

Question 015 [1 point]

What is the exposure rate at 1 ft from 2-curie Co-60 source? Co-60 emits two gamma photons per decay with energies of 1.17 MeV and 1.33 MeV.

a. 3 R/hr

b. 5 R/hr

c. 6 R/hr

d. 30 R/hr

Question 016 [1 point]

An area in which radiation levels could result in an individual receiving a dose equivalent of 120 mRem/hr at 30 cm is defined as:

a. Radiation area

b. Unrestricted Area

c. High Radiation Area

d. Very High Radiation Area

Question 017 [1 point]

Which ONE of the following is the definition of site boundary for the TAMU AGN-201M reactor facility?

a. Reactor room (Room 61B) only

b. Reactor room and Accelerator room

c. Entire Zachary Engineering building

d. Nuclear Engineer laboratory areas 60/61 and 133/134/135

Question 018 [1 point]

The MAIN purpose of the thermal fuse is to:

a. measure the temperature of fuel core

b. measure any gases released from the fuel core

c. separate the reactor core to prevent exceeding the Safety Limit (SL)

d. send a scram signal to the Nuclear Safety # 2 if Limiting Safety System Setting (LSSS) is exceed

Question 019 [1 point]

The shield tank is designed to provide shielding from:

a. the glory hole area.

b. high energy β radiation.

c. high energy γ radiation.

d. fast neutron radiation.

Question 020 [1 point]

The shield tank water temperature interlock prevents reactor operation:

a. during periods of high thermal stress.

b. in the event of a high temperature condition.

c. during a condition that will produce excess radiation levels.

d. from a reactivity addition due to a temperature decrease.

Question 021 [1 point]

The shield tank water level trip will occur if water level drops below:

a. 8 inches

b. 9.5 inches

c. 12 inches

d. 20 inches

Question 022 [1 point]

The reactor Access Ports pass through the steel tank:

a. up to the reflector.

b. then the lead shield, up to the reflector.

c. then the lead shield, the graphite reflector and then back out again.

d. then the lead shield, graphite reflector, and the core and then back out again.

END OF WRITTEN EXAMINATION

Answer: 001 d.
Reference: Glasstone & Sesonke, Nuclear Reactor Engineering, Chapter 1, Section 1.51 & 1.52

Answer: 002 b.
Reference: Glasstone & Sesonke, Nuclear Reactor Engineering, Chapter 5, Section 5.170, Chapter 2, Table 2.10.

Answer: 003 b.
Reference: Basic Reactor Theory

Answer: 004 b.
Reference: Standard NRC Question

Answer: 005 b.
Reference: Safety Analysis Report

Answer: 006 c.
Reference: Glasstone, Nuclear Reactor Engineering, Chapter 5, Section 5.172

Answer: 007 a.
Reference: Glasstone & Sesonke, Nuclear Reactor Engineering, Chapter 5, Section 5.62;

Answer: 008 b.
Reference: Lamarsh, Introduction to Nuclear Engineering, 3rd Edition, page 64.

Answer: 009 c.
Reference: Safety Analysis Report.

Answer: 010 d.
Reference: Lamarsh, Introduction to Nuclear Engineering, 3rd Edition, page 88.

Answer: 011 b.
Reference: Technical Specifications, 6.6

Answer: 012 c.
Reference Technical Specifications, 2.1

Answer: 013 d.
Reference: Technical Specification, 1.22

Answer: 014 d.
Reference: Technical Specifications, 6.1.11

Answer: 015 d
Reference: R/hr = 6CE = 6 x 2 x 1*(1.17+1.33) = 30 R/hr

Answer 016 c.
Reference 10 CFR 20

Answer: 017 d
Reference: Emergency Plan

Answer: 018 c.
Reference: TAMU AGN-201M Safety Analysis Report § 4.5.3

Answer: 019 d.
Reference: Technical Specifications 5.1.d.

Answer: 020 d.
Reference: Technical Specifications 3.2.

Answer: 021 b.
Reference: Technical Specifications 3.2.e.

Answer: 022 c.
Reference: TAMU AGN-201M Safety Analysis Report