March 7, 2001

Dr. Aris Chistou, Chairman
Department of Materials and Nuclear Engineering
University of Maryland
College Park, MD 20742

Dear Dr. Chistou:

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-166/OL-01-01

During the week of February 05, 2001, the NRC administered initial examinations to employees of your facility who had applied for a license to operate your University of Maryland Reactor. The examination was conducted in accordance with NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1. At the conclusion of the examination, the examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report.

In accordance with 10 CFR 2.790 of the Commission's regulations, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at (the Public Electronic Reading Room) http://www.nrc.gov/NRC/ADAMS/indesx.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 Patrick Isaac at (301)415-1019 or via Internet E-mail at pxi@nrc.gov.

Sincerely,

/RA/

Ledyard B. Marsh, Chief
Events Assessment, Generic Communications
  and Non-Power Reactors Branch
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No. 50-166

Enclosures: 1. Initial Examination Report No. 50-166/OL-01-01
2. Examination and answer key (RO)

cc w/encls:
Please see next page

cc:

Director, Dept. of Natural Resources
Power Plant Siting Program
Energy & Coastal Zone Administration
Tawes State Office Building
Annapolis, MD 21401

Mr. Roland Fletcher, Director
Center for Radiological Health
Maryland Department of Environment
201 West Preston Street
7th Floor Mail Room
Baltimore, MD 21201

Mr. Vincent G. Adams
Associate Director-Reactor Facility
Department of Materials and
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University of Maryland
College Park, MD 20742

Dr. Mohamad Al-Sheikhly, Director
Radiation Facilities
2309A Chemical and Nuclear
Engineering Building
The University of Maryland
College Park, MD 20742-2115

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DATE	03/ 05 /2001		02/ 27 /2001		03/ 07 /2001	

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

REPORT NO.: 50-166/OL-10-01

FACILITY DOCKET NO.: 50-166

FACILITY LICENSE NO.: R-28

FACILITY: University of Maryland

EXAMINATION DATES: February 05, 2001

EXAMINER: Patrick Isaac, Chief Examiner

SUBMITTED BY: */RA/* 02/16/2001
Patrick Isaac, Chief Examiner Date

SUMMARY:

During the week of February 05, 2001, NRC administered Operator Licensing Examinations to one Reactor Operator (RO) candidate. The candidate passed the examinations.

REPORT DETAILS

1. Examiner: Patrick Isaac, Chief Examiner

2. Results:

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

3. Exit Meeting:

Personnel attending: Mr. Mohamad Al-Sheikhley, Director
Mr. Patrick Isaac, Chief Examiner

There were no generic concerns raised by the chief examiner.

ENCLOSURE 1

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

FACILITY: University of Maryland

REACTOR TYPE: MUTR

DATE ADMINISTERED: 2001/02/05

REGION: I

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

ENCLOSURE 2

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.

001 a ___ b ___ c ___ d ___

002 a b c d ___

003 a b c d ___

004 a b c d ___

005 a b c d ___

006 a b c d ___

007 a b c d ___

008 a b c d ___

009 a b c d ___

010 a b c d ___

011 a b c d ___

012 a b c d ___

013 a b c d ___

014 a b c d ___

015 a b c d ___

016 a b c d ___

017 a b c d ___

018 a b c d ___

019 a b c d ___

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

B. NORMAL/EMERG PROCEDURES & RAD CON

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.

001 a b c d ___

002 a ___ b ___ c ___ d ___

003 a ___ b ___ c ___ d ___

004 a b c d ___

005 a b c d ___

006 a b c d ___

007 a b c d ___

008 a b c d ___

009 a b c d ___

010 a b c d ___

011 a b c d ___

012 a b c d ___

013 a b c d ___

014 a b c d ___

015 a b c d ___

016 a b c d ___

017 a b c d ___

018 a b c d ___

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

C. PLANT AND RAD 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.

001 a b c d ___

002 a b c d ___

003 a b c d ___

004 a b c d ___

005 a b c d ___

006 a b c d ___

007 a b c d ___

008 a b c d ___

009 a b c d ___

010 a b c d ___

011 a b c d ___

012 a b c d ___

013 a b c d ___

014 a b c d ___

015 a b c d ___

016 a b c d ___

017 a b c d ___

018 a b c d ___

019 a b c d ___

020 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 <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.

QUESTION A.1 [2.0 points, 0.5 each]
Match each term in column A with the correct definition in column B.

	Column A		Column B
a.	Prompt Neutron	1.	A neutron in equilibrium with its surroundings.
b.	Fast Neutron	2.	A neutron born directly from fission.
c.	Thermal Neutron	3.	A neutron born due to decay of a fission product.
d.	Delayed Neutron	4.	A neutron at an energy level greater than its surroundings.

QUESTION A.2 [1.0 point]
You enter the control room and note that all nuclear instrumentation show a steady neutron level, and no rods are in motion. Which ONE of the following conditions **CANNOT** be true?

a. The reactor is critical.

b. The reactor is subcritical.

c. The reactor is supercritical.

d. The neutron source has been removed from the core.

QUESTION A.3 [1.0 point]
Which ONE of the following describes the **MAJOR** contributor to the production and depletion of Xenon respectively in a **STEADY-STATE OPERATING** reactor?

	Production	Depletion
a.	Radioactive decay of Iodine	Radioactive Decay
b.	Radioactive decay of Iodine	Neutron Absorption
c.	Directly from fission	Radioactive Decay
d.	Directly from fission	Neutron Absorption

QUESTION A.4 [1.0 point]
Which factor of the Six Factor formula is most easily varied by the reactor operator?

a. Thermal Utilization Factor (f)

b. Reproduction Factor (η)

c. Fast Fission Factor (τ)

d. Fast Non-Leakage Factor (L_f)

QUESTION A.5 [1.0 point]
Which of the following does NOT affect the Effective Multiplication Factor (Keff)?

a. The moderator-to-fuel ratio.

b. The physical dimensions of the core.

c. The strength of installed neutron sources.

d. The current time in core life.

QUESTION A.6 [1.0 point]
You perform two initial startups a week apart. Each of the startups has the same starting conditions, (core burnup, pool and fuel temperature, and count rate are the same). The only difference between the two startups is that during the **SECOND** one you stop for 10 minutes to answer the phone. For the second startup compare the critical rod height and count rate to the first startup.

	Rod Height	Count Rate
a.	Higher	Same
b.	Lower	Same
c.	Same	Lower
d.	Same	Higher

QUESTION A.7 [1.0 point]
Several processes occur that may increase or decrease the available number of neutrons. SELECT from the following the six-factor formula term that describes an **INCREASE** in the number of neutrons during the cycle.

a. Thermal utilization factor (f).

b. Resonance escape probability (p).

c. Thermal non-leakage probability ($\mathcal{L}_{th}$).

d. Reproduction factor (η).

QUESTION A.8 [1.0 point]
Which ONE of the following atoms will cause a neutron to lose the most energy in an elastic collision?

a. Uranium^{238}

b. Carbon^{12}

c. Hydrogen^{2}

d. Hydrogen^{1}

QUESTION A.9 [1.0 point]
K_{eff} for the reactor is 0.98. If you place an experiment worth **+$1.00** into the core, what will the new K_{eff} be?

a. 0.982

b. 0.987

c. 1.013

d. 1.018

QUESTION A.10 [1.0 point]
About two minutes following a reactor scram, period has stabilized, and is decreasing at a CONSTANT rate. If reactor power is 10^{-5} % full power what will the power be in three minutes.

a. 5×10^{-6} % full power

b. 2×10^{-6} % full power

c. 10^{-6} % full power

d. 5×10^{-7} % full power

QUESTION A.11 [1.0 point]
Core excess reactivity changes with…

a. Fuel burnup

b. Control Rod Height

c. Neutron Level

d. Reactor Power Level

QUESTION A.12 [1.0 point]
INELASTIC SCATTERING is the process by which a neutron collides with a nucleus and …

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

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

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

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

QUESTION A.13 [1.0 point]
For most materials the neutron microscopic cross-section for absorption τ_a generally …

a. increases as neutron energy increases

b. decreases as neutron energy increases

c. increases as target nucleus mass increases

d. decreases as target nucleus mass increases

QUESTION A.14 [1.0 point]
Which one of the following is the definition of the FAST FISSION FACTOR?

a. The ratio of the number of neutrons produced by fast fission to the number produced by thermal fission

b. The ratio of the number of neutrons produced by thermal fission to the number produced by fast fission

c. The ratio of the number of neutrons produced by fast and thermal fission to the number produced by thermal fission

d. The ratio of the number of neutrons produced by fast fission to the number produced by fast and thermal fission

QUESTION A.15 [1.0 point]
WHICH ONE of the following is the **MAJOR** source of energy released during fission?

a. Kinetic energy of the fission neutrons.

b. Kinetic energy of the fission fragments.

c. Decay of the fission fragments.

d. Prompt gamma rays.

QUESTION A.16 [1.0 point]
As primary coolant temperature increases, rod worth:

a. increases due to higher reflector efficiency.

b. decreases due to higher neutron absorption in the moderator.

c. increases due to the increase in thermal diffusion length.

d. remains the same due to constant poison cross-section of the control rods.

QUESTION A.17 [1.0 point]
The term ***PROMPT JUMP*** refers to …

a. the instantaneous change in power due to withdrawal of a control rod.

b. a reactor which has attained criticality on prompt neutrons alone.

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

d. a negative reactivity insertion which is less than τ_{eff}.

QUESTION A.18 [1.0 point]
Which one of the following factors has the **LEAST** effect on K_{eff}?

a. Fuel burnup.

b. Increase in moderator temperature.

c. Increase in fuel temperature.

d. Xenon and samarium fission products.

QUESTION A.19 [1.0 point]
Which ONE of the following is the correct reason that delayed neutrons enhance control of the reactor?

a. There are more delayed neutrons than prompt neutrons.

b. Delayed neutrons increase the average neutron generation time.

c. Delayed neutrons are born at higher energies than prompt neutrons and therefore have a greater effect.

d. Delayed neutrons take longer to reach thermal equilibrium.

QUESTION B.1 [1.0 point]
Which ONE of the following statements define the MUTR Technical Specification term "Channel Test?"

a. The adjustment of a channel such that its output corresponds with acceptable accuracy to known values of the parameter which the channel measures

b. The qualitative verification of acceptable performance by observation of channel behavior

c. The introduction of a signal into a channel for verification of the operability of the channel

d. The combination of sensors, electronic circuits and output devices connected to measure and display the value of a parameter

QUESTION B.2 [2.0 points, 0.5 each]
Match the type of radiation in column A with its associated Quality Factor (10CFR20) from column B.

	Column A	Column B
a.	alpha	1
b.	beta	2
c.	gamma	5
d.	neutron (unknown energy)	10
		20

QUESTION B.3 [2.0 points, 0.5 each]
Match the radiation reading from column A with its corresponding radiation area classification (per 10 CFR 20) listed in column B.

	COLUMN A		COLUMN B
a.	10 mRem/hr	1.	Unrestricted Area
b.	150 mRem/hr	2.	Radiation Area
c.	10 Rem/hr	3.	High Radiation Area
d.	550 Rem/hr	4.	Very High Radiation Area

QUESTION B.4 [1.0 point]
10CFR50.54(x) states: *"A licensee may take reasonable action that departs from a license condition or a technical specification (contained in a license issued under this part) in an emergency when this action is immediately needed to protect the public health and safety and no action consistent with license conditions and technical specifications that can provide adequate or equivalent protection is immediately apparent.* 10CFR50.54(y) states that the minimum level of management which may authorize this action is …

a. any Reactor Operator licensed at facility

b. any Senior Reactor Operator licensed at facility

c. Facility Manager (or equivalent at facility).

d. NRC Project Manager

QUESTION B.5 [1.0 point]
Per Technical Specifications, for a period of time not to exceed _______, the Exhaust Radiation Monitor may be taken out of service for maintenance if it is replaced with a portable gamma sensitive instrument observable by the reactor operator.

a. 8 hours

b. 24 hours

c. 48 hours

d. 7 days

QUESTION B.6 [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 does 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.7 [1.0 point]
<u>Two</u> inches of shielding reduce the gamma exposure in a beam of radiation from 400 mR/hr to 200 mR/hr. If you add an **<u>additional four</u>** inches of shielding what will be the new radiation level? (Assume all reading are the same distance from the source.)

a. 25 mR/hr

b. 50 mR/hr

c. 75 mr/hr

d. 100 mr/hr

QUESTION B.8 [1.0 point]
Your Reactor Operator license expires after _____ years.

a. 2

b. 4

c. 6

d. 8

QUESTION B.9 [1.0 point]
Which one of the following is the basis for maintaining the reactivity coefficients for the reactor within Technical Specification Safety Limits?

a. To assure that the reactor can be shutdown from any operating condition.

b. To ensure that the net reactivity feedback is negative.

c. To ensure that the operable core is similar to the analyzed core in the FSAR.

d. To provide protection against the reactor operating outside the safety limits.

QUESTION B.10 [1.0 point]
In accordance with Technical Specifications, which One of the following statements is TRUE?

a. Each fuel experiment shall be controlled such that the total inventory of Iodine isotopes 131 thru 135 in the experiment is no greater than 1.5 curies.

b. The reactivity worth of any individual in-core experiment shall not exceed $3.00.

c. Experiments containing materials corrosive to Rx components shall not be irradiated in the Rx.

d. Explosive experiments shall be doubly encapsulated

QUESTION B.11 [1.0 point]
Which one of the following is a Reportable Occurrence per Technical Specifications?

a. The safety-system setting (LSSS) for reactor fuel temperature is set at 365°C.

b. The interlock for the Beam Port is disabled by the Senior Reactor Operator while the reactor is at power.

c. One of the Bridge Radiation Monitor is inoperable while the reactor is a power.

d. An unexpected reactivity change of $0.75

QUESTION B.12 [1.0 point]
Which ONE of the following events is designated as the Maximum Hypothetical Accident (MHA) for the University of Maryland reactor?

a. Fuel handling mishap resulting in fuel element failure outside the reactor.

b. Malfunction of an experiment or an experimental apparatus.

c. Loss of Coolant Accident.

d. Control Rod ejection accident.

QUESTION B.13 [1.0 point]
The total reactivity worth of in-core experiments is 1.50 dollars.
What is the maximum excess reactivity allowed relative to cold critical conditions?

a. 3.50 dollars

b. 2.00 dollars

c. 1.50 dollars

d. 0.50 dollars

QUESTION B.14 [1.0 point]
Which of the following individuals assumes the role of Acting Emergency Director during an emergency?

a. Reactor Director

b. Director of the Nuclear Engineering Program

c. Senior Reactor Operator

d. Director of the Environmental Safety Department

QUESTION B.15 [1.0 point]
A small radioactive source is to be stored in the reactor bay with no shielding. The source reads 2 R/hr at 1 foot. A Radiation Area barrier would have to be erected approximately ___ from the source.

a. 400 feet

b. 40 feet

c. 20 feet

d. 10 feet

QUESTION B.16 [1.0 point]
Which one of the following does NOT require NRC approval for changes?

a. License

b. Requalification plan

c. Emergency Implementation Procedures

d. Emergency Plan

QUESTION B.17 [1.0 point]
Which one of the following evolutions could be performed without being supervised by a senior reactor operator?

a. Resumption of operation following an unscheduled shutdown due to interruption of electrical power to the plant.

b. Resumption of operation following an unscheduled shutdown due to incorrect action by a student.

c. Experiments being manipulated in the core that have an estimated reactivity worth of 0.90 dollars.

d. Removal of control rods.

QUESTION B.18 [1.0 point]
The reactor is operating with the following power indications:

- Safety Channel I = 75 %
- Safety Channel II = 80 %
- Linear Power Chart Recorder (Red Pen) = 63% with range switch on 30KW
- Log-Power Channel = 83 %

Which one of the indications should be used as true power level?

a. Safety Channel I

b. Safety Channel II

c. Linear Power Chart Recorder

d. Log-Power Channel

QUESTION C.1 [1.0 point]
The regulating rod is operating in automatic. Select the response if the operator attempts to withdraw Shim I while the Regulating Rod is being withdrawn by the servoamplifier.

a. The Regulating Rod will withdraw but Shim I will be interlocked to prevent movement.

b. The Shim I rod will withdraw but the Regulating Rod will be shifted to manual mode.

c. The Shim I rod will withdraw but the Regulating Rod will be interlocked to prevent further withdrawal.

d. Both rods will withdraw simultaneously.

QUESTION C.2 [1.0 point]
The ion chamber power indications are correlated to the heat balance calculated thermal power by:

a. adjusting the detector high voltage.

b. adjusting the circuit comparator voltage.

c. moving the graphite reflectors to change the neutron flux near the detectors.

d. physically adjusting the height of the detectors in the support assembly.

QUESTION C.3 [1.0 point]
In the automatic power regulation mode, reactor response to a large increase in demand is limited by:

a. a period limiter in the input to the rate error pre-amplifier.

b. the maximum voltage on the demand potentiometer.

c. the speed of the rod drive motor.

d. the decay constant of the longest lived delayed neutron precursor group.

QUESTION C.4 [1.0 point]
What is achieved by use of the diffuser above the core during operation?

a. Better distribution of heat throughout the pool.

b. Better heat transfer across all fuel elements in the core.

c. Reduced dose rate at the pool surface.

d. Consistent water chemistry in the core.

QUESTION C.5 [1.0 point]
When is the replaceable demineralizer cartridge in the primary system required to be replaced?

a. An annunciator light on the console is illuminated during primary system operation.

b. The differential pressure across the orifice indicates a flow rate of less than 10 gpm.

c. The differential pressure across the filter exceeds 5 psid.

d. Conductivity on the outlet exceeds 1 x 10 -6 mhos/cm.

QUESTION C.6 [1.0 point]
A control rod interlock is applied when the trip test switch for Safety Channel I is placed on.
This control rod interlock is required because the:

a. period scram signal is bypassed.

b. minimum source count rate interlock can be bypassed.

c. gain of the instrument is affected by operation of the trip test knob.

d. the input signal to the automatic-servo is affected by the trip test knob.

QUESTION C.7 [1.0 point]
What feature of the area radiation monitors allows the operator to check that the channels are functional when the reactor has been shutdown for an extended period and the background radiation levels are very low?

a. The self check circuitry in the instrument channel illuminates the yellow light if readings are below the range of the indicator.

b. The self check circuit maintains an artificial input signal at a level just above the instrument minimum sensitivity so that it is never below scale.

c. A low level source is installed in the detector to keep the instrument on scale.

d. A portable Co-60 source is provided for positioning near the detector and verifying, or adjusting, the channel linearization to within 10% of known radiation levels.

QUESTION C.8 [1.0 point]
In addition to the control room, where can the exhaust fan radiation level be read?

a. Left hand side of the entrance to the west balcony laboratories from reactor bridge.

b. Opposite the door into the west balcony, from the outside hallway.

c. Opposite the door into the reception room, from the outside hallway.

d. In the Nuclear Engineering Program office.

QUESTION C.9 [1.0 point]

The instrumented fuel rod will measure core temperature that is:

a. equal to the average of all fuel rod temperatures.

b. the highest fuel rod temperature during normal conditions.

c. at least 50% of the temperature of the hottest fuel rod during accident conditions.

d. the highest fuel rod temperature during accident conditions.

QUESTION C.10 [1.0 point]
If an operator were to continuously withdraw a shim rod from the core approximately how long would it take for the rod to go from the bottom to the top of the core?

a. 30 seconds.

b. 45 seconds.

c. 75 seconds.

d. 120 seconds.

QUESTION C.11 [1.0 point]
Operation of which of the following Calibrate switches will result in a scram?

a. Fuel temperature

b. Wide range log power channel

c. Multirange linear channel

d. Safety Channel I

QUESTION C.12 [1.0 point]
Select the location where the ventilation system can be secured.

a. Entrance to the west balcony from the hallway.

b. Inside the water room.

c. Pneumatic transfer system laboratory.

d. West wall of the ground level.

QUESTION C.13 [1.0 point]
During pre-startup checkout, the reactor operator lines up the makeup water system to add water to the pool and neglects to check the level later. Overflow from the pool will go:

a. into the holdup tank in the water handling room sump through the pool overflow piping.

b. directly into the water handling room sump through the pool overflow piping.

c. directly into the water handling room sump through the floor drain gratings around the base of the reactor.

d. directly into the sewer system through the floor drain gratings around the base of the reactor.

QUESTION C.14 [1.0 point]
The thermocouples in the instrumented fuel bundle measure temperature at the:

a. interior surface of the cladding

b. center of the zirconium rod

c. outer surface of the fuel

d. interior of the fuel

QUESTION C.15 [1.0 point]
The output of the Uncompensated Ion Chamber provides the signal:

a. for the period circuit

b. for Safety Channel #1

c. to the % Demand Controller

d. for Safety Channel #2

QUESTION C.16 [1.0 point]
Which ONE of the following pairs of elements would be expected to undergo ion exchange in the primary coolant demineralizer?

a. Xenon and Iodine

b. Boron and Carbon

c. Nitrogen and Argon

d. Calcium and Magnesium

QUESTION C.17 [1.0 point]
Which ONE of the following describes the action of the rod control system to drive the magnet draw

tube down after a dropped rod?

c. Deenergizing the rod magnet initiates the down motion of the draw tube.

b. MAGNET DOWN limit switch OFF initiates the down motion of the draw tube.

c. ROD DOWN limit switch ON initiates the down motion of the draw tube.

d. MAGNET DOWN limit switch OFF and ROD DOWN limit switch ON initiates the down motion of the draw tube.

QUESTION C.18 [1.0 point]
Switching the REACTOR POWER RANGE switch to the ZERO position while in the automatic mode will result in which ONE of the following actions?

a. regulating rod insertion

b. regulating rod withdrawal

c. reactor scram

d. scram of the regulating rod only

QUESTION C.19 [1.0 point]
The poison section of the MUTR control rods consist of:

a. Boron-Aluminum alloy (Boral)

b. powdered borated graphite

c. Boron Carbide mixed with Zirconium Hydride

d. compacted and sintered Boron Carbide

QUESTION C.20 [1.0 point]
When a compensated ion chamber is used for neutron detection, how is the gamma flux accounted for?

a. Pulse height discrimination is used to cancel the gamma flux.

b. The gamma flux is proportional to neutron flux and is counted with the neutrons.

c. The gamma flux is canceled by creating an equal and opposite gamma current.

d. The gamma flux passes through the detector with no interaction because of detector design.

A.1 a, 2; b, 4; c, 1; d, 3
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, § 2.5, p. 2-36.

A.2 c
REF: Standard NRC question

A.3 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1988, §§ 8.1 —8.4, pp. 8-3 — 8-14.

A.4 a
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 3.2, pp. 3-13 — 3-18.

A.5 c
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 3.3.4, p. 3-21.

A.6 d
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 5.7, pp. 5-28 — 5-38.

A.7 d
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 3.2, pp. 3-13 — 3-18.

A.8 d
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, § 2.5.3 p. 2-45.

A.9 b
REF: SDM = $(1-k_{eff})/k_{eff}$ = (1-0.98)/0.98 = 0.02/0.99 = 0.02041 or 0.02041/.0075 = $2.72, or a reactivity worth (τ) of -$2.72. Adding +$1.00 reactivity will result in a SDM of $2.72 - $1.00 = $1.72, or .0129081 τ K/K
K_{eff} = 1/(1+SDM) = 1/(1 + 0.0129081) = 0.987

A.10 c
REF: $P = P_0\, e^{-T/\tau} = 10^{-5} \times e^{(-180sec/80sec)} = 10^{-5} \times e^{-2.25} = 0.1054 \times 10^{-5} = 1.054 \times 10^{-6}$

A.11 a
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 6.2 p. 6-1 — 6-4.

A.12 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 2.4.5 p. 2-28.

A.13 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 2.5.1 p. 2-36.

A.14 c
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 3.3.1 p. 3-16.

A.15 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 3.2.1, p. 3-4.

A.16 c
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 3.3.2, p. 3-18

A.17 a
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, § 4.7, p. 4-21

A.18 c
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 3.3.2, p. 3-18.

A.19 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 3.2.4, p. 3-12.

B.1 c
REF: Technical Specifications Section 1.0, Page 1

B.2 a, 20; b, 1; c, 1; d, 10
REF: 10CFR20.100x

B.3 a, 2; b, 3; c, 3; d, 4
REF: 10 CFR 20.1003, Definitions

B.4 b
REF: 10CFR50.54(y)

B.5 c
REF: Technical Specifications 3.6

B.6 a
REF: 10 CFR 20.1003 *Defintitions*

B.7 b
REF: Nuclear Power Plant Health Physics and Radiation Protection, Research Reactor Version©1988, § 9.2.3 "Half-Thickness and Tenth-Thickness"

B.8 c
REF: 10CFR55.55(a)

B.9 b
REF: Tech. Specs 3.2

B.10 d
REF: Tech Specs 3.5

B.11 a
REF: Technical Specifications 1.27, "Definitions"
Technical Specifications 3.0

B.12 a
REF: FNR Safety Analysis, Section 13.0

B.13 a
REF: Technical Specification 3.1

B.14 c
REF: EP 406, Responsibilities and Instructions of the MUTR Emergency Organization, Section 4.0

B.15 c
REF: $\frac{DR_1}{X_2^2} = \frac{DR_2}{X_1^2} X_2^2 = \frac{DR_1}{DR_2} X$ $X_2^2 = \frac{2000}{5} \times 1^2 = 400 ft^2 X_2 = 20 f$

B.16 c
REF: 10 CFR 50.54 (q); 10 CFR 50.59; 10 CFR 55.59

B.17 a
REF: Technical Specification 6.1.3

B.18 b
REF: OP-104, Reactor Operations, Step 3.6

C.1 d
REF FSAR Section 6.1.3.

C.2 d
REF ENNU 320, Vol. 2, Sect. 7.3; SP-202, Step 6.2

C.3 a
REF FSAR section 6.3.2.

C.4 c
REF FSAR section 8.3

C.5 a
REF FSAR section 4.1.

C.6 b
REF ENNU 320, Volume 2, section 6.1.2.1.

C.7 c
REF ENNU 320, Vol. 2, Sect. 6.3; SP-205, Sect. 5.0

C.8 a
REF ENNU 320, Volume 2, section 6.3

C.9 c
REF ENNU 320, Volume 2, section 6.1.3.2.

C.10 b
REF ENNU 320, Volume II, Appendix A.

C.11 d
REF ENNU 320, Volume II, section 6.1.4.

C.12 d
REF ENNU 320, Volume II, Figure 2.5.

C.13 a
REF ENNU 320, Vol.2, Sect. 8.1

C.14 d
REF ENNU 320 MANUAL VOL. 2, Page 3-1

C.15 d
REF: ENNU 320 MANUAL VOL. 2, Page 6-2

C.16 d
REF ENNU 320 MANUAL VOL. 2, Page 4-2

C.17 d
REF ENNU 320 MANUAL VOL. 2, Page 6-7

C.18 b
REF OP 104

C.19 b
REF FSAR Section 3.2.1

C.20 c
REF ENNU 320 Vol. 2 Section 3.3.5.3