February 23, 2001

Dr. David Wehe, Director
Phoenix Memorial Laboratory
Ford Nuclear Reactor
University of Michigan
2301 Bonisteel Blvd.
Ann Arbor, Michigan 48109-2100

Dear Dr. Wehe:

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-002/OL-10-01

During the week of January 22, 2001, the NRC administered initial examinations to employees of your facility who had applied for a license to operate your University of Michigan 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. 50-002

Enclosures: 1. Initial Examination Report No. 50-002/OL-10-01
2. Examination and answer key (RO)

cc w/encls:
Please see next page

cc:

Special Assistant to the Governor
Office of the Governor
Room 1 - State Capitol
Lansing, MI 48909

Mr. Christopher Becker
Phoenix Memorial Laboratory
University of Michigan - North Campus
Ann Arbor, MI 48109

Michigan Department of Environmental Quality
Drinking Water & Radiological
Protection Division
P.O. Box 30630
Lansing, MI 48909-8130

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

REPORT NO.: 50-002/OL-10-01

FACILITY DOCKET NO.: 50-002

FACILITY LICENSE NO.: R-28

FACILITY: University of Michigan

EXAMINATION DATES: January 22-23, 2001

EXAMINER: Patrick Isaac, Chief Examiner

SUBMITTED BY: ***/RA/*** 01/29/2001
Patrick Isaac, Chief Examiner Date

SUMMARY:

During the week of January 22, 2001, NRC administered Operator Licensing Examinations to two Reactor Operator (RO) candidates. Both candidates passed the examinations.

REPORT DETAILS

1. Examiner: Patrick Isaac, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	**2/0**	**N/A**	**2/0**
Operating Tests	**2/0**	**N/A**	**2/0**
Overall	**2/0**	**N/A**	**2/0**

3. Exit Meeting:

Personnel attending: Mr. Christopher Walter Becker, Manager of Operations
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 Michigan

REACTOR TYPE: POOL

DATE ADMINISTERED: 2001/01/22

REGION: III

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. RX THEORY, THERMO & FAC OP CHARS

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 *****)

ANSWER SHEET

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 *****)

ANSWER SHEET

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 represents the normal facility weekly whole body and extremity exposure limits?

a. 10 mrem and 10 mrem

b. 10 mrem and 100 mrem

c. 100 mrem and 100 mrem

d. 100 mrem and 1000 mrem

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 regarding the NW Column Beamport Floor radiation monitor: "If placed out of service for a period of more than (_______), the reactor shall be shutdown or the monitor shall be replaced by a locally alarming unit of similar range.

a. 8 hours

b. 24 hours

c. 7 days

d. 30 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 pool level within Technical Specification Safety Limits?

a. To “Scrub out” radionuclides that are released from the reactor core.

b. To provide adequate reactor core moderation.

c. To maintain the dose rate in the pool as low as reasonably achievable.

d. To maintain the hot channel in the core below the boiling point of the coolant.

QUESTION B.10 [1.0 point]
Which one of the following does not require specific permission from the console operator during fuel movements?

a. Unlock the fuel tool.

b. Unlatch the fuel tool from elements inserted into the core.

c. Remove the fuel elements from the core.

d. Insert fuel elements into the core.

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

a. Operating in the Forced Convection Mode with a pool conductivity of 50 micromhos/cm.

b. An unexpected actuation of the Emergency Pool Fill System.

c. The high thermal reactor power safety system trip setting was found to be 100 kw while operating in the Natural Convention Flow Mode.

d. An unexpected reactivity change of 0.002 delta k/k.

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

a. Loss of reactor pool water

b. Failure of an experiment

c. Sustained loss of electrical power

d. Shim rod ejection

QUESTION B.13 [1.0 point]
In accordance with EP-101, “Reactor Building Emergency”, which one of the following conditions warrants evacuating the reactor building?

a. Unauthorized intrusion (Duress).

b. A minor fire is in progress. However, it is being handled by operations personnel.

c. Washtenaw County has been placed under a tornado watch.

d. One area radiation monitor unexpectedly alarms due to high airborne radioactivity in the atmosphere.

QUESTION B.14 [1.0 point]
Which ONE of the following would result in the calorimeter power level being LESS than true power during the performance of OP-106, Power Level Determination”?

a. Reactor power is 0.95 MW during the determination.

b. Actual pool level was higher than the level used in the calorimeter.

c. The reactor was shutdown 48 hours prior to the determination.

d. Temperature data was taken every five (5) minutes.

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]
How would an operator in the control room first become aware of a broken air supply line to the reactor building?

a. Reactor scram

b. Reactor auto rundown

c. Ventilation alert beacon

d. Building alarm

QUESTION B.18 [1.0 point]
During reactor operation the telephone system is declared inoperable. Which one of the following is the initial action of the reactor operator?

a. Contact the telephone company and request repair.

b. Notify the On-Call Supervisor.

c. Notify the Reactor Laboratory Manager.

d. Shutdown the reactor.

QUESTION C.1 [1.0 point]
Which one of the following correctly describes the LOG N PERIOD Channel?

a. During the initial phases of startup, the actual power level is generally above the indicated power due to under compensation of the LOG N channel.

b. A LOG N period of 30 seconds will inhibit control rod withdrawal.

c. A LOG N period of 11 seconds will cause an automatic rundown of the shim safety rods.

d. During the initial phases of startup, the actual power level is generally below the indicated power due to over compensation of the LOG N channel

QUESTION C.2 [1.0 point]
Which one of the following is NOT a reason high purity is maintained in the moderator coolant of the FNR?

a. Minimize corrosion of fuel clad and structural materials.

b. Reduce radioactivity in the pool water thereby reducing exposure at the pool surface and in the basement.

c. Decrease release of radioactivity to the environment when pool water evaporates.

d. Improve visibility thereby making underwater manipulations easier.

QUESTION C.3 [1.0 point]
Match the following parameters to their nominal or typical values.

R2	Primary pump 2; Core Exit	a.	105; 120; 120; 75; 90
R3	Primary Heat Exchanger Outlet	b.	120; 105; 105; 75; 90
R5	Pool at 20 ft.	c.	105; 120; 120; 90; 75
R6	Secondary Heat Exchanger Inlet	d.	120; 105; 105; 90; 75
R7	Secondary Heat Exchanger Outlet		

QUESTION C.4 [1.0 point]
There are four applied voltage regions of operation for a gas filled detector. In what region do the fission chambers operate?

a. Recombination.

b. Ion Chamber.

c. Proportional.

d. Geiger-Mueller.

QUESTION C.5 [1.0 point]
The reactor is brought to full steady state power, but someone has either forgotten to turn on the secondary coolant pump or to valve in the heat exchanger properly. What would be the reactor response eventually be?

a. Reactor scram at 2.4 MW

b. Auto rundown at 129°F

c. Auto rundown at 116°F

d. Reactor scram at 100 KW

QUESTION C.6 [1.0 point]
Which one of the following auto rundown or scram functions can be defeated?

a. 10 second period.

b. Bridge not clamped.

c. Beamport door open.

d. >1 mr/hr building air.

QUESTION C.7 [1.0 point]
Which one of the following is NOT needed to establish auto control?

a. Shim range

b. τ > 30 seconds

c. No linear level range change

d. Indication > setpoint

QUESTION C.8 [1.0 point]
What is the emergency pool fill water source and its normal flow rate?

a. City water - 4000 gpm

b. City water - 400 gpm

c. Retention tanks - 400 gpm

d. Retention tanks - 4000 gpm

QUESTION C.9 [1.0 point]
Which one of the following will result from a loss of the PML Heating and Ventilation Air Compressor?

a. PML heaters fail in the OFF condition.

b. PML exhaust dampers fail CLOSED.

c. Stack damper fails OPEN.

d. Hot DI isolation valves fail CLOSED.

QUESTION C.10 [1.0 point]
The reactor is operating at 2 MW, and normal makeup through the Cold Demineralizer has been lost. Which one of the following is a possible reason for this loss of flow?

a. Demineralizer outlet conductivity is 1.5 micromhos and the isolation valve has closed automatically.

b. Pool conductivity is 5.0 micromhos and the demineralizer isolation valve has closed automatically.

c. The demineralizer outlet pump tripped and the isolation valve has closed due to low system pressure.

d. The air to the demineralizer outlet isolation valve has been lost and the valve closed.

QUESTION C.11 [1.0 point]
Assume the reactor is at 100 percent power with all systems in automatic. Assume that one of the common sensing lines for the primary flow D/P cells fails, such that primary flow indicates greater than 1000 gpm. (No reactor scram)
Which one of the following scram signals is still available to protect against a loss of coolant flow accident?

a. High Power/No Water Flow

b. Header Up/No Water Flow

c. High Power/Header Down

d. Holdup Tank Static Pressure Low

QUESTION C.12 [1.0 point]
A one millicurie Sr-90 fission product sample is spilled on the pool floor. The radiation is best detected with:

a. GM detector with thin-window probe

b. Ion chamber - closed window

c. Ion chamber - open window

d. Neutron ball

QUESTION C.13 [1.0 point]
The north wall and the north east column area monitors are unexpectedly alarming, which one of the following is the expected action you should take in this situation?

a. Scram the reactor

b. Notify the HP for an area survey

c. Enter the building emergency procedure

d. Shutdown the reactor by driving in all rods

QUESTION C.14 [1.0 point]
If the high voltage to the compensating circuit of the CIC in the linear level servo control system failed, which way would the controller direct motion to the control rod?

a. The rod would drop.

b. The rod would be driven inward.

c. The rod would be driven outward.

d. The linear abnormal interface will compensate to detector and maintain the rod in present position.

QUESTION C.15 [1.0 point]
Why are 1000 gallons of water routinely left in the Retention Tank 1?

a. Provide net positive suction head for the turbine pump.

b. Prevent sludge carry over to the pool.

c. Provide water for filling the transfer chute.

d. Provide accurate level indication to determine pool leakage collection rates.

QUESTION C.16 [1.0 point]
Prior to reactor startup, the operator notices that the E beamport door status light are both out. Which one of the following describes the status of the system?

a. The beamport door is open and interlocked to the scram system.

b. The beamport door is open and the scram interlock is defeated.

c. The beamport door is closed and interlocked to the scram system.

d. The beamport door is closed and the scram interlock is defeated.

QUESTION C.17 [1.0 point]
Which one of the following operations allows the use of the building crane?

a. Removal of the hold-down mechanisms.

b. Removal of the rod magnets.

c. Removal of fuel from the core grid plate.

d. Removal of the reactor gate.

QUESTION C.18 [1.0 point]
A rupture is detected by the flow switch in the Hot Demineralizer System. Which one of the following automatic actions occurs as a result of actuation of this flow switch?

a. ONLY the inlet pump stops and the automatic isolation valve on the inlet pump suction closes.

b. ONLY the outlet pump stops and the automatic isolation valve on the outlet pump discharge closes.

c. The inlet and outlet pumps stop and the automatic isolation valve on the inlet pump suction closes.

d. The inlet and outlet pumps stop and the automatic isolation valve on the outlet pump discharge closes.

QUESTION C.19 [1.0 point]
Which one of the following is NOT a function of the pool level monitoring system?

a. An ultrasonic probe generates a local alarm at -3 inches to warn of decreasing pool levels.

b. An audible alarm is generated at approximately -0.3 inches as a warning during pool fills.

c. A control room alarm is generated at -5 inches.

d. A low pool alarm is sent to the University Department of Public Safety and Security at -12 inches.

QUESTION C.20 [1.0 point]
Which one of the following describes the purpose of the control fuel element holddown mechanism?

a. Prevents the inadvertent withdrawal and possible subsequent dropping of a fuel element while withdrawing a control rod.

b. Prevents the inadvertent ejection of the fuel element during a steam explosion caused by a catastrophic reactivity excursion.

c. Provides vertical support to the fuel element thereby preventing tipping or leaning into unanalyzed fuel geometries.

d. Provides horizontal support thereby preventing flow induced vibrations during forced circulation.

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 d
REF: Health Physics Manual, Sect. 2.3

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 Table 3.2

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

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 d
REF: Tech. Specs, Sections 2.1.1 and 2.1.2

B.10 a
REF: AP-301, Section 6

B.11 a
REF: Technical Specifications 1.0, “Definitions”
Technical Specifications 3.4, “Primary Coolant System”

B.12 b
REF: FNR Safety Analysis

B.13 a
REF: EP-101 “Reactor Building Emergency”

B.14 b
REF: OP-106, “Power Level Determination”.

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

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

B.17 c
REFERENCE OP-101 *Reactor Startup*

B.18 d
REFERENCE OP-207

C.1 b
REFERENCE (C.1)
FNR System Descriptions, Ch. 13

C.2 c
REFERENCE (C.2)
FNR System Descriptions, Ch 4

C.3 b
REFERENCE (C.3)
FNR System Descriptions, Ch 4 and 5

C.4 c.
REFERENCE (C.4)
FNR System Descriptions, Ch 13

C.5 b
REFERENCE (C.5)
FNR System Descriptions, Ch 13

C.6 c
REFERENCE (C.6)
FNR System Description, Ch 13

C.7 b
REFERENCE (C.7)
FNR System Description, Ch. 13

C.8 b
REFERENCE (C.8)
FNR System Descriptions, Chapter 4

C.9 b
REFERENCE (C.9)
FNR System Description, 10.1

C.10 a
REFERENCE (C.10)
FNR System Description, 6.2.3

C.11 d
REFERENCE (C.11)
FNR System Descriptions, Ch 13

C.12 c
REFERENCE (C12)
Nuclear Power Plant Health Physics and Radiation Protection Ch.5

C.13 d
REFERENCE (C13)
FNR System Descriptions Ch. 13

C.14 b
REFERENCE (C14)

FNR System Description Ch. 13

C.15 c
REFERENCE (C15)
FNR System Description Ch. 9

C.16 b
REFERENCE (C16)
Instrumentation and Control, p. 13-1

C.17 d
REFERENCE (C17)
OP-205

C.18 c
REFERENCE (C18)
FNR System Description 7.3.3

C.19 a
REFERENCE (C19)
System Descriptions Ch. 13 Sect. 13.11.1

C.20 a
REFERENCE (C.20)
FNR System Descriptions, Chapter 3, p. 3-9