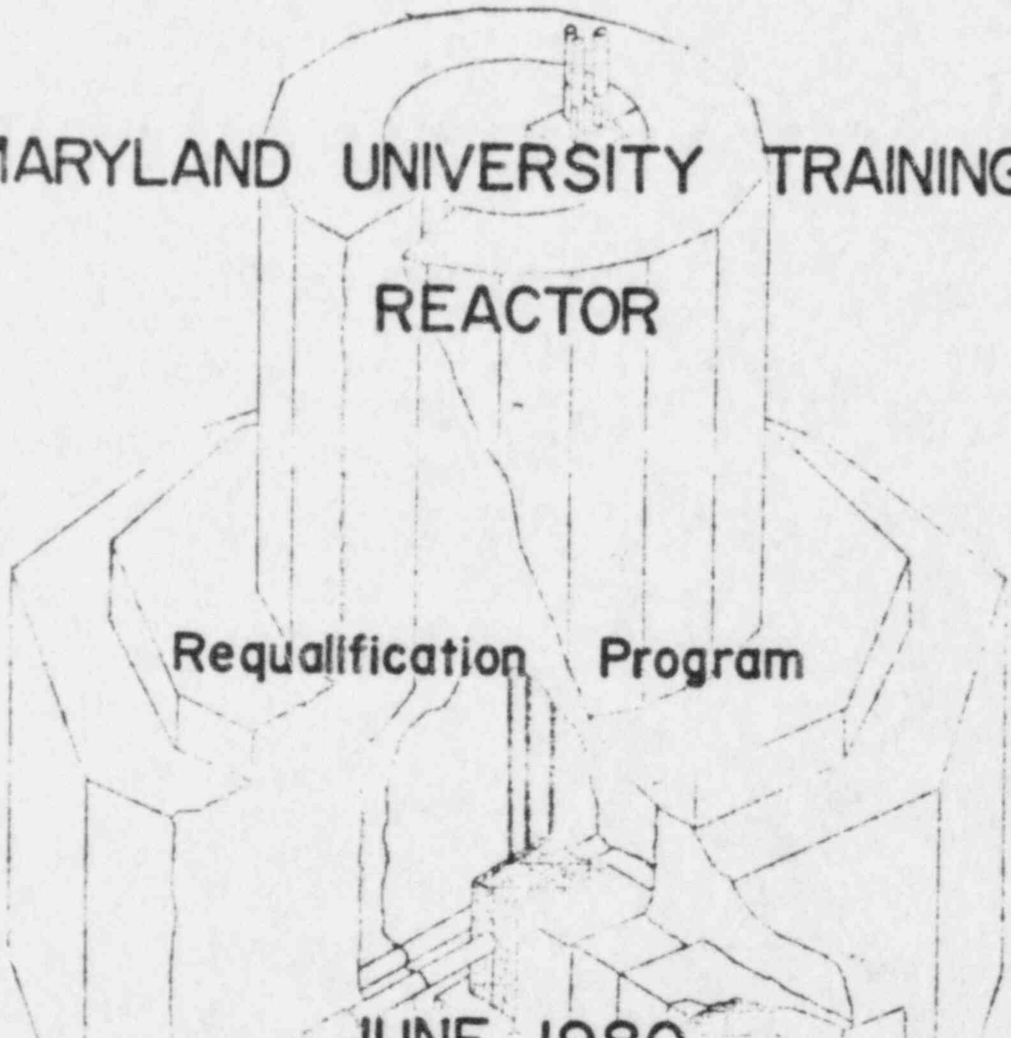
MARYLAND UNIVERSITY TRAINING REACTOR



Requalification Program

JUNE 1980

COLLEGE PARK
MARYLAND, 20742

REQUALIFICATION PROGRAM

FOR

LICENSED OPERATORS

Pursuant to 10CFR, Part 55 Section 55.33 which requires that each licensed individual demonstrate his continued competence every two years in order for his license to be renewed, the following outline of the University of Maryland Operator requalification program is submitted.

1. Schedule: "The requalification program shall be conducted for a continuous period not to exceed two years."

Licensees at the University of Maryland and generally staff members of students participating in the nuclear program. Thus, during the period of their license they are either teaching or taking courses related to reactor theory or operation. Such duties require frequent operation of the training and research reactor.

2. Lecture: "The requalification program shall include preplanned lectures on a regular and continuing basis throughout the license period."

During the period of his licenses at the MUTR the licensee is either teaching or taking the following courses in our nuclear program. They are:

ENNU 215: Introduction to Nuclear Technology

ENNU 320: Nuclear Reactor Operations

ENNU 440: Nuclear Technology Laboratory

ENNU 450, 455: Nuclear Reactor Engineering I & II

ENNU 460: Nuclear Heat Transport

These courses are taught at least once per year. Operator may be required to participate in the laboratory sections of ENNU 320 which involves teaching the practice of Nuclear Reactor Operations.

3. On-the-job training: "The requalification program shall include on the job training."

Each license is required to perform at least ten start-ups and shut-downs during each calendar year. At least one of these is under the observation/direction of the Reactor Director. In addition each licensee participates in the preventive maintenance program involving such areas as,

a) Control rod inspection

b) Fuel inspection

c) Rod drop time measurement.

Licensees are also encouraged to attend the quarterly meeting of the Reactor Safety Committee.

4. Evaluation: The annual enduction of the licensee is based upon a written examination, and discussion and actual start-up and reactor operations.

The written examination covers the following areas:

a) Principles of Reactor Operations

b) Features of Facility Design

c) General Operating Characteristics

d) Instruments and Controls

e) Safety and Emergency Systems

f) Standard and Emergency Operating Procedures

g) Radiation Control and Safety

h) Administrative Procedures, Controls and Limitations.

A typical examination is shown in Appendix A.

5. Records: Annual examination records and expired operators' licenses are kept on file for a period of at least two years. Current operators' licenses are prominently displayed in the reactor console room.

In accordance with 10CFR, Part 55.60 Section 6 of Appendix A, the Reactor Director prepares the annual examination, reviews it with the licensee and maintains records of these examination. He certifies that each licensee has a minimum of ten operations wherein the controls are manipulated. In accordance with past policy, the Reactor Director is exempted from taking the written requalification examination.

January 1974

MARYLAND UNIVERSITY TRAINING REACTOR OPERATOR

REQUALIFICATION EXAMINATION

A. Principles of Reactor Operation

x 1. Discuss and explain the role of the moderator and reflector in a reactor.

x 2. What is meant by stable reactor period? Explain.

x 3. A source of neutrons from an external source is usually used in connection with start-up of a reactor. Explain why this source is used. Is it always needed?

x 4. What is the source of delayed neutron, and what are their role in reactors?

5. How does the critical control rod position vary with power level? Explain your answer.

6. Define the following:

(a) Multiplication factor, (b) Reactivity,

(d) % Δk/k, (e) $, (f) cent.

7. What is the value of excess reactivity for MUTR (250kW) What does it mean? How can it be determined? Explain your answer.

8. Xe 135 and Sm 149 are very strong neutron absorbers; therefore, the accumulation of these fission products in the fuel region of a reactor will have a large (positive), (negative) reactivity effect. The strongest poison of the two fission products Xe 135 and Sm 149 is (______________).

9. Explain briefly the following:

(c) Criticality.
(d) Neutron flux.
(e) Nuclear cross section.
(f) Prompt critical.

10. As operator, you are bringing the reactor to power on a stable period of thirty seconds. At a certain time, the nuclear instrumentation indicates a level of ten watts. What level will be indicated at the following times:

(a) two minutes-
(b) Three minutes-

B. Features of Facility Design

2. Name and draw positions of each neutron detector in the core.

3. What are the control rods (MUTR) made of?

4. How many exhaust fans are there at the MUTR facility?
They are located at ______________.

5. List the following information.
(a) Active core dimensions.
(b) Number of fuel elements.
(c) Fuel enrichment.

X 6. For the following console readouts indicate:

(a) The name of the detector supplying the signal.
(b) The trip setting(s) associated with the Channel.

(1) Log Power Meter
(2) Linear Chart Recorder
(3) Safety Channel 1
(4) Safety Channel 2
(5) Period Meter

(c) For each detector noted above, indicate how it distinquishes between neutron and gamma induced pulses.

7. Where in the core is the instrumented fuel element located?
Can it be relocated without changing the console setting for the upper limit temperature? If so, Why?

X 8. List the materials composing the thermal column, starting at the face of the reactor shielding and proceeding toward the reactor core.

C. General Operating Characteristics

OPERATION AND PROCEDURE

1. Why is an instrument check-out required before start-up? Explain.

2. If the building monitor alarm nearest the pool goes off scale and sounds a high radiation level alarm while the reactor is operating steadily, what would you as the reactor operator do? Consider possible causes of this event. How would one establish what the real cause is, and what action would be taken?

3. Should you ever operate the reactor when one of the ion chambers has failed? Explain.

4. What would be the consequences if all of the pool water should be lost so that the core is uncovered?

5. You are the duty operator, and the reactor is operating at full power when an experimenter asks if he may lower a small sample down against the core. What procedure would you follow in assisting him?

6. Give values for each:

   (a) Average thermal flux
   (b) Void coefficient
   (c) Temperature coefficient
   (d) Critical mass

x 7 What would be the effect of xenon buildup after three days of operation at full power?

x 8 Give method for determining when the reactor is critical.

9. What actions should be taken if, during the MUTR start-up, you believe that-

   (a) The detectors do not indicate the true situation in the reactor.
   (b) Source drive motor is not working properly.
   (c) Source "in" and "out" indications not working.
   (d) In addition to all above, you couldn't locate and get in touch with the senior operator.

D. Instruments and Controls

1. Why is there an interlock which prevents you from lifting the safety rods if you have less than 2 CPS on the Log count rate motor?

2. Describe briefly each channel in the control system, and explain its primary purpose.

3. Draw recorder traces on changing power levels and going up to power.

4. Draw the two safety channels, and discuss each circuit.

5. Give values for each:

   (a) Regulating rod speed.
   (b) Control (Shim) rod speed.
   (c) Rod drop time.
   (d) Minimum power level for automatic operation.

6. How often is the instrument check done? How often the startup?

7. What would happen if CIC were overcompensated, would the counts increase or decrease?

8. What is the purpose of the siphon break, and on which pipe is it located?

9. List three indicators which will determine if the source has been driven into the core.

E. Safety and Emergency System

1. List the six scram indicators and give the appropriate trips for each; what three conditions will give: a MANUAL; an EXTERNAL scram?
2. Indication for gross release of radioactivity.
3. Why is the pressure different in the primary and secondary circuits in the heat exchanger?
4. How would a leaky fuel element in the core be detected? Explain in detail.
5. Why is the difusser necessary for operation at 250 kW? What is the principle governing its use?
6. What useful information is obtained from the "Bulk Water Meter?"
7. Which of the three detectors, fission chamber, CIC, and IC has its individual power supply? Why?
8. Will the build-up of Argon-41 in the beam tube and through tubes be a problem when operating at 250 kW. If so, what method has been proposed to alleviate such a problem?

F. Standard and Emergency Operating Procedures

1. Explain the procedure for emergency evacuation of the reactor building. Duties of the reactor operator.
2. State the rules and regulations for:

   (a) Disposal of liquid waste.
   (b) Removing samples from the pool.

3. What would happen if all water suddenly were lost? Reactivity would be what? How about heating?

4. While you are operating the MUTR at 10 kW automatic, you have noticed that the power is steadily increasing. What do you do? Explain.

5. While you are operating the MUTR at 0.5 watts. What happens if the Shim I drops into the core. Specify the indications.

6. How do you insure that the reactor is scrammed when electric power failed (for about 0.5 hr) during the reactor operation. Explain.

7. Describe the procedural requirements which must be met before you, as an operator, would insert a sample into or near the reactor for irradiation.

G. Radiation Control and Safety

1. What i the acceptable emergency maximum permissible whole body radiation dose for once in a lifetime exposure? Under what circumstances would you take this amount or instruct another to do so? Explain.

2. When you pull a sample out of the pool, you have available a portable geiger counter and an ionization chamber type survey meter. Which would you use and why? Explain.

3. Explain what each sign means and what level or dose each implies:

   (a) Caution radiation area.
   (b) Caution high radiation area.
   (c) Caution radioactive materials.

4. (a) When can the console be left unattended?
   (b) When can the console operator leave the console?
   (c) When can an unlicensed operator handle the controls?

5. Discuss the purpose and use of the two counts per second bypass

6. What is N^{16} and A^{41}. Are these big problems for the MUTR? Explain.

X 7. Give the values of RBE for Alpha, Beta, Gamma, Fast Neutrons, and Thermal neutrons.

X 8. A 1.7 millicurie Co^{60} source, and a 1 curie Pu-Be source, are both housed in a Rad Waste Container. The gamma dose rate at 20 cm was measured and found to be 80 milli-Roentgens/hr. The thermal neutron dose rate at 40 cm was found to be 40 millirads/hr, and the fast neutron dose rate at the same point, was found to be 4 millirads/hr.

   (a) What will be the total dose rate in millirems/hr at a point 100 cm from the container.
   (b) How long could one spend at that point without exceeding the AEC hourly dose limits?

9. (c) Write down the reaction resulting in neutron production for the Pu-Be source.

H. Reactor Theory

1. What is meant by a reactor period of 10 sec.?

2. What do you mean by "critical", and what criterion may we use to determine that this condition exists in the MUTR facility?

3. Assume a small step insertion of reactivity. What will be the reactor response after the initial transient.

4. Among the products of fission, there exist particles which are larger, and some which are more highly ionizing, than neutrons, also gamma rays and heat. In view of this, why do we select to measure the neutron population?

5. Of what use is a control-rod calibration (integral and differential) curves?

6. What is the difference between an integral and a differential rod worth curves. How do we obtain this at the MUTR?

7. If we have total of 10 fast fission neutrons (= nx) available for slowing down, and one is absorbed while slowing down, so that nine escape absorption, the resonance escape probability, p, is (9), (10), (1.11), (0.9).

I. Radioactive Materials, Handling, Disposal and Hazards

1. Tell operator's role in case of a reactor malfunction, release of radioactivity in air or water.

2. What design features do we have to hold Ar 41 down to permissable level?

3. If you stay in a "Radiation Area" for 120 minutes, what will be the ~~maximum~~ radiation dose you ~~should~~ receive

4. What is the air sampling procedure at the MUTR?

5. If 2 curies of I(131) is mixed with 20 liters of water, according to 10CFR20, Appendix B, after how much time can this mixture be released to the regular outlet?

6. A man is exposed to 10 mrem/hr. of gamma, 5 mr/hr of beta and 1500 thermal neutrons/cm^2-sec. What dosage does he pick up in half an hour in rem. And how long can he stay in this field before he picks up maximum weekly exposure?

7. What is the approximate attenuation to 1 Mev gamma rays afforded by:
   (a) one inch of lead shielding.
   (b) one foot of water shielding.
   μ of lead= 2.3/inch
   μ of water= 0.19/inch

8. An operator in his haste to run from a suddenly exposed gamma source, trips and strikes his head. Assuming that he lay unconscious three feet from the source, calculate the following:

   (a) Average whole body dose received in one hour.
   (b) If the man were not removed for eight hours, discuss the probable state of his health after the exposure.

   NOTE: Source strength is 20 curies, emitting gamma energies of 1.7 and 1.4 MEV.

9. Assume there is a release of radioactive material within the reactor building and it is necessary that your operators enter the building area without waiting for a health physicist to arrive.

   (a) What kind of monitoring equipment would you require?
   (b) What precautions would you take prior to entry?
   (c) Explain in detail how you would determine how long the operators could stay in the vessel.

J. Specific Operating Characteristics

1. If, when you are operating the reactor under regular conditions, someone reports that a beam tube is open, and a high intensity beam is escaping, what action would you take? Explain.

2. What would operator do upon loss of high voltage, low voltage, and compensating voltage?

3. The reactor is critical at 50 watts of power and increasing on a stable reactor period. The start-up channels show a 100 second period and the intermediate channels show a 65 second period. Which period do you consider is the more accurate? Explain your answer."

4. Outline a method that may be used to determine the cold minimum core shutdown margin during low reactor power operation.

K. Fuel Handling and Core Parameters

1. What effect does the thermal column have on the reactor? Explain.

2. What precautions are taken so that there is no unauthorized handling of fuel?

3. Neutrons produced near the outer edge of the core could travel away from the core and have no opportunity to produce fission. The reflector is placed around the core to scatter many of these neutrons back into the core where they can produce (steam), (heat), (fission).

4. Let us assume that a reactor has a temperature coefficient of $-0.002\% \frac{\Delta k}{k}$ /°F and the operating temperature is increased from 100°F to 140°F. Which is equivalent to a $\Delta T=$. The total reactivity (loss), (gain) will be equal to______.

5. It is generally true that the "end positions" of control-rod travel are not as effective as the "middle positions." Why?

6. Define the "reflector savings"

7. A start-up detector is placed near a reactor core to monitor a new core loading. As the loading proceeds, the following data are obtained.

Step	No. of Elements	CPS
**	0	10
1	4	12
2	8	15
3	10	20
4	12	30
5	13	60
6	14	150

(a) Estimate the number of fuel elements that will make the reactor critical and show how you arrived at this figure.

(b) Do you think the detector is optimumly placed, too close or too far away from the source? Explain.

L. Administrative Procedures, Conditions and Limitations.

1. What is the responsibility of licensed operator and senior operator?

2. Outline the steps you would normally follow to irradiate a sample for a few minutes. (Include administrative and technical safety answers.)

3. List the kinds of records that must be kept according to the provisions of the facility license and the regulations.

4. Assume that you are the senior operator on duty and are supervising a core loading change. An operator is lowering a fuel element into the core (it is halfway inserted) when the reactor top fixed radiation monitor alarms. What should be your actions?

5. On your answer sheet, complete the following table by listing the personnel that must be in each status for the event given:

Event	In Control Room	At Facility	On Call
Replacement of fuel in core			
Reactor re-start after scram from high flux.			
Reactor power escalation after a 10% power drop, cause unknown. Conditions appear normal.			
Normal reactor shutdown			

6. List the responsibilities of the Reactor Safety Committee.

7. Who can legally operate the MUTR?