REACTOR OPERATOR REQUALIFICATION PROGRAM

FOR

MARYLAND UNIVERSITY TRAINING REACTOR

Department of Chemical and Nuclear Engineering

University of Maryland

College Park, Maryland 20742

Revised April 25, 1981

I. PURPOSE

This document sets forth the requirements for the Reactor Operator (R.O.) and Senior Reactor Operator Requalification Program for the Maryland University Training Reactor in accordance with the Code of Federal Regulations, Title 10, Part 55, Appendix A.

II. SCHEDULE

The licensee will complete the requalification program every two years. The licensee will enter the requalification program on the date the Nuclear Regulatory Commission issues a new license or a renewal ot a previous license. The licensee will continue in the requalification program until either the expiration date of the current license or the date at which the current license in terminated. The license will have completed the requalification program by the expiration date of the current license.

III. REACTOR OPERATION

The licensee will perform each of the following operations a minimum of ten times during the two year period.

1. Startup (Instrument) check list.
2. Reactor startup
3. Automatic or Steady State Operation
4. Reactor Shutdown
5. Shutdown checklist.

In addition, each licensee will participate in the preventative maintenance program involving.

1. Control rod inspection
2. Fuel inspection
3. Rod drop time measurement

Further, as part of the "on the job" training, licensees participating in the requalification program will attend appropriate lectures and laboratory sessions relating to the University Nuclear Reactor Program.

IV. EVALUATION

The evaluation of the licensee's knowledge and performance of the requirements set forth in the requalification program will be accomplished by written and oral examinations, including a demonstration at the reactor console. These will be administered annually to each licensed operator. The written examination for the reactor operator licensee will be prepared in accordance with 10CFR-55.21 and for the senior reactor operator licensees in accordance with 10CFR-55.33. The oral examination and console performance will be in accordance with 10CFR-55.23. The examination will be administered by either the Reactor Director or his designee.

The licensees examination will be graded by the Reactor Director. A licensee receiving an overall grade of 70% or lower will be removed from his licensed duties and enrolled in an accelerated additional training program. A licensee receiving a score of less than 80% in any subject shall be tutored order to bring his performance to a minimum of 80%.

V. ADDITIONAL TRAINING

The additional training that a licensee may require (as indicated by his examination) will consist of additional written exams, console performance and oral facility examinations. The additional training and the examination that the license receives will depend upon the weak areas exhibited on previous examinations. The number of lectures and examinations that a licensee will receive will be determined by either the Reactor Director or his designee. The licensee must obtain a rating of at least 80% on the re-evaluation in order to be reassigned to his licensed duties.

The major areas in which additional training will be given are as follows:

1) Nuclear Theory and Principles or Operation
2) General and Specific Facility Operating Characteristics.
3) Facility Instrumentation & Control System.
4) Radiation Hazards
5) Safety and Emergency System

6. Standard and Emergency Operating Procedures

7. Radiation Control and Safety

8. Radioactive Materials - Disposal and Hazards.

9. Special operating characteristics

10. Fuel Handling and Core Parameters

11. Changes in Facility, Facility Design, Operating Procedures and Licensee Condition.

12. Procedures for Responding to Abnormal and Emergency Condition

VI. DOCUMENT REVIEW

The licensee will review annually the following documents and instructions that are pertinent to the operations of the Reactor Facility.

1. Reactor License (R-70)

2. Technical Specification

3. Final Safety Analysis Report (FSAR)

4. Maryland University Training Reactor (MUTR) Procedures

5. 10CFR-19,20,30,50,55 and 70.

The licensee will review the changes to these documents at the time the new revisions are available.

VII. RECORDS

An individual record file will be maintained for each licensee and the record file will contain the following information:

A. Current copy of either the licensee's reactor operator or senior reactor operator license.

B. Copies of all written examinations administered to the licensee, and the correct answers given to the licensee.

C. The licensee's requalification program progress checklist.

D. The summary of additional training received by the licensee documented in a memorandum for record and any additional documentation that is pertinent to the additional training received by the licensee.

VIII. ADMINISTRATION

The Reactor Director or his designee is responsible for the development, administration and execution of the Reactor Operator Requalification Program. The Reactor Director will be exempt from taking the annual written, console performance, and oral facility examinations, but will be required to perform the operations set forth in Section III and the review of the documents set forth in Section VI.

LICENSEE'S REQUALIFICATION PROGRAM PROGRESS CHECKLIST

Licensee _____ License # _____

Effective Date _____ Expiration Date _____

Date Started _____ Date Completed _____

I. REACTOR OPERATIONS

1. Completed 10th Startup Checklist _____ (Date) ... _____

2. Completed 10th Reactor Startup _____ (Date) ... _____

3. Completed 10th Reactor Shutdown _____ (Date) ... _____

4. Completed 10th Shutdown Checklist _____ (Date) ... _____

II. EVALUATION

1. Annual Console Performance Examination Completed _____ (Date) ... _____

   _____ (Date) ... _____

2. Annual Written Examinations Completed _____ (Date) ... _____

   _____ (Date) ... _____

3. Annual Evaluations Completed _____ (Rating) ... _____

   _____ (Rating) ... _____

4. Final Written Examination Completed _____ (Date) ... _____

III. DOCUMENT REVIEW

1. Reactor License Review Completed _____ (Date) ... _____

   _____ (Date) ... _____

2. Technical Specifications Review Completed _____ ... _____
Date
_____ ... _____
Date

3. 10 CFR-19 Review Completed _____ ... _____
Date
_____ ... _____
Date

4. 10 CFR-20 Review Completed _____ ... _____
Date
_____ ... _____
Date

5. 10 CFR-30 Review Completed _____ ... _____
Date
_____ ... _____
Date

6. 10 CFR-50 Review Completed _____ ... _____
Date
_____ ... _____
Date

7. 10 CFR-55 Review Completed _____ ... _____
Date
_____ ... _____
Date

8. 10 CFR-70 Review Completed _____ ... _____
Date
_____ ... _____
Date

9. MUTR FSAR Revised Review Completed _____ ... _____
Date
_____ ... _____
Date

IV. RECORDS

1. Annual Examination Score and Answers Filed

Subject	Part	Score
Principle of Reactor Operation	A	
Features of Facility Design	B	
General and Specific Operational Characteristics	C	
Radiation Hazards	D	
Safety and Emergency Systems	E	
Standard and Emergency Operating Procedures	F	
Radiation Control and Safety	G	

Subject	Part	Score
Reactor Theory	H	
Radioactice Materials--Disposal and Hazards	I	
Special Operating Characteristics	J	
Fuel Handling and Core Parameters	K	
Administrative Procedures.	L	

2. Annual Examinations and Answers Filed _____ ... _____
Date

3. The Licensee has satisfactorily completed the Reactor Operator Requalification

_____ _____
Reactor Director (Date)

REACTOR OPERATOR'S REQUALIFICATION

Exam

1980

A. Principles of Reactor Operation.

1. Define and/or explain the following:

a) Cold critical (T.S. p.2)

b) Reactor shutdown (T.S. p.1)

c) Reactor secured (T.S. p.1)

d) Reactor Operation (T.S. p.2)

e) Flux trap (T.S. p.2)

2. True or False (circle answer)

a) Special experiments are experiments designed to use Special Nuclear Materials only.
True False (T.S. p.3)

b) Opeation in violation of a "limiting condition for operation" is considered a reportable occurrence.
True False (T.S. p.3)

c) Shim I drops from all out position to completely down during a rod calibration experiment. This is considered a reportable occurrence.
True False (T.S. p.4)

d) The limiting safety system setting for the fuel element temperature channel is 400^{o}C.
True False (T.S. p.7)

e) The objective of the "Limiting Condition for Operation" is to assure that the reactor can be shut down at all times.
True False (T.S. p.9)

f) The MUTR limit for excess reactivity is 2.5 $\Delta k/k$
True False (T.S. p. 10)

h) A reactivity insertion of 25¢ when critical at 25 watts will give a period of 5 sec.
True False

i) The MUTR starting source is worth ~5¢.
True False

j) For the MUTR to be just critical the following conditions must not be.
1. Period must be shorter than 30 sec.
2. Source in
3. Key on
4. Senior operator present
True False

B. FEATURES OF FACILITY DESIGN

Fill in Blanks:

1. The total number of standard fuel elements in the MUTR core is _____.
2. The core contains _____gms. of U-235.
3. The enrichment of the U-235 in _____ percent.
4. The start up source is worth approximately _____cents.
5. The excess reactivity permitted is _____ percent.
6. The reactor can be taken to critical on two rods. They are _____ and _____.
7. Fire Pull alarms are located at the following positions in the containment building.
   a._____
   b._____ _____
   c._____ _____
8. The effluent from the two sinks on the west balcony flows into the _____.
9. The automatic power control obtains its signal from the _____ chamber.
10. The rod drop time cannot exceed _____ seconds.
11. Emergency safety equipment are stored in
    a._____ b._____
12. The NRC maintains a 24 hour INCIDENT RESPONSE CENTER. The telephone number is _____.
13. A red light on the alarm panel at the console double doors indicate that the alarm is _____.

14. Pool water conductivity is maintained at _____ micromhos.

15. Vistors _____(are, are not) permitted to manipulate the control rods when the reactor is at power.

C. General & Specific Operating Characteristics

1. The reactor is in a shut-down condition when sufficient control rods are inserted to assure that the reactor is subcritical by at least $1.00 of reactivity
   a) True b) False

2. The reactor is secured when which of the following conditions are satisfied (circle correct answer(s))
   a) The reactor is shut-down
   b) Power to the control-rod magnets and actuating solenoids has been switched off and the key removed and under the control of a licensed operator or stored in a locked storage area.
   c) No work is in progress involving in-core fuel handling or refueling operation, maintenance of the reactor or it's control mechanisms, or insertion or withdrawal of experiments from the core.

3. The MUTR is started and placed on automatic operation after 250 kW with the regulation rod 56% withdrawn, with no other changes to the reactor or the position of the shims. As a function of time, the % withdrawn will
   a) decrease or b) increase

4. What methods are used to control nitrogen-16 concentrations on the bridge?

5. Turning on the diffuser and primary coolant pump during operation at 200 kW will a) increase or b) decrease reactivity.

6. Max speed of control rods drives: _____

7. The value of the primary system pressure during normal operation is _____ psig.

C. continued

8. Explain the effect on core reactivity of the following
   a) The thru tube is flooded.

9. Sketch a differential rod worth curve and explain shape of curve.

10. What indication would you receive at the consol
    if a shim rod were to drop into the core during operation.

D. Radiation Hazards Which May Arise During The Performance of Experiments, Shielding Alternatives Maintenance Activities and Various Contamination Conditions.

1. True or False

a. There is no need to worry about neutron exposures at the University of Maryland reactor because it is low power.
True_____ False _____

b. Records of radiation doses received at the University of Maryland are kept at the University of Maryland Radiation Safety Office.
True _____ False _____

c. Lifetime whole body dose for occupational exposure to ionizing radiation may not exceed

$$5\text{rem} \times (N-18)$$

where N is a person's age.

True_____ False _____

d. Background radiation comes primarily from nuclear weapons fallout and nuclear power plants.
True _____ False _____

e. A film badge or pocket dosimeter must be worn in the reactor facility only when the reactor is operating.

f. A geiger-mueller (GM) counter can detect beta and gamma radiation.
True _____ False _____

g. Neutrons are about the same mass as protons but neutrons are negatively charged.
True _____ False _____

h. Alpha particles cannot penetrate the dead layers of the skin but cause biological damage if they are deposited internally.
True _____ False _____

i. A quality factor is used when calculating radiation does absorbed by man.
True_____ False _____

j. The rate of radioactive decay of an element is slowed if the material is placed in a freezer.
True _____ False _____

2. Objective

a. The four basic types of radiation are _____, _____, gamma and neutron.

b. The least penetrating radiation is _____ radiation.

c. _____ particles have the same mass as electrons.

d. The unit of radiation exposure is the _____.

e. Occupational radiation limit is _____rem per year.

f. Activity of a radioactive material is expressed in _____ per minute.

g. A gamma ray originates in the _____ of an atom whereas an x-ray comes from the electron shells.

h. A naturally occurring radioactive material used to fuel nuclear reactors is uranium.

i. The device used to monitor personnel doses in the University of Maryland reactor is called a _____.

j. If you spend 3 hours in a radiation field which delivers a dose of 16 rem per hour, your total dose will be _____rem.

k. An individual is exposed to 0.25 rad of gammas, 0.32 rad of Betas and 0.05 rad of neutrons. The quality factors are 1, 1 and 10 respectively. The total dose in rem is _____.

l. A room in which the radiation area might be 100 mrem/hour or greater must be posted with a sign that states _____.

m. Three important regions of a gas filled ionization detector are _____, _____, and _____.

n. A neutron detector that is to be utilized in a mixed neutron-gamma field operates in the _____ region of its range so that the electronics may _____ between the neutron and gammas.

3. Multiple Choice

1. Background radiation in Maryland is about

   a) 1 mrem/year
   b) 125 mrem/year
   c) 50 rem/year
   d) 100 mrem/hour

2. Physical effects such as transient blood changes

   a) 20 rem
   b) 1000 rem
   c) 1000 mrem
   d) 5 rem

3. Alpha particles

   a) emit gamma rays
   b) are like electrons
   c) are like helium-4 nuclei
   d) have no energy

4. The time it takes for a radioactive sample to decay to one half its original activity is called its

   a) decay constant
   b) whole life
   c) gamma coefficient
   d) half life

5. When measuring human doses one uses the unit

   a) rad
   b) rab
   c) rem
   d) reb

6. Occupational exposure to ionizing radiation within legal limits

   a) will make you slightly radioactive
   b) will make you temporarily sterile
   c) will cause slight temporary reduction of red blood cell formation
   d) none of the above

7. Ionizing radiation is reliably detected by a

   a) geiger counter
   b) pH meter
   c) photoelectric densitometer
   d) teletype

8. 500 millirem per year is the legal limit for radiation exposure for

   a) disability payments radiation workers
   b) occupational radiation worker
   c) the general public
   d) a medical x-ray

9. Film badges record personnel doses for

   a) alpha and beta radiation
   b) microwave radiation
   c) Neutron radiation only
   d) beta, gamma and neutron radiation

10. Acute radiation sickness in man

   a) is noticed at an absorbed dose (one-time) of 5 rem
   b) is always fatal
   c) is characterized by nausea, skin reddening, loss of hair and/or blood changes
   d) has symptoms of a common cold and has no cure.

4. Match

_____ radiation absorbed dose
_____ unit of human dose
_____ loss of an orbital electron
_____ ionizing radiation detector
_____ 3.7×10^{10} disintegretions/second
_____ uncharged nucleon
_____ unit of energy
_____ electromagnetic radiation
_____ nuclear transformation

a. curie
b. geiger-mueller (GM)counter
c. rad
d. neutron
e. electron volt
f. gamma
g. radioactive decay
h. rem
i. ionization

E. Safety and Emergency Systems

1. What is the minimum number of area radiation monitors that must be operable for reactor start-up? _____; reactor power channels? _____

2. List the purpose and set point of each reactor scram.

3. The set point for the bridge monitor is _____mr/hr.

4. Check incorrect statement.
   On entering the reactor building you hear the external alarms bleeping, you should-
   a) Immediately leave the area,
   b) Return with radiation detector and safety equipment.
   c) Proceed to console room without detectors and turn off alarms.

5. At least _____ Senior Operators must be present when visual inspections test of the control rod is made.

F. Standard and Emergency Operating Procedures.

1. Outline your duties as reactor operator as set forth in the facility emergency evacuations procedure.
2. When must a instrument check out be performed.
   a) After the console power is turned off manually from the power on push button.
   b) Before each start-up
   c) Prior to each day's operation.
   d) After the console breader switch has been turned off for only 5 seconds.
   e) Prior to the start-up of an operation extending more than one day
3. List set points for all reactor scrams.
4. Where in the core is the instrumented fuel element located? Can it be relocated without changing the scram setting for the upper temperature limit?
5. You bring the reaction to power at 250 kW, Shim I at 65%, Shim II @ 65% and Reg. Rod at 79% in the automatic mode. One hour later Shim I is at 65%, Shim II at 65% and Reg Rod at 69%. Explain.

G. Radiation Control and Safety

1. Define the following:
   a) radiation area
   b) high radiation area
2. Each entrance or acces point to a high radiation area shall lie kept locked except during periods when access to the area is required, with positive control over each individual entry.a) true b) false.
3. Upon leaving a radiation zone, you wish to make a personal survey of your clothing with a G-M, and the background radiation level is 2000 c/m. You should.
   a) Not make any survey until you reach a location where the background is less than 200 to 500 c/m. ____
   b) Make the survey at this location. ____
   c) Survey here and again when the background is lower. ____
4. The G-M dose-rate instrument has a Bakelite shield on the front of the chamber, which is used to:
   a) Reduce the amount of gamma radiation entering the chamber. ____
   b) Prevent the chamber from becoming contaminated. ____
   c) Tell the difference between alpha and gamma radiation. ____
5. When surveying with an alpha proportional counter it is best to:
   a) Double check by rapidly surveying over an area several times. ____
   b) Hold the probe at least 2 inches away from the surface to avoid contamination. ____
   c) Cover the probe with plastic to avoid contamination. ____
   d) Hold the probe less than 1/2 inch from the surface and survey slowly. ____

H. REACTOR THEORY

1. A reactor whose integral rod worth curries are given in the attached Figures attains criticality as follows.

   Shim I - 65% withdrawn
   Shim II - 65% withdrawn
   Reg Rod - 40% withdrawn

   a) What was the shutdown margin?
   b) What was the initial k_{eff}?
   c) What was the excess reactivity?

2. What reactivity yields a period of
   a) 15 sec.
   b) 25 sec.
   c) 5 sec.

I. Radioactive Materials Handling Disposal and Hazards.

1. a) What is the technical specifications for operation with fueled experiments?
   b) Describe the basis for this specification.

2. Upon leaving a radiation zone, you wish to make a personal survey of your clothing with a G-M, and the background radiation level is 2000 c/m. You should:
   a) Not make any survey until you reach a location where the background is less than 200 to 500 c/m. _____
   b) Make the survey at this location. _____
   c) Survey here and again when the background is lower. _____

3. The G-M dose-rate instrument has a Bakelite shield on the front of the chamber, which is used to:
   a) Reduce the amount of gamma radiation entering the chamber. _____
   b) Prevent the chamber from becoming contaminated. _____
   c) Tell the difference between alpha and gamma radiation. _____
   d) Tell the difference between beta and gamma radiation. _____

4. When surveying with an alpha proportional counter it is best to:
   a) Double check by rapidly surveying over an area several times. _____
   b) Hold the probe at least 2 inches away from the surface to avoid contamination. _____
   c) Cover the probe with plastic to avoid contamination. _____
   d) Hold the probe less than 1/2 inch from the surface and survey slowly. _____

5. List the whole body exposure limits for:
   A. Occupational worker: _____
   B. General public: _____
   C. Pregnant workers: _____

J. Special Operating Characteristics

1. The Technical Specifications state that "the excess reactivity (i.e. the reactivity available with control rods removed, from the cold, critical Xenon free condition with or without experience in place) is less than 2.5% $\Delta k/k$".

   a. How can you verify that you meet this specification?

2. The University of Maryland Reactor is licensed to operate at a maximum power level of 250Kw. Explain how the staff insures that this limit is not exceeded.

3. In order to perform a fuel rod inspection at least _____ clusters must be removed from the core.

4. Shim I or II cannot be withdrawn when the reactor is in the automatic mode. True, False.

5. The Technical Specifications states that the reactor cannot be operated when the pool water temperature exceeds _____ ^{o}F.

K. Fuel Handling and Core Parameters

1. You are loading to critical the MUTR reactor. Dr. Almenas has predicted it will take 24 clusters containing 4 fuel rods each. After putting in 10 clusters data follows for the next ten clusters. Where would you predict critical?

Clusters #	C/min
11	11,550
12	12,031
13	13,125
14	13,125
15	14,438
16	16,500
17	19,985
18	19,250
19	19,914
20	23,100

2. There are two major criteria to remember when doing an approach to critical in the above way. They are:

L. Administrative Procedures, Conditions, and Limitations

1. You are called by the Campus Police to respond to a security alarm at 2 A.M. On arriving at the reactor you find that a door to the reactor building is open and you can hear the external alarms "bleeping" What action do you take?

2. Listed below are a number of situations which require evaluation or an immediate response. Include in your answer any license limits and basis for your response. Assume you are the only licensed Senior Operator immediately available.

   a) During a rod drop test you observe a 1.5 second drop time of a shim rod.

   b) An experiment of positive reactivity worth inserted in the Pneumatic System cuases the indication are Safety Channel II to reach 122% and no scram occurs.