Westinghouse Electric Corporation
Astronuclear Laboratory

WANL-TME 1304

1304

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

INFORMATION CATEGORY

October 1965

UNCLASSIFIED

W. P. Kovacik 10/13/65
Authorized Classifier Date

Submitted by:

Westinghouse Electric Corporation

Astronuclear Laboratory

Pittsburgh, Pennsylvania

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

Prepared by:

W. P. Kovacik
W. P. Kovacik, Supervisor

Approved by:

J. G. Gallagher
J. G. Gallagher, Manager

WESTINGHOUSE ASTRONUCLEAR

WANEF FCX TRAINING PROGRAM

(Title Unclassified)

DISTRICT

SW

ABSTRACT

A training program to assure the safe and efficient activation of the Flexible Critical Experiment (FCX) has been prepared for those WANEF staff members who are already qualified as PAX operators.

Table of Contents

	<u>Page</u>
Abstract	i
I. Introduction	I-1
II. Conclusion	II-1
III. Discussion	III-1
Appendix A	A-1

I. Introduction

In conformance with the requirement in WANL-TNR-099, "WANEF Safety Report," a training program was developed for the safe and efficient activation and operation of the Flexible Critical Experiment (FCX). This FCX training program was prepared specifically for WANEF personnel who were qualified as PAX operators. The present PAX operators were subject to a formal training program as given in WANL-TME-642, "WANEF Training Program." Since the requirements for knowledge in nuclear physics, health physics, instrumentation, facility, criticality, operational, and emergency procedures have already been satisfied by the PAX operators, it was deemed sufficient that training and examination would be directed to the FCX characteristics, its differences from PAX and the procedures that are unique to FCX.

Training and qualification of new WANEF staff members as PAX and FCX operators would involve a much more extensive program such as given in WANL-TME-642. "WANEF Training Program."

II. Conclusion

It is concluded that this FCX training program will provide the necessary competence and training to the WANEF PAX operators such that the FCX can be operated safely and efficiently.

III. Discussion

The significant nuclear and operational features of the FCX are given in two lectures. In addition, another lecture is given to cover other changes to documentation and procedures.

Lecture 1	Nuclear, Mechanical, and Electrical Features of the FCX	3 hours
Lecture 2	Changes in WANEF Operating Procedures and Limits due to FCX Operation	2 hours
Lecture 3	Review of Documentation and New Information to the Extent Necessary to Cover Facility Modifications, Changes in Operating Limits, and Procedural Changes	2 hours

Each prospective operator is required to perform two reactor checkouts and two mock operation runs. After the FCX is activated, additional reactor operators will be required to operate the FCX for two runs as Reactor Operators-in-Training prior to qualification as FCX operators.

A written examination based upon the information in the lectures is given in Appendix A.

APPENDIX A

WESTINGHOUSE ASTRONUCLEAR
EXPERIMENTAL FACILITY

OPERATORS EXAMINATION

October 1965

by

W. P. Kovacik
Supervisor
WANEF

Examinee _____ Date _____

Grader Name _____ Date _____

Score _____

WANEF OPERATIONS EXAMINATION

1. The FCX assembly is designed to utilize:
 - a. Specially designed UO_2 -graphite fuel with one 0.363" diameter axial hole.
 - b. Reject NERVA fuel elements.
 - c. KIWI fuel elements.
 - d. All of the above.

2. The initial FCX core loading will consist of:
 - a. A central fueled region reflected by graphite.
 - b. A mockup of the NERVA II reactor.
 - c. A beryllium-reflected, homogeneous loading of fuel and graphite clusters.
 - d. Three zones of fuel loadings using high, medium and low U-loaded elements.

3. The FCX loading and approach to critical is the same as PAX.

True_____

False_____

4. The KIWI fuel to be used in the FCX is a more significant source of α contamination because
 - a. of hydrogen absorption due to hydrolysis of the UC_2 .

- b. the uranium does not have a pyrolytic coating.
 - c. the uranium is in the form of UO_2 rather than UC_2 .
 - d. a niobium coating is not used.
5. The FCX tie rod is made of
- a. inconel
 - b. stainless steel
 - c. aluminum
 - d. none of the above.
6. The FCX cluster plates are made of
- a. silver-indium-cadmium
 - b. gadolinium-stainless steel
 - c. aluminum
 - d. stainless steel
7. The "flux trap" control rods in FCX utilize polyethylene and
- a. B_4C homogeneously mixed
 - b. a 120° plate of enriched boron-aluminum matrix
 - c. a surrounding tube of cadmium
 - d. none of the above
8. The polyethylene in a control rod serves to
- a. slow down the fast neutrons so they can be absorbed in the absorber.

- b. absorb the thermal neutrons.
 - c. absorb much of the mechanical shock when the control rod is
scrammed.
 - d. absorb epithermal neutrons
9. The FCX control rod is scrambled by interrupting the current to
- a. the clutch.
 - b. the rack and pinion drive.
 - c. the electromagnet.
 - d. out limit switch.
10. The minimum permitted number of control rods in FCX is
- a. 7
 - b. 5
 - c. 4 consistent with the 10\$ minimum shutdown.
 - d. 2 " " " " " "
11. The FCX position indicator shows the location of the
- a. control rod.
 - b. rack.
 - c. armature.
 - d. pinion.
12. The FCX control drive system differs from PAX in that
- a. both multiple drive "in" and "out" can be used on FCX.
 - b. larger drive motor currents are required for FCX.

- c. smaller drive motor currents are required for FCX.
- d. the position indicator shows the actual position of the absorber.

13. When an FCX control rod is fully inserted, the rack is fully inserted, and the magnet energized, the following condition will be noted at the console:

- a. "in" light off, "out" light off, "scram" light off.
- b. " off, " on, " off.
- c. " off, " off, " on.
- d. " on, " off, " off.

14. When an FCX control rod is fully inserted, the rack is fully inserted, and magnet de-energized, the following condition will be noted at the console:

- a. "in" light off, "out" light off, "scram" light off.
- b. " off, " on, " off.
- c. " on, " off, " on.
- d. " off, " off, " on.

15. Which of the following survey meters is the proper radiation detection instrument to use during cleanup after handling the KIWI fuel:

- a. cutie pie.
- b. thermal neutron survey meter.
- c. PAC-3G alpha survey meter.
- d. fast neutron survey meter.

16. The minimum number of neutron channels for normal FCX operation is
- a. one startup, 3 power level, and 1 period channel.
 - b. one startup, 2 power level, and 1 period channel.
 - c. one startup, 3 DAS, 2 power level and 1 period channel.
 - d. none of the above.
17. The PAX has been in operation and now the FCX is to be operated. What is the main step that has to be performed before the FCX patch panels are installed?
18. What is the maximum permissible total scram time for FCX?
19. During FCX operation with 7 control rods, what is the condition of the remaining 5 "in", "out", and "scram" lights on the console?
20. Manual lifting of the FCX control rods is permitted only during daily checkout when the system is in the bypass mode.
- True_____
- False_____
21. The FCX requires
- a. less nuclear instrumentation than PAX since it is a bare core.
 - b. the use of the PAX nuclear instrumentation.
 - c. the same number of nuclear channels as PAX.
 - d. none of the above.

22. A startup neutron source for the FCX
 - a. is routed through the source transfer switch.
 - b. consists of a built-in radium-beryllium source.
 - c. is not required because the FCX can "see" the neutrons from the PAX source.
 4. is required only for the first.
23. During FCX operation
 - a. the PAX drum keys will be locked in the key box.
 - b. seven of the PAX drum keus will be used to unlock the control rods and the remainder left in the console bypass panel.
 - c. all the PAX down keys are locked in the console bypass to prevent them from being used in PAX.
 - d. separate FCX keys are used to prevent confusion with the PAX drum keys.
24. Operation of either the PAX or FCX from the console requires
 - a. patch panels F, G, and H to allow the proper hookup between console and reactor.
 - b. adjustment of the drive motor symplytrol trip for the proper level.
 - c. conversion of the control element position indicator from degrees to centimeters.
 - d. activating the master PAX/FCX Power Switch.

25. Patch Panel G contains
- a. the reactor instrumentation signal leads.
 - b. control element and source transfer mechanism wiring.
 - c. all the FCX control and instrumentation wiring.
 - d. all the PAX control and instrumentation wiring.
26. Because of the relatively high humidity at WANEF what problem might arise during operation of the FCX using the KIWI type fuel?
27. The worth of an FCX control rod is
- a. considerably more than a PAX drum.
 - b. the same as a PAX drum.
 - c. slightly less than a PAX drum.
 - d. expected to be greater than 5\$.
28. The total control rod worth in the FCX will
- a. range from 13\$ to 25\$ depending upon the various cores to be installed.
 - b. be independent of the size of the core.
 - c. be at least twice the permissible excess core reactivity.
 - d. none of the above.

29. The maximum permissible reactivity insertion rate with the FCX control rods is
- a. $6.4\text{¢}/\text{sec.}$
 - b. $10\text{¢}/\text{sec.}$
 - c. $20\text{¢}/\text{sec.}$
 - d. depends upon the speed selected.
30. The maximum permissible excess reactivity in the FCX is
- a. $0.1\text{\$}$
 - b. $0.5\text{\$}$
 - c. $2.5\text{\$}$
 - d. $6.2\text{\$}$
31. The minimum permissible shutdown reactivity in the FCX is
- a. $2.8\text{\$}$
 - b. $5.3\text{\$}$
 - c. $10.0\text{\$}$ with personnel present.
 - d. $10.0\text{\$}$ without personnel present, $5.0\text{\$}$ with personnel present.
32. The reactivity worth of personnel next to a bare FCX core is much higher than for the PAX because
- a. the PAX has ~~a~~ beryllium and graphite reflectors.
 - b. the FCX leakage neutron flux has a harder spectrum.
 - c. a person can get closer to the FCX core.
 - d. all the above.

33. Because the "fat man" effect is much greater on the FCX, the following operating limit is placed on the FCX to insure safety:
- a. a minimum of 10\$ control rod shutdown reactivity and a maximum of 0.5\$ excess reactivity.
 - b. a minimum of 0.5¢ control rod shutdown and a maximum of 10\$ excess reactivity.
 - c. no people will be allowed next to the core.
 - d. Patch Panel F will be removed during core changes to insure that the control rods cannot be withdrawn during core changes.
34. What is the means by which the limit on excess core reactivity is not exceeded?
35. With only the FCX core installed in the test cell, the procedural control of water and other liquids in the test cell is less stringent because of the higher FCX shutdown.
- True_____
- False_____
36. Define the rod worth reversal effect. How could this effect, if it existed, be detected on the FCX prior to criticality?
37. What is the significance of the rule regarding a maximum of 20¢ in day-to-day changes in FCX core reactivity?