U. S. ATOMIC ENERGY COMMISSION
REGION I
DIVISION OF COMPLIANCE

Report of Inspection

CO Report No. 47/71-1

Licensee: U. S. ARMY MATERIALS & MECHANICS RESEARCH CENTER
License No. R-65
Category G

Dates of Inspection: March 29 thru April 1, 1971

Dates of Previous Inspection: May 8 and 9, 1969

Inspected by: J P Stohr 5/6/71
J. P. Stohr, Radiation Specialist Date

Reviewed by : R. T. Carlson 5/6/71
R. T. Carlson, Senior Reactor Inspector Date

Proprietary Information: None

SCOPE

A special announced inspection was made of the U. S. Army Materials and Mechanics Research Center (AMMRC) 5 MWt research reactor at Watertown, Massachusetts. The inspection was made in conjunction with the licensee's application to convert their license to "possess but not operate" license. Included in the inspection was a tour of the reactor building, performance of a radiation survey, review of operational records for the inspection period and discussions with staff personnel.

SUMMARY

Safety Items - None

Noncompliance Items -

1. 10 CFR 20.401(b) and Technical Specification VI.7.h. - Records of radioactive liquid waste releases were not maintained. (Section Q.)

2. License No. R-65, change No. 3 - On two occasions the licensed power level of 2 MWt was exceeded. (Section C.)

3. Technical Specification III.2.2. - The reactor was operated in violation of a limiting condition for operation. (Section C.)

4. Technical Specification VI.3.a.(6) - There were no detailed written procedures for the fuel handling involved in the dismantling operations which included core unloading. (Sections D and O.)

Unusual Occurrences -

1. On July 29, 1969 the reactor was operated at 2.1 MWt which exceeded the licensed power limit. This was due to an operacor error in adjusting an instrument. (See Section C.)

2. On August 20, 1969 the reactor was operated at 2.15 MW which exceeded the licensed power limit. This was due to an operator error during repositioning of chambers. (See letter from licensee dated November 20, 1969 and Section C of this report.)

3. On October 27, 1969 the reactor was operated in violation of Technical Specifications in that a limiting condition for operation was not met. The stack monitors were not operable and therefore could not supply automatic isolation capability. (See licensee's TWX dated October 30, 1969 and letter dated November 4, 1969, Section C of this report, and Inquiry Memorandum No. 65/69-A.)

Status of Previously Reported Problems - During the May, 1969 inspection AMMRC was cited for three items of noncompliance.

1. Four shim safety rods were installed whereas the license specified only three.

2. Fuel elements with a loading of 200 gm U-235 were loaded whereas the license specified up to 140 gram elements.

License Change No. 3 dated May 28, 1969, authorized four shim safety rods and 200 gm elements thereby correcting the above discrepancies.

3. 11 kg of U-235 was on hand whereas the license specified up to 9.35 kg.

License Amendment No. 8 dated August 21, 1969, authorized the licensee to possess up to 12 kg thereby correcting the above discrepancy.

Other Significant Items -

1. License Amendment No. 8, dated August 21, 1969, authorized the licensee to increase power from 2 MWt to 5 MWt. On August 22, 1969 AMMRC began power escalation and reached 5 MWt on September 2, 1969.

2. On December 3, 1969 the core configuration was changed from Core 112G to Core 114C. Core physics parameters were not clearly defined as to the excess reactivity, rod worths, or shutdown margin. (Section F.)

3. On January 15, 1970 Mr. J. O'Connor informed CO:I (Inquiry Memorandum No. 65/70-A) that the Army had decided to close the facility. During this inspection, Mr. O'Connor stated that word of this eventuality had first reached AMMRC personnel approximately in September, 1969 and that attitudes had been adversely affected.

4. On February 16, 1970 AMMRC submitted a request to amend the license to "possess but not operate."

5. On March 27, 1970 the licensee terminated reactor operation. By September 30, 1970 all irradiated fuel had been shipped to SRL.

6. In January, 1971 a deactivation report dated December 8, 1970, including the new Technical Specifications was submitted. The inspector observed the following four discrepancies:

   a. The report indicates that the 40,000 gallon retention tank located between the shell and Building 97 had been drained and flushed clean. The tank has been flushed but still contains 100 mCi of activity. AMMRC plans to accept bids from outside contractors for the cleaning of this tank. (Section T.)

   b. The Technical Specifications stated that a general radiation survey of the reactor facility will be conducted monthly. There were no surveys taken between October, 1970 and March, 1971. (Section P.)

   c. The report indicates that rubber gaskets will be removed from airlock doors - this had not been done. (Section T.)

   d. The shell cathodic protection system has been installed but is not operable. (Sections I and T.)

Management Interview - Mr. J. O'Connor was present throughout the inspection except for the time spent reviewing the Health Physics area. A final summation was held with Messrs. Hegge, Shebek, O'Connor, Levin and Cady.

The inspector stated that as a result of this review he was going to make a recommendation that DRL proceed to a "possess but not operate" license for AMMRC. The inspector stated that although he had found several deficiencies in AMMRC's program, there was nothing of a nature to prevent him from making this recommendation.

The inspector stated that he had reviewed the reactor facility in light of the deactivation report dated December 12, 1970 and found this report to be essentially correct. However, there were certain discrepancies noted. The rubber gaskets on the airlocked doors to the reactor building had not been removed, although the report indicated that this had been done. The inspector stated that it did not appear to make much difference one way or the other. The 40,000 gallon retention tank was indicated in the report as being flushed clean whereas a survey by Mr. Cady indicated that there was approximately 100 mCi of activity (Co-60, Cr-51) left in the tank. Mr. Levin stated that AMMRC was going to accept bids from outside contractors for the cleaning of this tank.

The inspector stated that although the new proposed Technical Specifications contained in the deactivation report dated December 8, 1970 indicated that a general radiation survey including smears would be conducted monthly in the reactor building, this had not been done between March, 1971 and sometime in October, 1970. The inspector stated that, although this may not yet be a legal requirement, if

AMMRC thought this survey was a necessary control, it should have been done all along. Mr. Hegge agreed and stated that these surveys would be taken monthly for at least a year until evidence was obtained that the monthly requirement was not necessary, and that then perhaps the frequency would be shifted to quarterly.

At this time the inspector discussed the requirements of 10 CFR 50.59 as regards changes to the facility or procedures and the reporting requirements. Mr. O'Connor indicated that he was aware of these requirements and that if there were any future changes to the facility, these changes would be reported on an annual basis.

The inspector stated that AMMRC would be cited for noncompliance for not having the liquid radioactive waste effluent records maintained and available for review. A general discussion to the possible whereabouts of these records followed. Mr. Hegge was adamant that these and other similar records are not to be removed from the facility, and he stated that this matter would be pursued further so as to retrieve the records at this time if possible. Mr. Cady stated that Mr. Foley had been contacted by telephone that morning (April 1, 1971) and that Mr. Foley's quick look around had failed to turn them up but that Mr. Foley would continue to look for them.

The inspector stated that the gaseous effluent records for March, 1970 had also been missing at the start of the inspection but that the record had been reconstructed by Mr. Foley from the operational log books which had hourly readings of the gaseous effluent monitor. The inspector stated that all gaseous effluent records should also be maintained.

In regard to past reactor operations while the reactor was operational, the inspector stated that there were three documented occasions when the reactor had either exceeded the licensed power limit or had operated in violation of the Technical Specifications in that a limiting condition for operation had not been met. The specifics were discussed briefly. Mr. O'Connor stated that AMMRC could take no corrective action for these matters at this time. The inspector stated that his review indicated that the occasions had been well documented and that appropriate corrective action had been taken at the time of the incidents. The inspector stated that these occasions might be set forth as items of noncompliance which would require no further reply from AMMRC.

The inspector stated that he thought that AMMRC should have had detailed written procedures for the dismantling of the reactor including how the core was to be unloaded and the fuel handled. These procedures should have been reviewed and approved by the Reactor Safeguards Committee. The inspector pointed out that the Technical Specifications stated that AMMRC would have this type of procedure. Mr. O'Connor replied that no corrective action could be taken for this matter at this time. The inspector stated that this might be another item which would be set forth as noncompliance but would not require further reply from the licensee.

The inspector stated that it appeared to him that when the core configuration was changed from 112-G to 114-C on or about December 3, 1969, the core physics parameters should have been more clearly defined. The inspector stated that he observed that some cursory measurements and comparisons were made at that time, however, that the physics parameters, such as excess reactivity, rod worths, and shutdown margin, were not clearly set forth. There was no discussion of this item.

DETAILS

A. Persons Contacted:

Mr. E. Hegge, Associate Director

Mr. E. Shebek, Chief of Administrative Division

Mr. Sid Levin, Chief of Radiation and Occupational Safety Branch

Mr. J. O'Connor, Facility Supervisor and Chief of Technical Programs Branch (former Reactor Manager)

Mr. Charles Dady, Reactor Health Physicist

B. Administration and Organization

The only persons left on hand who were previously associated with the operation of the reactor are Mr. J. O'Connor, the former Reactor Manager and Mr. Charles Dady, former Reactor Health Physicist. Mr. O'Connor has been named as the Facility Supervisor. He reports directly to the Director of AMMRC, Dr. Alvin Gorum. Mr. Dady is now assigned to the Radiation and Occupational Safety Branch and reports to Mr. Levin who in turn reports to Mr. Shebek.

The Reactor Safeguards Committee is currently composed of the following people:

Dr. Priest, Chairman, Chief of Material Science Division

Dr. Tauer, Chemist

Dr. Antal, Physicist

Dr. Chitman, Physicist

Mr. Charles Dady, RSO

The inspector reviewed the minutes of the Reactor Safeguards Committee (RSC) meetings. The inspector's review indicated that the RSC had played an active review function. The following items are some of the matters with which the committee was concerned.

1. The committee had reviewed the circumstances surrounding the dropping of a fuel element on May 6, 1969.* They had concurred in the TWX report to DRL concerning this happening.

2. The committee met on May 22, 1969 and discussed the containment leak test, the results of which were satisfactory. Also discussed were the items of apparent noncompliance pointed out during the AEC inspection on May 8 and 9, 1969. These items concerned the 200 gram fuel elements and the four shim safety rods. The committee thought that the reactor's operation was not in noncompliance with their license in light of discussions which had taken place with DRL. The committee concurred in AMMRC's TWX to DRL dated May 22, 1969 concerning these matters.

*CO Report No. 47/69-1.

3. There was a committee meeting on May 23, 1969, during which they reviewed and concurred on single failure criteria changes related to: (a) containment, (b) slow scram, and (c) fast scram.

4. There was a meeting on August 4, 1969, during which the committee discussed the unscheduled shutdown on July 29, 1969. (See Section C.) Mr. O'Connor stated that the committee had told him to send a letter to the Commission on this matter. He stated that he thought that he had done so; however, the inspector could find no evidence of such a letter in the Region I files. In light of the current status of the facility, no further action is planned on this item.

5. During a meeting on November 4, 1969, the committee reviewed the operations on August 20, 1969, during which the reactor was operated at a power of 2.15 MWt for 90 seconds due to the repositioning of the linear chamber while the reactor was in automatic mode at 1.95 MWt. (See Section C.) Also discussed during this meeting was the abnormal occurrence on October 27, 1969 during which the reactor was operated for 22 minutes without the capability for automatically shutting the isolation valves by the air monitoring unit, as this unit was inoperable. (See Section C.) The minutes also indicated that as part of the semi-annual review, the RSC had reviewed tests for 5 MWt operation, the health physics survey results for the 5 MWt operation, and the unscheduled shutdown file.

6. During a meeting on January 5, 1970, the RSC had reviewed procedures for flux mapping with the Westinghouse subminiature fission chamber.

7. During a meeting on June 2, 1970, the RSC had reviewed the fuel element and shipping procedures for the reactor facility and the National Lead operating instructions for shipping equipment.

8. During a meeting on March 19, 1971, the RSC had reviewed the status of the reactor and the posted procedure for access to the facility. Their recommendations were:

   a. The post-engineer should get at least one person authorized to have access. Mr. O'Connor stated that they were currently getting two persons qualified.

   b. The telephones in the airlocks should be connected to permit communication with Security during access. Mr. O'Connor stated that there is a phone outside the airlock now but it is more convenient to have the one which is mounted on the inside connected.

   c. The radiation work permit should be modified to allow for the maintenance of the air conditioning equipment without a radiation work permit. Mr. O'Connor stated that one of the two persons being qualified for access would be an air conditioning maintenance man.

   At the time of the meeting the RSC made a complete tour of the facility and the minutes of the meeting indicated that they had found the status of the facility to be satisfactory.

C. Operations

From the time of the last inspection on May 7 and 8, 1969 thru June 16, 1969, the licensee was engaged in loading the new 200 gram fuel elements into the desired core configuration. Associated core physics tests and other measurements were made during this time. The final core loading at this time was No. 112-G. On June 17, 1969, operations began at 550 KWt. From that date until August 21, 1969, operations were maintained at less than 2 MWt except on July 29, 1969, and August 21, 1969, when this level was exceeded.

July 29, 1969 Incident

The following is a description of the incident on July 29, 1969, which occurred at 1039 hours.

Personnel assigned at the time were Mr. Robert March, Shift Supervisor, and Mr. Joseph Vella, Reactor Operator. Mr. March was alone in the control room on console duty. The reactor was operating at 1.95 MWt with two primary loops running and a 500 gpm and a 1000 gpm secondary pump running.

The following report was submitted to Mr. J. O'Connor by Mr. March:

"The heat exchanger outlet indicated 92° on the 500 gpm and No.-1 - 1000 gpm secondary pumps. I decreased the vernier adjustment of the automatic power set by approximately 10 mm units (my reason for doing this was to offset the expected increase in reactivity following the starting of an additional secondary pump). No. 2 secondary pump was turned on. While observing the slow reaction time of heat exchanger outlet temperature, the rod drop and safety amplifier trouble light alarm indicated on the panel alarm. The No. 2 "red" drop light showed red. Within 2-1/2 minutes the power increased from 100% $\times 10^{-4}$ to 116% $\times 10^{-4}$ on the linear recorder. The control was operating in the manual position. It is assumed that the control kicked out of servo some time following the adjustment of power set to the turning on of the No. 2 secondary pump. The power recorder increased to 2.1 MWt and the Δ T increased to 8.5°. No other alarms were indicated. On July 30, 1969, at a power level of 200 kilowatts, I tried to reproduce the event without success."

Pending a review, Mr. J. O'Connor removed Mr. March from assignment as shift supervisor.

August 20, 1969 Incident

The following is a description of the incident on August 20, 1969, which was prepared by Mr. P. O'Connor. Personnel assigned at the time were Mr. John Veinott, Shift Supervisor and Mr. Robert March, Operator.

"On August 20, 1969 at 1706 hours, the reactor was inadvertently operated at a power level of 2.15 megawatts for approximately 90 seconds" "due to the repositioning of the linear chamber while the reactor was operating at power level of 1.95 megawatts in the automatic operation mode. The shift supervisor, John Veinott, a senior operator, decided to reposition the log N chamber to correct for rod shadowing effects which caused it to read 150% rather than 97.5%. He was unaware that the log N and the linear chamber connections had been interchanged at pool top at 1218 hours while he was not at the console. When he raised the linear chamber, believing it to be the log N chamber, the automatic control sensed a negative deviation of the power set point that caused the regulating rod to drive out approximately 2 inches, putting the reactor on about a 100-second period. The reactor operator, Robert March, informed Mr. Veinott that the log N power was increasing rather than decreasing. The log N power rose to 200% and levelled off for one minute. Mr. Veinott told his operator to place the reactor under manual control, secured the chambers and returned to the control room. At this point the reactor operator states that he was instructed to withdraw the shim rods. The shift supervisor states that he directed that the reactor be shut down and that he initiated the shutdown himself when the operator did not comply."

On August 21, 1969, license amendment No. 8 became effective. This amendment authorized operation of the reactor at a steady-state power level of up to a maximum of 5 megawatts thermal. New Technical Specifications were also included in this license amendment. Other than the two incidents described above and operation on October 27, 1969 involving a violation of a limiting condition for operation (see below), the inspector's review revealed no other instances in which the reactor was operated outside applicable operating limits.

On August 22, 1969, power was increased to 3 MWt. On August 27, 1969, the reactor was brought to a power level of 4 MWt. On September 2, 1969, the reactor was brought to a power level of 4.95 MWt. The power escalation program was completed with a 79 hour 5 MWt run during the week of September 8, 1969.

October 27, 1969 Incident

The following report describes the incident on October 27, 1969. This report was prepared by Mr. P. O'Connor.

"Confirming verbal report on October 27, 1969, it is reported that on October 27, 1969 the reactor was operated for 22 minutes in a condition which violated Technical Specification 3.2. When the containment building is not isolated, at least one air monitoring unit with readout in the control room shall be operative and capable of automatically closing the containment isolation valve. At 0937 after operating 22 minutes at 3 MWt, the shift supervisor discovered that the first balcony particulate monitor and first balcony gas monitor were inoperative and shut the reactor down. A loose connection was found in the AC power outlet which powered the detector pre-amplifier power supplies on the first balcony. This connection had opened and caused a loss of power to first balcony gas and particulate detectors. Both detectors had been" "operating properly and were checked during the startup check list between 0730 and 0855. The first balcony air monitoring unit has been modified by the addition of a relay which shuts the dampers when the AC power is lost to the first balcony pre-amplifier power supplies or to the first balcony rate meter power supply."

Starting on November 24, 1969, core configuration changes were made. The final core configuration, No. 114-C, was reached on December 3, 1969. The change had resulted in the addition of two new fuel elements in positions D-2 and E-2. Operations were continued at 5 MWt until March 27, 1970 at which time the reactor was shut down.

The inspector observed that whereas the 2 MWt operations had been for two shifts per day, the 5 MWt operations were generally conducted over one shift although on many occasions the operation extended beyond the normal quitting time for the shift. Mr. O'Connor stated that the reactor was run primarily for beam experiments but that approximately six irradiations per week were performed for various parties.

The inspector stated that based upon his review of the operations logs and the safety committee minutes, it appeared to him that the attitudes of the persons involved had not been the best and that he thought this might be attributed to the fact that the operators had probably known that the reactor was going to be shut down for some time before it became a fact. Mr. O'Connor stated that this was true, as the information that the reactor was going to be shut down first came out near September, 1969. Mr. O'Connor stated that he was concerned with the safety of the reactor during the time period before the reactor was actually shut down in March, 1971. Mr. O'Connor stated that he had watched operations more closely during this time period. Mr. O'Connor stated that, in retrospect, he did not think it was a good idea to have a reactor licensed for an extended period of time after the personnel involved had received notice that the facility was to be shut down in the near future. Mr. O'Connor stated that the operators appeared to be somewhat more interested in writing their resumés than in the operation of the reactor.

During the period of January 1, 1969 thru March 27, 1970, the reactor was operated for 1,715 hours and the energy generated was 6,143 MWt.

AMMRC's operations report No. 6 covers the period from January 1, 1969 thru March 27, 1970, and includes information on the operating experience during this time, the pre-neutron and post-neutron tests in support of the 5 MWt operation of the reactor, and the health physics survey at 5 MWt. The reactor test section includes information on core physics measurements through core 112-G.

AMMRC operations report No. 6 indicates that from January 1, 1969 thru March 27, 1970, there were a total of 62 unscheduled shutdowns. The inspector reviewed the unscheduled shutdown file and observed that the categorization of the shutdowns appeared to be correct. There were four unscheduled shutdowns categorized as being caused by operator action. The inspector reviewed these and observed that two of these shutdowns were on July 3, 1969. The reactor was shut down while operating at less than 2 MWt so as to change over from a two primary pump operation to a one primary pump operation when the heater element in the No. 2 pump went out. The other two operator action caused shutdowns were on August 20, 1969 and October 27, 1969 and these occurrences are described previously in this section.

The inspector reviewed the six unscheduled shutdowns categorized as due to operator error. The only one of significance was that on July 27, 1969, and this occurrence is described previously in this section.

D. Facility Procedures

The inspector reviewed the procedures covering the access to the reactor facility which were dated February 3, 1971. These had been reviewed and approved by the Reactor Safeguards Committee. The inspector's review of these procedures indicated that they appeared to provide adequate control of the facility in its present condition. A copy of these procedures is maintained in the CO:I files.

After reviewing the way the fuel was unloaded from the reactor (see Section O), the inspector asked Mr. O'Connor if there had been any written procedures covering the fuel unloading and handling and other dismantling operations. Mr. O'Connor stated that these operations had been discussed by himself and Mr. Paul O'Connor and that they had reached an agreement on how the fuel should be unloaded and handled. Mr. O'Connor produced a copy of National Lead's procedures for triming the fuel elements and he produced a copy of AMMRC's procedures which consisted of only a detailing of the types and kinds of equipment that would be needed to complete the operation. The inspector asked if there were any other procedures covering fuel handling as the Technical Specifications required procedures for this operation. Mr. O'Connor stated that he thought that AMMRC's routine procedures included fuel handling procedures but he was unable to come up with any. The inspector reviewed these routine procedures and the only procedure which seemed to reference fuel handling was procedure No. 385-12, Volume 3-B "Loading or Unloading the Active Lattice." This stated "Loading or Unloading of the Active Lattice may be done only under the direction of a reactor engineer, and the console will be monitored during any such operation. This will be enforced by keeping the handling tools locked in place." Mr. O'Connor stated that the console had been monitored during the operation by Mr. Paul O'Connor. The inspector stated that he thought AMMRC should have had detailed written procedures which would have indicated which elements (reflector or fuel) were to be unloaded first, where they should be stored, and, in addition, when the control rods were to be removed. These procedures should also have included consideration on how the fuel elements were to be transferred from the reactor pool down to the fuel storage pool. This evaluation should have included the appropriateness of using AMMRC's transfer task with nine fuel elements loaded therein. Mr. O'Connor generally agreed that detailed written procedures should have been available.

E. Primary System

The inspector's review of the operations logs indicated that the requirements of Technical Specifications III-6 had been met, namely, the maximum inlet temperature had been less than 110° F and that the minimum water height above the core had been maintained at greater than 21.5 feet. The inspector observed that the reactor pool had been drained. The inspector's review indicated that the primary system was as reported in the deactivation report dated December 8, 1970.

The inspector observed that the operations report No. 6 indicated that the natural convection device flow had been changed to install a larger one. This change was affected on August 11, 1969. Mr. O'Connor stated that this change had been reviewed by the Reactor Safeguards Committee and that the device had been tested 100 times to ensure its proper operation. The inspector further observed that on August 20, 1969, pieces of lead were added to this device. In reply to the inspector's questions about this, Mr. O'Connor stated that he did not consider this to be another facility change. He considered this to be more of an adjustment.

F. Reactivity Control and Core Physics

All core physics measurements pertaining to the operation of the reactor such as rod worths, excess reactivity, rod drop times, etc., are included in Appendix A to AMMRC's operations report No. 6 which covers a period from January 1, 1969 to March 27, 1970. These measurements in the report cover core loadings through core No. 112-G.

The inspector's review indicated that the surveillance requirements in Technical Specification IV.1 had been met. The inspector noted that change No. 1 to License No. R-65, as amended, gave the licensee permission to extend the interval between shim safety rod visual inspection from six months to seven months, which in effect meant that no inspection was required, as the seven-month time period put the minimal inspection requirement past the time of final shutdown.

The inspector's review of the operations logs indicated that during steady-state conditions, the rods had been banked within $\pm$ 2 inches of an average position.* The inspector observed that the flux measuring instruments had been repositioned daily. Mr. O'Connor stated that the thermal power measurements were the primary indication of the reactor power and that the flux measuring instruments were adjusted accordingly, as rod movement and drifting of the instrumentation affected their readings. Whenever either of these causes contributed to a difference approaching 20% with that of the power indicated by the power level instruments, the chambers were repositioned.

The inspector observed that starting on November 24, 1969 thru December 3, 1969, the core configuration had been changed from core 112-G to core 114-C. Two new fuel elements had been added (200 grams each) in positions D-2 and E-2. These elements were closest to shim safety rod No. 1 which was located in core position E-3. The inspector's review of the logbook for December 3, 1969, indicated that some cursory measurements were made to determine whether the worth of rod No. 1 had changed appreciably. A measurement was made to compare rod No. 1 with the reg rod. The logbook indicated that approximately 7/16" of rod No. 1 between 9 and 9-1/2" was equivalent to approximately 2" of reg rod between 8.2 and 10.2". The logbook also indicated that the movement of this amount of rod No. 1 had caused a 150 second period. The inspector asked Mr. O'Connor if any further measurements or determinations had been made as to the new worth of this rod, the worth of the other rods, and the excess reactivity change resulting from the loading of two new fuel elements. Mr. O'Connor stated that there might be more information on this change buried in the file someplace but he did not know where it was at this time or even if there was any information of this type available. The inspector stated that it appeared to him that more measurements should have been made at the time of the change in core configuration, i.e., a measurement to determine that the

*Technical Specification requirement III-6.4.d.

new excess reactivity was within the Technical Specification limit of 6.6% $\Delta k/k$ (Technical Specification III-6.3).

Using the information contained in Appendix A to operations report No. 6, and the information above, an analysis was made by the inspector partly at the time of the inspection and later when the inspector had returned to CO:I. This analysis indicated that the excess reactivity at normal operating temperature for core 114-C would have been somewhat less than 6.6%.

In summation of this matter at the time of the inspection, the inspector stated that although the calculations at this time did not indicate that AMMRC had exceeded the excess reactivity limit, it appeared that the necessary measurements and calculations had not been performed on December 3, 1969, when they should have been. The inspector stated that the core physics parameters should have been clearly defined at that time. Mr. O'Connor generally agreed and reiterated that more information on the core physics parameters might be buried in the files someplace.

Records indicated that the shim safety rods and armatures had been disposed of as high activity waste. The ionization chambers were also disposed of. The fission chambers have been retained and are now covered under SNM license No. 244. Total U-235 contained in these chambers is less than 5 grams.

G. Core and Internals

The inspector observed that the fuel and control rods had been removed. For information on this, see Section O. Mr. O'Connor stated that during operations there had been no problems with fuel failures or faulty control rods.

I. Auxiliary Systems

The reactor pool water cleanup system has been left intact. The demineralizer resins have not been removed. The inspector surveyed the demineralizers and observed that the radiation levels were approximately 50 mR/hr on contact.

The heating and ventilation system has been left in operation and is serviced on a scheduled basis. The temperature is maintained at about 55° to 60° F to prevent freeze-up. The fire extinguishers are still maintained in the reactor building, and the inspector noted that these were checked monthly. There are fire detector heads located in the reactor which automatically sound an alarm at the guard house. The inspector observed that little in the way of combustible material had been left in the building.

Mr. O'Connor stated that the cathodic protection system for the shell had been installed but that it was not yet working properly. Mr. O'Connor stated that this system would be placed in proper working order.

In general, the inspector observed that the auxiliary systems had been left in a condition as described in the deactivation report.

K. Containment

Mr. O'Connor stated that containment isolation requirements had been met for all operations including dismantling, with the exception of the previously reported incident on October 27, 1969. (Section C.)

O. Fuel Handling

As stated in Section D, there were no written detailed procedures for the dismantling operations which included the complete unloading of the core. The unloading of the core preceded in the following fashion. The reactor was shutdown on March 27, 1970 at 2347 hours. On March 30, 1970, the operators started removing the reflector elements. On April 2, 1970, five fuel elements were removed from the grid to the pool (this was approximately 1000 grams). Next, the four shim rods and the reg rod with their partial fuel elements were removed from the core (this was approximately another 500 grams). During all of these operations, Mr. P. O'Connor had manned the reactor console. Mr. O'Connor stated that reactivity considerations had been made and that, as he remembered it, the removal of the reflector elements and the five fuel elements got the core configuration down to approximately 1/2 of the critical mass. The inspector observed that when the control rods were removed, there were reflectors on only two sides of the core. The inspector observed that Appendix A to operations report No. 6 indicated that the critical mass loading for a three-side reflected core was approximately 2500 grams. Mr. O'Connor stated that it would have been approximately 2600 grams for two sides of the reflection. The actual core loading minus burnup at the start of fuel removal would have been approximately 2600 grams. Therefore, it would appear that the reactor had been substantially subcritical when the four shim rods were removed.

By April 9, 1970, all fuel elements had been removed from the grid plate. On April 10, 1970, a survey reading of reflector elements out of water indicated that they read 1 R/hr at 2 feet. The reg rod read 4.5 R/hr at one meter. On April 14, 1970, the last reflector elements and the plugs were removed from the grid plate. On May 7, 1970, the slant irradiation tube was cut. The cut portion read approximately 1 R/hr on contact.

On June 8, 1970, the National Lead Company equipment arrived (cask and saw). This equipment was surveyed. The fuel elements were transferred to the fuel storage facility in AMMRC's own cask. The first of the fuel elements were cut on this day. On June 9, 1970, the saw broke twice. On June 10, 1970, the fuel was placed in National Lead's shipping cask for the first shipment. This consisted of 25 elements. On June 15, 1970, four elements were transferred by AMMRC's cask from the reactor pool to the fuel storage facility. More trouble was experienced with the saw. Mr. Joe Brown from National Lead performed repairs on the saw. On June 16, 1970, more fuel elements were cut. There was more trouble with the saw, and the pump was not working (not removing chips). On June 19, 1970, the National Lead shipping cask was loaded for a second shipment. This consisted of 28 elements. Cutting then continued. The saw was sent back to National Lead in the same shipping box as it had arrived in due to more trouble.

On June 25, 1970, element N-19, which was the one which had been dropped on May 6, 1969 (see Section B) during core loading, was cut in the machine shop. This was a cold element.

On September 28, 1970, the saw had been received back from National Lead and the cutting of the fuel elements was resumed. On September 30, 1970, the remaining 28 elements were loaded in the National Lead cask for the third and last shipment. Subsequent to this, three unirradiated elements were sent to National Lead Company, Albany, New York, in a National Lead furnished packing container.

The inspector observed that the licensee possessed License No. SNM-1165 which had been received November 28, 1969. This license authorized AMMRC to deliver to a carrier for shipment, the MTR fuel elements in a National Lead cask model No. NL-BF-MTR-775. This cask has been approved by special permit No. 5786 for up to 28 fuel elements, each containing up to a maximum loading of 306 grams. National Lead had supplied AMMRC with a whole package of operating procedures covering the cutting and shipping of the fuel elements. The inspector observed that AMMRC had tested the boral plates in the shipping cask before using it for shipping to ensure that they had not been replaced with a substitute such as aluminum. Calculations and measurements had been performed to determine the decay heat left in the fuel elements. This had turned out to be much less than the 18,500 BTU/hour limit for this cask.

The inspector reviewed material transfer forms AEC-741's which indicated the following. The first shipment (actually logged on form #388) was shipped on June 11, 1970, and contained 3,266 grams of U-235 in 25 pieces. The second shipment was shipped on June 19, 1970 and contained 2,706 grams of U-235 in 28 pieces. The third shipment was shipped on September 30, 1970, and contained 4,217 grams of U-235 in 28 pieces. All of these three shipments had been received at SRL by October 2, 1970. On December 7, 1970, three unirradiated fuel elements containing 614 grams of uranium were shipped to National Lead, Albany, New York. These were received by December 10, 1970.

Material Status Report OR-674 indicated that AMMRC had remaining on hand 4.8 grams of U-235 contained in four fission chambers. This material is covered by License No. SNM-244 which also covers the 5 curie plutonium-beryllium source and other miscellaneous material such as neutron filters and neutron beam monitors. The fission counters were observed to be locked in cabinet No. 47 in the reactor building. (Cabinet 47 also contained the five control magnets and a probe source for the area monitoring system, Tracerlab model TA-63.)

P. Radiation Protection

Mr. Dady stated that he had been the reactor health physicist and that he and his technician had covered the reactor operations and dismantling. Mr. Dady stated that since the reactor has terminated operations, he has been temporarily assigned to the Radiation & Occupational Safety Branch of which Mr. Levin is in charge.

Mr. Levin and Mr. Dady stated that all radioactive material which had been associated with the operation of the reactor, is now covered by either one of the aforementioned SNM licenses or under byproduct material license No. 20-1010-4. The inspector noted that this license authorized isotopes with atomic Nos. 3 thru 83 in a total not to exceed 100 curies in all forms. This appeared to adequately cover the calibration sources and radioactive material which was left over from the previous reactor operations.

The inspector reviewed the exposure records for the 2nd, 3rd and 4th quarter of 1969, and the year 1970. The medical department maintains DOD forms 1141 which are equivalent to form AEC-5's. These forms were maintained only for people who are still employed at AMMRC. Persons who have left AMMRC's employ and are still government employees, have their files forwarded. Other persons who have gone on to civilian occupations, have their files sent to the storage facility in Kansas City. The personnel department notifies the medical department as to which employees have terminated. Only three employees are still on hand who had been associated with reactor operations. These are Mr. J. O'Connor, Mr. Dady, and Mr. Doody, an electronics technician. The inspector reviewed their forms 1141 and found them to be adequate. AMMRC did not maintain a form AEC-4 for their employees and so therefore were limited to an exposure not to exceed 1.25 rem/calendar quarter. Film badges were supplied by the Department of the Army, Blue Grass Army Depot, Lexington, Kentucky. Films for both beta-gamma and neutrons were provided in these badges. The inspector reviewed the records which were available and observed that approximately 33 persons had been monitored. The inspector observed that the highest exposure for 1969 had been received by Mr. R. Cook. His total was 1.436 Rem for the year. He had received an exposure of approximately 110 mrem/month with a maximum of 200 mrem/month during December, 1969. The maximum neutron exposures had been approximately 50 mrem/month with the normal exposure being 0. During 1970 the maximum exposure was approximately 100 mrem/month and the average was less than 50.

The inspector observed that Appendix B to operations report No. 6 contained the complete health physics survey of the reactor during the initial stages of the 5 MWt operations. This had been completed in October, 1969. In reply to the inspector's question, Mr. Dady stated that changes which had been brought about as a result of the higher radiation levels during 5 MWt operation had included the adding of shielding to certain facilities, and the addition of an interlock at the maze entrance in the basement to the area of the reactor primary pumps and cleanup system.

During the course of the inspection the inspector had surveyed the reactor facility and found that the levels observed agreed with those reported in Section G of the Deactivation Report of the AMMRC Reactor, dated December 8, 1970. The inspector observed that the newly proposed Technical Specifications contained in Section G of this Deactivation Report indicated that a general radiation survey including smears would be conducted monthly in the reactor facility. The inspector asked to see copies of these inspections. Mr. Dady stated that there had been no survey taken since the time of the survey taken for the deactivation report (October, 1970 until just recently in March, 1971). The inspector reviewed this survey and observed that 17 swipes were counted in a gas flow proportional counter and that the results indicated less than 200 dpm/100 cm^2. An air sample taken from the reactor pool area indicated approximately background. (This would have been equal to or less than 4×10^{-12} uCi/ml). The radiation survey portion indicated levels which were in agreement with the previous deactivation report, and they were essentially the same as those found by the inspector during the inspection.

The inspector commented that if it had been felt necessary to include the monthly radiation survey requirement in the new Technical Specifications, it should have been complied with. Mr. Dady and Mr. Levin agreed and stated that in the future monthly surveys will be taken.

Q. Radioactive Waste Systems

1. Gaseous Effluents

The inspector reviewed the calibration of the top balcony effluent monitor (closest instrument to a stack monitor) and AMMRC's method of determination of stack gaseous and particulate effluents. During operation this monitor pulls a sample from the exhaust immediately after the HEPA filter and prior to exit from the reactor facility and entry into the stack. The monitor consists of a GM tube looking at a moving tape particulate filter (HV-70) and the gaseous detector which has a chamber for the gas and a GM probe looking at the gas within this chamber. The inspector observed that the sampling point was right after a 180° bend in the exhaust duct. Mr. Dady stated that the probe was not an isokinetic probe. The inspector commented that this sampling system did not appear to be adequate, especially for particulates. Mr. Dady agreed. Mr. Cady stated that the gaseous detector had been originally calibrated with argon-41 obtained by activating air. His description of the calibration procedure indicated that it was adequate. Mr. Cady stated that the detector was calibrated in this fashion approximately once per year. Mr. Cady stated that he had taken samples of stack air in a Marinelli beaker and counted them on the NaI crystal associated with the gamma spectrometer. These results indicated that essentially all of the activity released was argon-41. This monitor incorporated a scaler from which a daily reading of the integrated count was taken. These counts were averaged over a month and were used to determine the monthly release.

The monthly discharge rates for 1969 for both gaseous and particulates is contained in the AMMRC operations report No. 6. The stack flow rate was 1,000 cfm and the total curie release may be calculated using this figure. Mr. Cady produced the following information from records for releases during January and February, 1970.

Month	Particulate Concentration	Gaseous Concentration
January	1.8×10^{-11} uCi/cc	6×10^{-6} uCi/cc
February	2.3×10^{-11} uCi/cc	9×10^{-6} uCi/cc

Mr. Cady stated that he coul' not find the records for the March, 1970 effluent releases. During a subsequent review of reactor operations, the inspector observed that the operators had recorded the readings of the gaseous and particulate monitors on an hourly basis. The inspectors suggested that Mr. Cady utilize these hourly readings to determine the gaseous and particulate effluent releases during March, 1970. Mr. Cady subsequently did this, and his results indicated the following for March, 1970.

Gaseous : 6.45×10^{-6} uCi/ml

Particulates : 2.5×10^{-11} uCi/ml

Records indicated that at 5 MWt the release rate for gaseous activity was approximately 5 x 10^{-5} uCi/ml. Mr. Cady stated that, in addition to the particulate and gaseous readings, he had also taken iodine samples utilizing charcoal cartridges during operations at 5 MWt. Analysis of these charcoal cartridges indicated concentrations of approximately 5 x 10^{-14} uCi/ml.

The inspector observed that AMMRC was within their limits for radioactive effluents which are contained in Technical Specification III-2.1. AMMRC released, on a yearly average basis, approximately 1% of their limit for gaseous effluents. The inspector also reviewed the set points which had existed for alarm and isolate conditions on the stack monitor. The inspector's review indicated that these set points had been properly set.

2. Liquids

The inspector observed that AMMRC operations report No. 6 indicated that 0.654 mCi of liquid waste had been disposed of to the sanitary sewerage system for the calendar year 1969. The inspector asked Messrs. Cady and Levin for records pertaining to these releases and subsequent releases in 1970 when the reactor systems had been drained. Mr. Cady stated that he could find no records containing information on any of these releases. Mr. Cady stated that a Mr. Leo Foley, the former radiochemist, had performed these analyses and that this information for the last three years had been recorded in a logbook. During the dismantling and moving operations, this logbook had somehow come up missing. Mr. Cady stated that he had looked all over the reactor facility and through all his records to no avail. Mr. Cady stated that he thought that Mr. Foley, who had since transferred to the Army Materials Command, Field Safety Agency, Charleston, Indiana, might have taken the record with him. During the inspection, Mr. Cady called Mr. Foley by telephone and asked him if he had this logbook. Mr. Foley told Mr. Cady that after a five-minute search he couldn't find it but that he would continue to look for it, and if it did show up, he would send it to AMMRC. The inspector stated that not maintaining records of liquid releases was an item of noncompliance and that AMMRC would be cited for the same.

Mr. Cady stated that all releases had been batch releases and that samples had been analyzed before the release was made. Mr. Cady stated that the most predominant isotopes released were cobalt-60, iron-59, and cromium-51. Mr. Cady stated that AMMRC was well below release limits.

3. Solids

Mr. O'Connor stated that all radioactive solid waste had been disposed of to a licensed commercial disposal firm. The inspector reviewed records of these waste shipments which indicated the following.

There was a shipment made on June 15, 1970 by Nuclear Engineering Company in their own truck in a container authorized under DOT Permit #SP-6058. This container had contained: 30 beryllium oxide reflectors reading approximately 5 R/hr at one foot; 8 assemblies of shim safety rods and armatures reading approximately 5 R/hr at one foot; and one control rod.

The next shipment was made in the same container with the same company on November 10, 1970. This shipment contained the ends of the fuel elements which read approximately 10 R/hr and miscellaneous stainless steel pieces, such as the ends of the guide tubes.

The third shipment was made on March 23, 1971. This shipment was in a dumpster which was carried by an exclusive-use vehicle and was shipped to Nuclear Engineering Company. The dumpster had contained approximately 1100 mCi of mixed fission products in 83.4 cubic feet of waste. The dumpster had read approximately 60 mR/hr at 2 inches at 16 mR/hr at one meter.

R. Environment

Messrs. Cady and Levin stated that although an environmental monitoring program had been proposed for the reactor facility, there had never been any measurements made outside of the facility itself.

S. Experiments and Tests

Mr. O'Connor stated that there had not been any new experiments other than the irradiation of a few new types of materials in the irradiation facility. The inspector's review of the minutes of the Reactor Safeguards Committee meetings indicated that this committee had reviewed and approved these new irradiations.

T. Facility Modifications

The inspector's review indicated that facility modifications had been as described in operations report No. 6 and in the deactivation report dated December 8, 1970, except for the following.

1. The deactivation report indicates in Section C.f. that the inflatable rubber gaskets on the doors of the air locks have been removed. The inspector found that the rubber gaskets had not been removed.

2. Section C.k. of the deactivation report indicates that the cathodic protection system of the shell is being replaced by the post engineer. Their report states that this work will be completed and the system maintained. The inspector found that the system had been replaced but was inoperable. Mr. O'Connor stated that work was continuing to make the system operable.

3. Section C.k. of the deactivation report indicates that the 40,000 gallon retention tank which is located between the shell and building 97 has been drained and cleaned. The inspector found that this tank has been drained but that it is not clean. A report dated January 19, 1971 from Mr. Dady to Mr. Levin indicated that as much as 100 mCi may be left in the tank which can probably only be removed by scrubbing walls and floors with a detergent. AMMRC personnel later indicated that this tank would be cleaned some time in the future and that it would probably be done by outside personnel on a contract basis.

FORM AEC-591
(6/71)

UNITED STATES ATOMIC ENERGY COMMISSION

DIVISION OF COMPLIANCE

INSPECTION FINDINGS AND LICENSEE ACKNOWLEDGMENT

1. LICENSEE	2. REGIONAL OFFICE
Department of the Army Army Materials and Mechanics Research Center Watertown Massachusetts 02172	U. S. Nuclear Regulatory Commission Office of Inspection& Enforcement Region I 631 Park Avenue Kingof Prussia, Penna. 19406

3. DOCKET NUMBER(S)	4. LICENSE NUMBER(S)	5. DATE OF INSPECTION
	SUB-238 SNM-244 20-01010-04	February 18, 1976

6. INSPECTION FINDINGS

The inspection was an examination of the activities conducted under your license as they relate to radiation safety and to compliance with the Commission's rules and regulations and the conditions of your license. The inspection consisted of selective examinations of procedures and representative records, interviews with personnel, and observations by the inspector. The findings as a result of this inspection are as follows:

☒ No items of noncompliance or unsafe conditions were found.

The following items of noncompliance related to records, signs, and labels were found:

☐ A. Rooms or areas were not properly posted to indicate the presence of a RADIATION AREA. 10 CFR 20.203(b) or 34.42

☐ B. Rooms or areas were not properly posted to indicate the presence of a HIGH RADIATION AREA. 10 CFR 20.203(c) (1) or 34.42

☐ C. Rooms or areas were not properly posted to indicate the presence of an AIRBORNE RADIOACTIVITY AREA. 10 CFR 20.203(d)

☐ D. Rooms or areas were not properly posted to indicate the presence of RADIOACTIVE MATERIAL. 10 CFR 20.203(e)

☐ E. Containers were not properly labeled to indicate the presence of RADIOACTIVE MATERIAL. 10 CFR 20.203(f) (1) or (f) (2)

☐ F. A current copy of 10 CFR 20, a copy of the license, or a copy of the operating procedures was not properly posted or made available. 10 CFR 20.206(b)

☐ G. Form AEC-3 was not properly posted. 10 CFR 20.206(c)

☐ H. Records of the radiation exposure of individuals were not properly maintained. 10 CFR 20.401(a) or 34.33(b)

☐ I. Records of surveys or disposals were not properly maintained. 10 CFR 20.401(b) or 34.43(d)

☐ J. Records of receipt, transfer, disposal, export or inventory of licensed material were not properly maintained. 10 CFR 30.51, 40.61 or 70.51

☐ K. Records of leak tests were not maintained as prescribed in your license, or 10 CFR 34.25(c)

☐ L. Records of inventories were not maintained. 10 CFR 34.26

☐ M. Utilization logs were not maintained. 10 CFR 34.27

☐ N. Records of radiation survey instrument calibration were not maintained. 10 CFR 34.24

☐ O. Records of teletherapy electrical interlock tests were not maintained as prescribed in your license.

☐ P. Other ____________________

Charles T. Stearns
(AEC Compliance Inspector)

7. The AEC Compliance Inspector has explained and I understand the items of noncompliance listed above. The items of noncompliance will be corrected within the next 30 days.

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(Date) (Licensee Representative - Title or Position)

ORIGINAL TO LICENSEE