U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT

Region 1

Report No. 70-687/82-05

Docket No. 70-687

License No. SNM-639 Priority 1 Category UR

Licensee: Union Carbide Corporation

P. O. Box 324

Tuxedo, New York 10987

Facility Name: Hot Laboratories

Inspection at: Tuxedo, New York

Inspection conducted: June 28-July 2, 1982

Inspectors: J. Roth 7/21/82
J. Roth, Project Inspector date signed

Approved by: for R. E. Keimig 8/2/82
R. R. Keimig, Chief Projects Branch #2 date signed

Inspection Summary:
Inspection on June 28-July 2, 1982 (Report No. 70-687/82-05)
Areas Inspected: Routine unannounced inspection by a region-based inspector (48 hours) of the licensed program including: organization, facility changes and modification, internal review and audit, safety committees, training, maintenance, review of operations, nuclear criticality safety, transporation, nonroutine events, licensee action on previously identified enforcement items, followup on headquarters requests (plutonium content of waste), and, participation in licensing/licensee meetings.

Results: No violations were identified.

DETAILS

1. Persons Contacted

   * J. J. McGovern, Business Manager, Radiochemicals
   * M. H. Voth, Manager, Nuclear Operations
   * D. D. Grogan, Manager, Radiochemical Production
   * C. J. Konnerth, Manager, Health, Safety and Environmental Affairs
   * F. J. Morse, Manager, Radiochemical Process Engineering
   * L. C. Thelin, Health and Safety Supervisor

   * denotes those present at the exit interview

   The inspector also interviewed other licensee employees during the inspection.

2. Licensee Action on Previously Identified Enforcement Items

   (Closed) Infraction (687/80-04-01, Criticality Monitoring System does not meet requirements of 10CFR70.24(a). The inspector verified that the licensee completed installation and activated a new facility wide criticality monitoring system on June 30, 1982. This new system, which is described in detail in paragraph 5a of this report meets the requirements of 10CFR70.24(a)(1). Corrective actions were completed.

   (Closed) violation (687/81-06-01) Failure to indicate the actual amount of Special Nuclear Material (SNM) present on the criticality safety sign posted near the Lower Level Counting Area. The inspector verified that the licensee was maintaining a log indicating the quantity of SNM present in the Counting Area. Corrective actions were completed.

   (Closed) Violation (687/81-07-01) Failure to post a nuclear safety sign in the target counting room and maintain a running balance of SNM in the area. The inspector verified that the licensee posted a nuclear safety sign in the target counting room and was maintaining a running balance of all the SNM located in the area. Corrective actions were completed.

   (Closed) Violation (687/81-07-02) Failure to audit the licensed SNM program every 12 months. The inspector verified that the licensee conducted an audit of the licensed SNM program on November 3, 1981 and has modified the computer "tickler" file to assure that all audits are conducted in a timely manner. Corrective actions were completed.

3. Organization

   As was previously discussed in inspection report 70-687/81-07, the inspector determined that portions of the Sterling Forest site had been leased to the Cintichem subsidiary of Hoffmann-La Roche effective

during April, 1981. The site and buildings are owned by Union Carbide. The Reactor and Hot Laboratory are owned and operated by Union Carbide for the benefit of Cintichem. However, during the current inspection the inspector determined that not all personnel working in the Reactor and Hot Laboratores were Union Carbide employees. Those personnel responsible for U-235 analysis and Quality Control of the "targets" are employed by Cintichem. Therefore, there are periods of time during the processing of the U-235 when employees of a subsidiary of a foreign based company may control the SNM. This may be contrary to the provisions of the Atomic Energy Act of 1954 as amended (Sec. 57). According to licensee representatives, Cintichem is a subsidiary of Roche-America which is a subsidiary of Hoffman-LaRoche. All officers of Roche-America are U. S. citizens. Roche-America conducts business only in the United States. Quality control personnel, formerly employees of Union Carbide and all U. S. citizens, were transferred to the Cintichem payroll during 1981 and do not control significant quantities of SNM (less than 350 grams U-235) at any one time. This was identified as an unresolved item which will be referred to NRC NMSS for resolution (82-05-01).

4. Review of Operations

The inspector examined all areas of the hot laboratory facility to observe operations and activities in progress, to inspect the general state of cleanliness, housekeeping, and adherence to fire protection rules, and to assure that all areas in which SNM was handled or stored were properly posted with proper radiation safety or criticality safety signs as required by federal regulations or license conditions.

a. Solution Make-Up Area

The inspector noted that a plastic bottle of U-235 in solution was stored in Feed Cabinet No. 4. This bottle was encapsulated in one sealed plastic bag. Storage requirements state that solutions shall be double encapsulated. The inspector stated that the bottles should be encapsulated in two sealed plastic bags to maintain integrity in case the plastic bottle leaked. The licensee stated that the plastic bottle was considered to be one layer of encapsulation. This was discussed at the exit interview.

No violations were identified.

b. Waste Storage Building

The inspector observed that a portion of the locked waste storage building (low level waste) was roped off to restrict entry to high radiation areas of the building. The inspector stated that the rope should be posted with a sign to inform employees of the radiation level at the rope to preclude loitering in a zone of elevated radiation. This was discussed at the exit interview and the licensee stated that a sign with the required information would be posted on the rope.

No violations were identified.

c. New Waste Storage Facility

The inspector noted that the licensee had initiated use of the new high level waste storage facility authorized by Amendment 7 to License No. SNM-639, dated November 25, 1981. Storage of waste was initiated on February 10, 1982 and as of the date of this inspection 56 of 100 storage locations had been filled. Forty-five of the fifty-six filled locations contain SNM.

The inspector observed the transfer of drum number 7F from a Model B-3 cask located outside the hot cells into hole Number 32. The entire area was cleared of personnel as the drum was transferred from the B-3 cask into the transfer cask.

The drum was placed into the transfer cask through the top. The top plate of the transfer cask was outfitted with 4 magnets which held the drum in place for subsequent lowering into the storage cavity through the open bottom. The transfer cask was moved into the waste storage facility by crane. The cask was then picked up by a special cart for placement over a preselected and opened storage location. Radiation levels on contact with the transfer cask approached a maximum of 40 mR/hr. During lowering of the drum into the vault hole, instantaneous radiation readings of 1R/hr were observed at floor level at about six feet from the cask-floor interface. During this operation personnel maintained a distance of about 10 feet from the transfer cask. Upon completion of this operation, radiation readings were taken at the surface of the hole, contamination smears of equipment used were taken and the vault hole cover was replaced and sealed.

No violations were observed.

d. Housekeeping

The inspector observed that housekeeping within the various areas of the facility was adequate.

No violations were identified.

5. Nuclear Criticality Safety

a. Nuclear Criticality Safety Monitors

As stated previously, the licensee has completed installation of a new criticality monitoring system. The system was made operational on June 30, 1982. The system consists of eight monitors in the Hot Laboratory and five monitors in the Research Reactor facility. The monitors in the Hot Laboratory are new Eberline RMS-II units and Tracerlab units are used in the reactor facility. The alarm logic has been established in accordance with 10CFR70.24(a)(1) which

requires that two monitors must be set off to activate the evacuation signal. In the Hot Laboratory the alarm pairs are: machine shop-South Dock, South Dock-Gamma Facility, Gamma Facility-Packaging Area, Packaging Area-Waste Storage Facility, Packaging Area-Make-up Lab North, Radiochemistry Laboratory-Make-Up Lab North, Gamma Facility-Make-Up Lab South, and Make-Up Lab North-Make-Up Lab South. In the Reactor Building, the alarm pairs are: South Reactor Wall (third floor) - Canal South End, South Reactor Wall (third floor) - East Reactor Wall, Canal South End-North Reactor Wall, North Reactor Wall-East Reactor Wall, and, East Reactor Wall-Reactor tunnel. In each case, the alarm pairs are fail-safed so that in the event of a monitor failure, either upscale or downscale, the second monitor is armed to immediately set off the evacuation alarm. The alarm set points have been set at 1 R/hr. radiation level which has been calculated to be less than the requirements of 10CFR70.24(a)(1).

No violations were identified.

b. Calibration and Criticality Monitors

The inspector determined that each monitor had been calibrated upon installation into the new criticality monitoring system.

No violations were identified.

c. Monitor checks and tests

The inspector verified that the licensee conducted documented daily operability tests and weekly alarm checks on each radiation/ criticality monitor between January 4, 1982 and June 4, 1982. Corrective action was taken and completed when inadequacies were identified.

No violations were identified.

6. Safety Committees

a. Nuclear Safeguards Committee

The inspector examined the records of 2 meetings of the Nuclear Safeguards Committee held between August 12, 1981 and April 6, 1982. In each case, review actions and recommendations made by the committee were adequately documented. Included in these records were supporting documents used by the committee to develop the recommendations made. In addition, the implementation of these recommendations was adequately documented in the committee minutes. The next meeting of this committee is scheduled for July 6, 1982.

No violations were identified.

b. General Safety Committee

The licensee has established a management level General Safety Committee. The committee consists of the following personnel:

R. A. Johnston, Chairman, Safety Officer, UCC
M. E. Bordoni, Manager, Production, Cintichem
F. Fuest, Laboratory Director, Cintichem
R. E. Hubbard, Manager, Maintenance and Engineering, Cintichem
C. J. Konnerth, Manager, Health, Safety and Environmental, UCC
J. J. McGovern, Business Manager, Radiochemicals, UCC
L. C. Thelin, Supervisor, Health and Safety, UCC

The committee will review general safety and operational radiation safety aspects of the facility. Building Safety (Industrial) inspections will be conducted monthly. First aid training and Fire Training will be provided, areas of the facility will be inspected for housekeeping, fire hazards, use of safety glasses and safety shoes, and, accidents will be investigated by the committee.

The committee held an organizational meeting on May 6, 1982 during which the scope of responsibility was reviewed and the results of a Building 1 and 2 Safety Inspection conducted on April 21, 1982 was examined.

No violations were identified.

7. Facility Changes and Modifications

The inspector determined that only one significant facility change occurred since the last inspection. This change, initiation of use of the Waste Drum Storage Facility, was previously described in Paragraph 4c.

No violations were identified.

8. Review of Nonroutine Event Reports

The inspector reviewed licensee records and determined that only one non-routine event within the scope of this inspection occurred at this facility since the last inspection.

Two containers of recovered uranium fell behind the storage rack in Cell No. 5 over the weekend of May 15-16, 1982. On May 17, 1982, the cell door was opened to locate the two containers with the aid of TV cameras. On May 18, 1982, cell 5 was reopened to retrieve the two containers. Personnel received no significant radiation dose during this operation and there were no airborne releases from the hot cell.

No violations were identified.

9. Internal Review and Audit

Tne inspector examined the records of 8 audits of the facility conducted between October 9, 1981 and February 2, 1982. The audits covered various aspects of facility operation including: operations, training, security, transportation and measurement quality assurance, the SNM accountability program, and, the SNM nuclear safety program.

The inspector discussed the facility audit program at the exit interview and stated that the licensee should consider establishing an ongoing operational audit program which could be maintained by the Health Physics group. This audit should include at least a weekly documented review of postings, container marking, operational status of radiation monitors and instruments, contents of bulletin boards, etc. The licensee stated that this would be reviewed for applicability to the facility operation.

No violations were identified.

10. Training

a. New employee

The inspector examined the training records for 35 new employees hired between January 5, 1981 and June 1, 1982. The licensee uses a training pamphlet entitled "Understanding Radiation" as the basis for training. The Training Manual was also reviewed. This manual included: instructions for the accounting for special nuclear materials; title 10 Code of Federal Regulations Parts 70 and 73; and License No. SNM-639 license conditions.

The test results for several new hires were examined. The tests appeared to be comprehensive. The licensee considers a 70 percent score to be passing. The minimum test score observed during review of the records was 85 percent.

No violations were identified.

b. Health Physics Technician Training

The licensee has established an annual ongoing training program for health physics technicians. The training sessions held between August 5, 1981 and November 17, 1981 covered significant aspects of health physics including: filter efficiency calculations, techniques of decontamination, hot cell entry procedures, equipment calibration, SNM accountabiltiy and use of breathing air systems.

No violations were identified.

11. Maintenance

The inspector discussed various aspects of the Hot Laboratory

maintenance program with licensee representatives. The maintenance program includes routine and preventative maintenance of ventilation systems, hot cell manipulators, the hot cell conveyor system, and hot cell windows. Procedures have been written for changing ventilation system filters, and hot cell window oil. The inspector examined records of monthly and weekly checks of pressure drop across ventilation system filters and laboratory hood face velocity flow rates from January 30, 1978 through April 28, 1982. Absolute filters are changed when the pressure drop exceeds 2 inches water. All make-up laboratory filters are changed at least once each year unless required at a more frequent interval. Pressure sensors and magnehelic gauges are replaced when necessary (high readings, plugged, etc.).

No violations were identified.

12. Transporation

a. QA Program for Packages

The licensee conducted the annual audit of Type B packages on May 13, 1982. No problem areas were identified. However, there were two areas of concern, it was felt that a more formal method of recording specification 2 R containers leak rate data should be devised and many of the welds on the Uranium Waste Fission Product containers had to be rewelded because of leaks identified during QC Testing. Corrective action has been initiated by the licensee.

No violations were identified.

b. Receiving

The inspector examined the receipt records of SNM for the period January 5, 1982 through June 23, 1982 and determined that the licensee was maintaining records of monitoring upon receipt of a package of radioactive material as required by 10CFR20.205(b)(1).

No violations were identified.

c. Shipping Records

The inspector examined records of waste and/or SNM shipments made during the period October 6, 1981 through May 20, 1982, and determined that radiation surveys were taken and recorded, and all shipments were labeled, marked, placarded, inspected and recorded as required.

It was noted that one of the radiation readings recorded on the bill of lading was taken on the surface of the cask and not on the surface of the vehicle as indicated on the form. This form will be revised by the licensee to reflect actual practice.

No violations were identified.

13. Licensing/Licensee Meeting

On June 30 and July 1, 1982 meetings were held with NRC-NMSS personnel, an NRC-NMSS contractor, and licensee representatives attending. The inspector participated in these meetings which covered various aspects of the prepartion of the License No. SNM-639 renewal application. Areas discussed included: the relationship between the New York State and NRC licensing authority, preparation of needed environmental information, preparation of a consolidated license renewal application, preparation of a site wide emergency plan, preparation of accident analysis information and specific information required by NRC to conduct a safety assessment on the renewal application. The licensee was informed that the required information was to be submitted in the following order of priority.

1. Emergency plans/accident analysis information
2. Environmental Information
3. Consolidated Renewal Application

Item 1 above was to be submitted to NRC by September 6, 1982 followed by the Item 2 information. Item 3 information was expected to be submitted by January 1, 1983.

14. Transuranic Content of Process Waste for Burial

a. Background

During inspection 70-687/80-02 all areas of concern, listed in a letter from Howard G. Shealy, Chief, Bureau of Radiological Health of the State of South Carolina to G. Wayne Kerr of the NRC Office of State Programs dated December 7, 1979, were addressed with the exception of concerns with the transuranic element content in shipments of waste to the Chem-Nuclear burial site. Since that inspection, NRC Region I and the licensee have developed, implemented and completed an analytical test program to determine the transuranic element content of the waste.

b. Sampling and Analysis

During Inspection 70-687/82-01 conducted on January 8 and 11, 1982, a Region I inspector observed the sampling of the Raw Fission Waste and the waste process filtrate. Direct sampling of the waste form sent to the burial site was not considered to be acceptable because the form of the material is a non-homegeneous sludge which would preclude representative sampling. The transuranic content of the waste form can be calculated by difference following analysis of the raw fission waste and filtrate.

Four samples each of the raw fission waste and filtrate were taken under controlled conditions to assure that each contained exactly 3 ml of solution. Two samples of each were sent to Oak Ridge National Laboratory (ORNL) by the licensee and to Exxon-Idaho by the NRC for analysis. The analytical results are tabulated in Table I attached to this report. As can be seen in the table, Exxon-Idaho analyzed and reported analytical values for each sample in duplicate. ORNL reported only one analytical value for each sample analyzed. The ORNL plutonium isotopic results were not reported since ORNL contaminated the sample during sample preparation. In addition to plutonium concentration, analytical results were obtained for uranium concentration, uranium isotopic and major fission products observed.

c. Discussion of Results

Although additional analytical results are presented in Table 2, this discussion will be restricted to the results concerning transuranic elements (plutonium). The raw fission waste consisted of a total volume of 3000±100 ml. The filtrate consisted of a total volume of 3400±100 ml. On the basis of these volumes, the waste form sent to the burial site (the difference between the two values) contains 3.264 ± 0.123 mgram plutonium per batch of waste form prior to solidification. On the basis of the plutonium isotopic values depicted in table 2, a batch of waste form contains 1075.2 microcuries of transuranic isotopes per batch of waste form prior to solidification (Pu-239+240+242-218.1 microcuries; Pu 241-857.1 microcuries). Upon solidification, the waste form sent to burial contains 46.4 nanocuries of transuranic isotopes per gram of waste (9.4 nanocuries of Pu-239+240+242; 37.0 nanocuries of Pu-241). These latter values are based on solidification of the waste batch with a minimum of 51 pounds of the solidification medium.

The accuracy of the Pu241 and Pu 242 values shown in Table 2 is questionable because the precision indicated by the 1 sigma error bands for the isotopic analytical results indicate that these isotopes may not be present in significant quantities within the mixture. Therefore, if all of the plutonium present were treated as the Pu-239 and Pu-240 isotopes, the waste form sent to burial would contain 9.4 nanocuries of plutonium per gram of waste sent to burial.

d. Conclusions

The conclusions derived from this study depend on the method used for the calculation of the number of curies of plutonium contained in the waste form.

1.) If each transuranic isotope is treated seperately, the waste does not meet the criteria defined in license condition 32 of the Chem-Nuclear Systems, Inc., State of South Carolina License No. 097 dated January 8, 1982.

2.) The licensee states that there is a verbal agreement with the State of South Carolina and the burial site to treat all plutonium as Pu-239 (Reference: licensee's trip report dated June 23, 1982) The referenced trip report also indicated that the South Carolina personnel at the meeting stated that there were no objections to the present method of determining compliance with the transuranic limit (the licensee's current method is to treat all plutonium as Pu-239.) If this is the case, the transuranic isotopic content of the waste sent to burial will meet the conditions of the burial site's State of South Carolina license.

3.) The licensee's waste as sent to the burial site meets the criteria defined in proposed 10CFR Part 61.

The inspector discussed the statements made by the licensee, as shown above in paragraph 14d(2), with representatives of the State of South Carolina, Department of Health and Environmental Control. The State of South Carolina would not specifically concur that there was a verbal agreement as indicated by the licensee. However, they realize that there are technical problems associated with the analytical techniques used to determine the isotopic distribution of the small quantity of plutonium contained in the waste form as discussed in paragraph 14c. As long as small quantities of plutonium are involved, final resolution of the transuranic content by istopic analysis will be deferred to a later date.

15. Unresolved Items

Unresolved items are matters about which more information is required in order to ascertain whether they are acceptable items, items of noncompliance, or deviations. An unresolved item disclosed during this inspection is discussed in Paragraph 3.

16. Exit Interviews

The inspector met with the licensee representatives (denoted in Paragraph 1) at the conclusion of the inspection on July 2, 1982. The inspector summarized the scope and findings of the inspection and stated that no violations were identified. The licensee (Mr. C. Konnerth) was notified of the unresolved item discussed in Paragraph 3 by telephone on July 7, 1982.

TABLE 1

Union Carbide Corporation Process Waste Sample Analysis

	U conc. (mg U/mL)	U-234 (a/o)	U-235 (a/o)	U-236 (a/o)	U-238 (a/o)	Pu conc. (μg Pu/mL)	Pu-238 (a/o)	Pu-239 (a/o)	Pu-240 (a/o)	Pu-241 (a/o)	Pu-242 (a/o)	Sr-90 (mCi/mL)	Ce-144 (mCi/mL)	Ce-141 (mCi/mL)	Ru-103 (mCi/mL)	Cs-137 (mCi/mL)	Zr-95 (mCi/mL)	Nb-95 (mCi/mL)
EXXON/NRC																		
Raw Fission Waste																		
Sample 1-1	68.1	1.009 2	93.0889	0.5328	5.3491	1.16	0	99.72	0.24	0.04	0.00	0.832	31.622	9.576	53.514	1.027	98.649	121.351
1-2	68.1	1.0127	93.0882	0.5333	5.3740	1.16	0	99.55	0.31	0.07	0.07	0.257	31.351	9.605	53.514	1.051	97.568	120.811
Sample 2-1	68.0	1.0308	93.0954	0.5398	5.3841	1.18	—	—	—	—	—	0.805	31.351	9.596	52.703	1.027	98.649	140.270
2-2	68.1	1.0166	93.0517	0.5358	5.3819	1.18	0	99.75	0.20	0.01	0.04	0.258	31.622	9.576	53.873	1.041	98.649	140.000
Filtrate																		
Sample 1-1	51.4	1.0150	93.079	0.5378	5.348	0.0334	0	99.74	0.23	0.03	0.00	0.014	0.546	1.508	27.568	0.714	3.7027	5.2873
1-2	51.4	1.0199	93.041	0.5416	5.392	0.0334	0	99.55	0.32	0.03	0.10	0.013	0.793	1.951	27.568	0.695	3.7027	5.7568
Sample 2-1	49.6	1.0157	93.0661	0.5385	5.3857	0.0334.0	0	99.62	0.28	0.00	0.10	0.014	0.937	1.738	26.595	0.662	3.5946	6.2162
2-2	49.6	1.0138	93.0725	0.5380	5.3756	0.0319	0	99.82	0.17	0.00	0.01	0.015	0.774	1.441	24.865	0.686	3.5946	6.0541
ORNL/UCC																		
Raw Fission Waste																		
Sample 1-1	68.6	1.018	93.127	0.536	5.369	1.083	—	—	—	—	—	0.58	28.9	57.7	32.8	1.12	72.0	57.7
1-2	—	—	—	—	—	1.090	—	—	—	—	—	—	—	—	—	—	—	—
Sample 2-1	67.9	1.017	93.094	0.536	5.351	1.093	—	—	—	—	—	0.60	28.8	57.3	33.3	1.1	72.0	54.0
2-2	—	—	—	—	—	1.093	—	—	—	—	—	—	—	—	—	—	—	—
Filtrate																		
Sample 1-1	49.3	1.017	93.107	0.538	5.338	0.093	—	—	—	—	—	0.0.7	0.7	0.85	17.2	0.75	2.82	2.43
1-2	—	—	—	—	—	0.093	—	—	—	—	—	—	—	—	—	—	—	—
Sample 2-1	49.0	1.012	93.094	0.536	5.354	0.090	—	—	—	—	—	0.026	0.7	0.9	16.4	0.9	2.93	2.64
2-2	—	—	—	—	—	0.090	—	—	—	—	—	—	—	—	—	—	—	—

ORNL	Sr-89 (mCi/mL)	Ru-106 (mCi/mL)	La-140 (mCi/mL)
RFW			
1-1	59.7	1.8	1.93
1-2	—	—	—
2-1	59.3	3.6	3.0
2-2	—	—	—
Filtrate			
1-1	5.2	1.1	—
1-2	—	—	—
2-1	5.6	0.9	—
2-2	—	—	—

TABLE 2

ANALYTICAL RESULTS

Sample (element)	Raw Fission Waste (RFW)	Filtrate	Computer Comparison (RFW)
Uranium (mgU/ml)	68.13 ± 0.22	50.05 ± 0.98	
U-234 (a/o)	1.016 ± 0.005		
U-235 (a/o)	93.079 ± 0.025		
U-236 (a/o)	0.538 ± 0.003		
U-238 (a/o)	5.367 ± 0.021		
Plutonium (ugPu/ml)	1.130 ± 0.041	0.037 ± 0.004	
Pu-238 (a/o)	0		--
Pu-239 (a/o)	99.679 ± 0.098		99.92
Pu-240 (a/o)	0.250 ± 0.052		0.08
Pu-241 (a/o)	0.026 ± 0.023		6E-5
Pu-242 (a/o)	0.046 ± 0.041		4.7E-8
Sr-90 (m Ci/ml)	0.722 ± 0.097	0.018 ± 0.006	1.070
Ce-144 (m Ci/ml)	30.524 ± 1.370	0.549 ± 0.113	30.550
Ce-141 (m Ci/ml)	82.951 ± 17.997	1.265 ± 0.277	84.500
Cs-137 (m Ci/ml)	1.061 ± 0.036	0.716 ± 0.043	1.057
Zr-95 (m Ci/ml)	89.586 ± 12.441	33.908 ± 3.687	92.733
Nb-95 (m Ci/ml)	106.022 ± 35.633	47.324 ± 15.809	89.266
Sr-89 (m Ci/ml)	59.5 ± 0.2	5.4 ± 0.2	73.233
Ru-106 (m Ci/ml)	2.7 ± 0.9	1.0 ± 0.1	1.751
Ru-103 (m Ci/ml)	46.467 ± 9.493	23.699 ± 4.900	47.233

(1) 1 sigma error band