SCHOOL OF
ENGINEERING
& APPLIED SCIENCE
NUCLEAR REACTOR FACILITY
Department o. Mechanical,
Aerospace & Nuclear Engineering
University of Virginia
Charlottesville, VA 22903-2442
804-982-5440 · FAX: 804-982-5473

December 11, 1992

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C.
20555

Subject: Final report from t.e University of Virginia Reactor Facility [Reactor Docket Nos. 50-62 and 50-396] relating the recovery of ceramic beads spilled in the UVAR pool.

Gentlemen:

A special written report was made to the NRC on October 9, 1992 that described the in-pool disassembly of two canisters used for neutron activation of ceramic beads. This resulted in the dispersion of small, insoluble and non-floatable aluminum oxide/silicon dioxide beads to the research reactor's pool floor and primary coolant system. A final report covering the bead recovery operation in detail was promised in the special report.

UVAR Technical Specification 6.4.2 did not require reporting of this occurrence because an unsafe condition was not created and was unlikely to be generated in the future. This because the UVAR pool is designed to contain safely radioactive irradiation experiments, cobalt sources and nuclear fuel. A special report to the NRC was made because considerable reactor downtime to perform the recovery of the beads was anticipated.

Written procedures for a safe recovery of the beads with an underwater suction device were planned, reviewed, approved by the Reactor Safety Committee (RSC), and then practiced in dry-runs. The bead recovery operation was completed on October 21, 1992. Return of the UVAR to operation at power was authorized by the RSC on October 26, 1992. The RSC authorization was based on a review of the cleanup operation and a determination that the very small amount of beads which were not recovered could remain at the bottom of the pool without affecting reactor safety or posing a radiological risk.

Iridium bead irradiations will resume once the company providing the material accepts improved canister specifications and QA/QC forms approved for use by our R. ctor Safety Committee. Attached to this report please find copies of the following documents considered by the RSC: New canister

150014

A020 1/1

(Cover letter to Final Report, page 2, cont.)

specifications; Changes to the Facility's QA/QC checklist based on 10CFR50.59 and; Modifications of the Irradiation Request Form.

Sincerely,

Robert U. Mulder, Director
U.VA. Reactor Facility

Albemarle
Commonwealth of Virginia

I hereby certify that the attached document is a true and exact copy of a letter (type of document) presented before me this 14th day of Dec, 1992 by Robert Mulder (name of person seeking acknowledgement)

Vickie S. Thomas
Notary Public

My commission expires 2/28 1994

inc: Canister Specifications & QA/QC Checklist
QA/QC Form changes
Revised Irradiation Request Form
Final Report

cc:

U.S. Nuclear Regulatory Commission
Region II Regional Administrator
101 Marietta St. N.W.
Atlanta, Georgia
30323

FINAL REPORT OF IRIDIUM BEAD RECOVERY FROM UVAR POOL

Health Physics Considerations

Recovery of activated aluminum/silicon oxide beads from the reactor pool began on Tuesday, October 13, 1992 and was fully concluded on October 21, 1992. Two health physics personnel from the Office of Environmental Health and Safety observed all phases of the operation. All personnel involved in the operation were issued self-reading dosimetry. The suction system's water filters were monitored by an audible radiation dose rate meter throughout the recovery process. Four portable radiation survey instruments were used to monitor radiation dose rates while work was in progress. The highest individual personnel exposure during the entire recovery process was 1.7 mR, as measured with self-reading dosimetry. Total measured personnel dose was 2.9 mR. These readings are consistent with expectations for the work performed.

The (1-inch diameter) hoses connecting the suction nozzle to the collection chamber, and the chamber to the water filter/pump, were kept suspended under a minimum of about 4 feet of water (see Figure 1). This was sufficient to reduce the dose rate at the pool surface to very small levels. The physical principle for bead recovery was bead drop-out of water flow in the (3 in. diameter) collection chamber pipe, and into a removable recovery can at the base of the collection chamber, due to decreased waterflow velocity with the increase in flow crossectional area. A fine-mesh metallic filter was located at the exit of the collection chamber to prevent very small beads from passing to the water filters and pump located above poolwater level. The audible doserate meter strapped to the filters confirmed that no beads were passing beyond the collection chamber.

Recovery Timetable:

The recovery, using special RSC approved procedures, was performed as follows:

10-13-92 Beads lying on the in-pool underwater table located at a wall at the north-end of the pool were the first to be collected with the suction system. These beads came from the canister which had been successfully retrieved from reactor gridplate position 74, but which had fallen onto the table when an attempt was made to secure the canister. (In the attempt to envelop the canister in a sock, the bottom of the canister came loose.) Following the recovery of these beads, the recovery can was removed from the suction system's collection chamber while submerged and visually inspected. It was almost full of beads, indicating near complete

recovery of one canister. The can was capped while underwater, tagged and stored in the pool. Next, an empty second recovery can was installed in the collection chamber to recover beads on the pool bottom below the underwater table. The highest individual personnel exposure during this phase of the recovery process was 0.4 mR. The monitor placed on the water filters registered 0.5 mR.

10-14-92 Suctioning of the pool floor beneath the underwater table and buttress area adjacent to the primary flow return line was initiated. The recovery can was removed, visually inspected (and found to be about 20% filled), capped and stored. The amounts recovered up to this point corresponded to one canister.

Next, the suction system was relocated from the north end of the pool to the south end. Suction of beads from around gridplate positions 64 and 74 (where the canisters had been irradiated) was performed. Fuel and graphite elements adjacent to grid positions 64 and 74 were removed from the gridplate. Each element was visually inspected underwater. As expected, no beads were present on the elements. The elements were stored at the north end of the pool in racks. The freed area on the gridplate was then suctioned, following which the gridplate was completely unloaded of the remaining elements. The highest individual personnel exposure during this phase of the recovery process was 0.2 mR. The monitor at the vacuum filters registered 5.0 mR.

10-15-92 The empty gridplate was suctioned. Visual observation with a scope indicated no beads on the gridplate. The collection chamber was moved to the underwater table and the recovery can removed. It was about 1/5 full. The can was capped, tagged and moved to storage at the side of the pool. An empty can was installed in the collection chamber and the reactor bridge moved toward the center of the pool. Visual inspection with a scope revealed some beads on the header "funnel" and at the bottom of the primary piping underneath the header. The header and primary piping were suctioned clean. The collection chamber was then moved to the underwater table and the recovery can removed. It appeared to be about 90% full. Like the other cans, it was capped, the stringer labelled and the can stored underwater at the side of a pool wall. The highest individual personnel exposure during this phase was 0.6 mR. The monitor at the vacuum filters registered 6.5 mR.

10-16-92 The primary pump was started and run for about 1 hour. A detector placed by the heat exchanger shell to record activity variations indicated a temporary rise in activity for about 14 seconds followed by a drop to a level slightly higher than the one before the pump was started. This behavior showed that a few beads not recovered by suction from the primary piping were passed

through the heat exchanger and carried to the exit of the primary water return line at the bottom of the pool. Personnel in the reactor room observed these beads exiting the flow diverter and fall to the bottom of the pool. A few beads were retained by the flow baffles in the heat exchanger (see Figures 2). The reactor coolant pump was then "jogged" on and off about 15 times to pass the beads trapped by the baffle plates and the heat exchanger was then surveyed again (see Figures 3 and 4).

The pool floor area underneath the header and the primary piping was suctioned for about an hour. No beads were found in this area. The highest individual personnel exposure for the day was 0.2 mR. The monitor at the vacuum filters registered 1.9 mR.

10-19-92 To collect the beads that traversed the primary coolant system (the heat exchanger), the pool floor at the north end of pool adjacent to primary water return line and the area around center buttress was suctioned. The highest individual personnel exposure for this operation was 0.2 mR. The monitor at the vacuum filters registered 2 mR.

10-20-92 The primary pump was started and run for about 2.5 hours. The floor area at the north end of pool adjacent to primary flow return line and center buttress were inspected and suctioned. The recovery can was removed from the suction system and inspected underwater. A small layer of beads, about 1/2 inch in depth, was found in the can. The can was capped, tagged and stored at the side of pool. The suction system was again relocated to the south end of pool and the pool floor at this end suctioned. Highest individual personnel exposure for the day was 0.3 mR. The monitor at the vacuum filters registered 5.1 mR.

10-21-92 A thorough visual inspection was made, with a scope, of the gridplate and areas around the header and primary piping. No indication of beads was found in those areas.

Summary:

All reasonable actions to recover beads from the reactor pool were taken. The recovery process went very smoothly and the staff did an excellent job. Poolwater conditions remained within TS limits throughout. Surveys indicated no contamination at poolside. From the mass collected, it was possible to estimate (by weight and neutral balance) that about 98% of the beads were recovered. Unirradiated beads from unused canisters were available for this comparison. The amount of material present in the irradiated canisters was estimated from an average of the amount in the remaining unirradiated canisters, and may have been overestimated.

It is likely that the actual recovery was greater than 98% (as indicated by visual inspection and spot sampling of the pool floor). A better estimate of the percentage recovered would have been possible if the irradiated bead mass had been known more precisely. Recovery estimates based on activity would not be more accurate than the one obtained, given the greater uncertainty in activity measurements.

The few beads still retained in the heat exchanger (about 1 gram or 1 mCi) pose no radiological hazard. When they eventually complete passage through the heat exchanger, they will settle out on the floor at the north end of the pool and decay over a period of time. These beads will not enter the reactor coolant flow, given their high (2.5) specific gravity (Were this not so, there still would be no impact, i.e. no significant reactivity effects, tramp activation, coolant flow blockage or control rod jamming, because of the trace levels of iridium involved and the small maximum diameter of the beads compared to the relevant reactor dimensions).

The beads which were recovered will most likely be kept within the UVAR pool and permitted to decay to disposal level.

A complete file on the iridium bead spill will be kept with the Reactor Facility records.

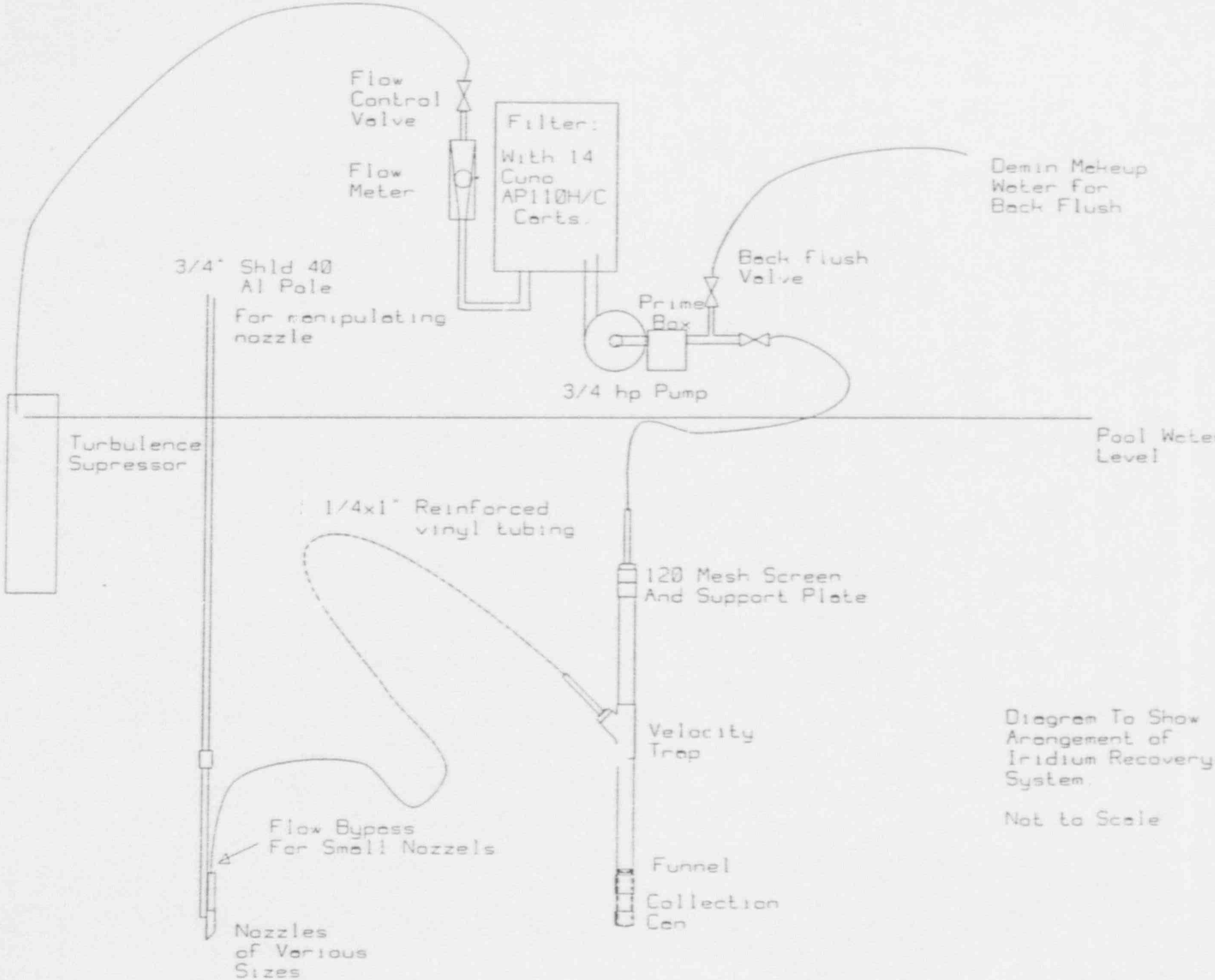


Figure 1: Underwater Suction System

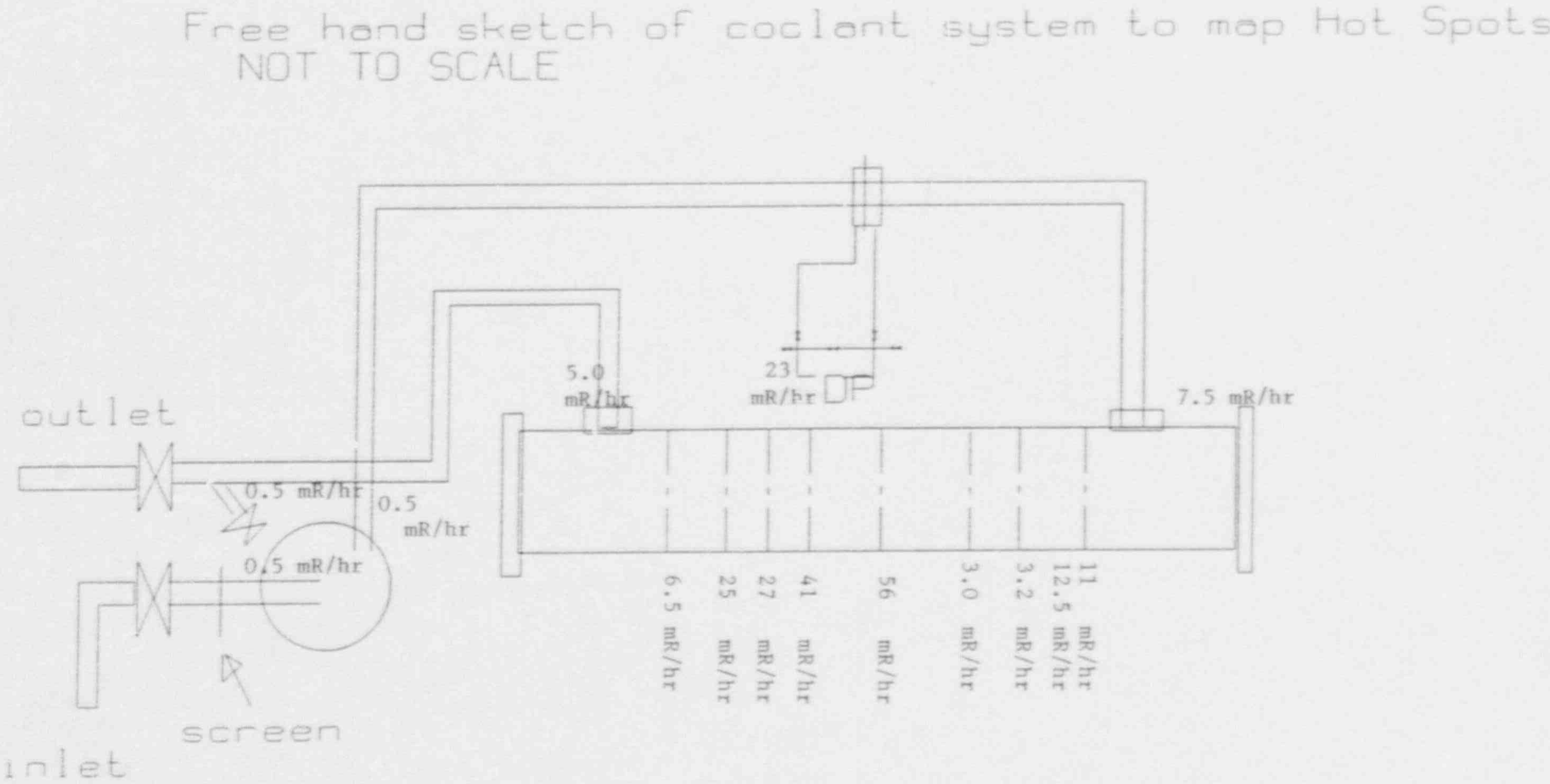


Figure 2. Heat Exchanger Survey Results Prior to Coolant Pump Start, Following Bead Recovery

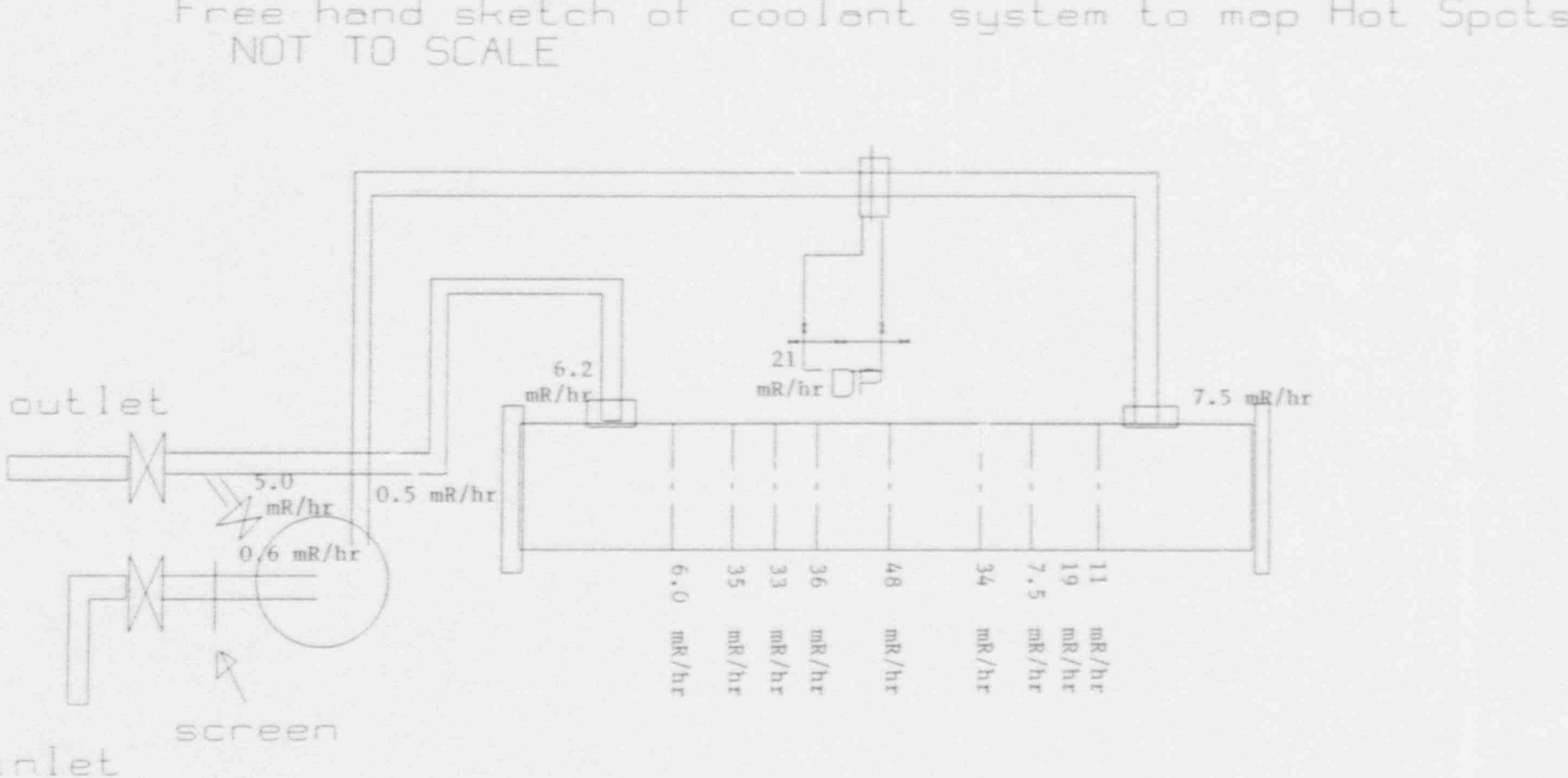
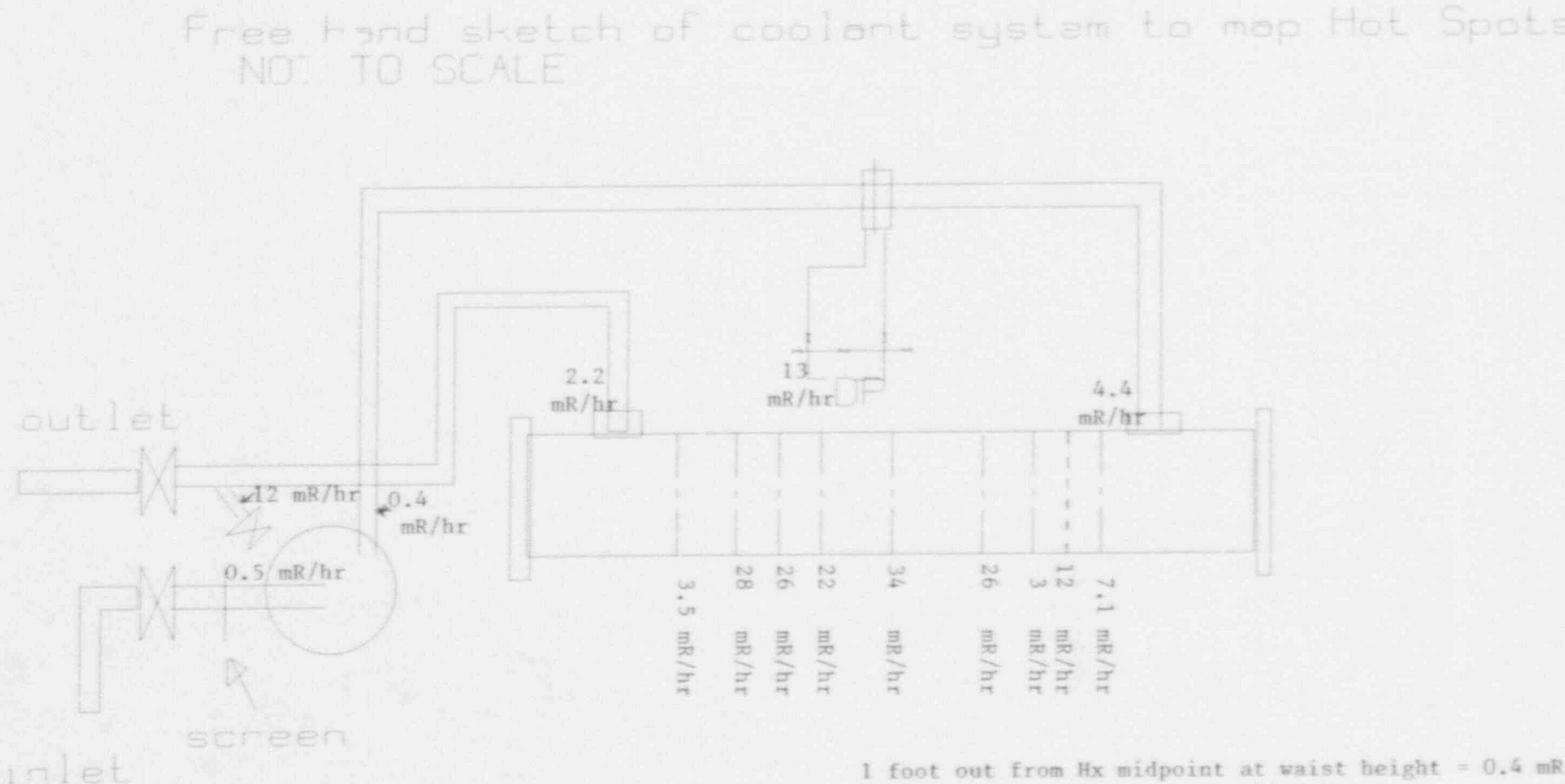


Figure 3. Heat Exchanger Survey Results Following Bead Recovery and Coolant Pump Start.

Survey done 1 December 1992
Eberline ESP-1 #2154
Calibration due 4-22-93

Survey by: [signature]



1 foot out from Hx midpoint at waist height = 0.4 mR/hr
1 foot below Hx midpoint = 0.85 mR/hr

Figure 4: Heat Exchanger Survey Results Following Operation of Coolant Pump for 125 hrs.

QUALITY ASSURANCE CHECKLIST FOR ALUMINUM CONTAINERS CONTAINING IRIDIUM OR SCANDIUM IN CERAMIC MEDIA FOR IRRADIATION AT THE UNIVERSITY OF VIRGINIA NUCLEAR REACTOR FACILITY

CAN ID:_______________________ DATE:_______________________

CONTENTS: (circle one) **IRIDIUM** **SCANDIUM**

(check)	QUALITY ASSURANCE ITEM
	Proppant material is 65% Al_2O_3 - 35% SiO_2 manufactured for Protechnics International by Norton Alcoa
	Proppant material contains no visible foreign matter and is free of "fines"
	Proppant bead diameter is between 20 and 100 mesh
	Aluminum can is made of either alloy 6061, 6063 or 1100
	Bottom of can is welded in place with a circumferential weld (no grinding)
	Empty can with bottom is weighed (**insert weight below**)
	Can filled with proppant and weighed (**insert weight below**)
	Lifting lug with ≥ 1/8" hole is welded to top center of can
	Can lid is welded in place with a circumferential weld
	Assembled can is weighed (**insert weight below**)
	Max. can diameter is measured to be ≤ 3.1 inches (**record below**)
	Max. can length is measured to be ≤ 10.25 inches (**record below**)
	Can ID #, gross and net weights are imprinted on the can
	No leaks found upon completing leak test

1. Weight of empty can	grams
2. Weight of unsealed can plus proppant	grams
3. Weight of sealed can	grams
4. Weight of contained proppant (item 2 - item 1)	grams
5. Maximum diameter of can (≤3.02" or ≤3.1")	inches
6. Maximum length of can (≤10.25")	inches

Checklist completed by:

Signature ____________________ Date ____________________

Name printed ____________________ Position title ____________________

♦♦

Reviewed for UVA by (signature) ____________________ Date ____________________

FACILITY DESIGN, CONSTRUCTION OR MODIFICATION EVALUATION FORM

[This Q/A Form based on 10 CFR 50.59 requirements was approved by RSC on 12/05/85 and revised (item #4.16) and approved by RSC on 11-24-92]

1. Requested by:________________________ Date:______________________

2. Description: ____

____

____

3. Safety Analysis:

a) Is the facility to be designed, constructed or modified described in the SAR?
_____ yes, in section ____________________________________
_____ no
_____ N/A

b) Is a change required in SOP as referenced in the SAR?
_____ Yes, updated SOP to be reviewed by RSC on __/__/__
_____ No
_____ N/A

c) Does the proposed change, test, experiment or facility involve a change in Technical Specifications?
_____ Yes, to Tech. Spec.__________________________________.
(therefore a license amendment pursuant to 10 CFR 50.90 is required)
_____ No

d) Is the probability of an accident with or malfunction of the equipment such that it may bear on safety items considered in the SAR?
_____ Yes, bearing exists on SAR items ________________________
_____ No

e) Are the consequences of a malfunction of this equipment important to safety evaluations previously made in the SAR?
_____ Yes, affects evaluation in SAR section____________________
_____ No

f) Is an accident or malfunction of a different type than previously evaluated in the SAR possible?
_____ Yes, the scenario not previously considered is____________
_____ No

g) Is the margin for safety as defined in the basis for any Technical Specification reduced?
_____ Yes, margin of safety for T.S.____________(is, are) reduced.
_____ No

UNIVERSITY OF VIRGINIA REACTOR FACILITY

SPECIAL IRRADIATION REQUEST FORM (SIRF)

IRF # ____________________ page # 1 of ___

Requestor____ ___Authorized, ___Qualified, ___Restricted

Supervisor of work__________________________ __________________ ___Authorized, ___Qualified

Work performed for______________________________________ ___no direct charges, ___billable

Sample description____

____

Irradiation time:__________(nominal), __________(maximum) Power level:________(nominal), ________(max)

Location(s):__________________ Encapsulation:______________ Reactivity worth:______________

Special handling:____

Additional QA/QC requirements are applicable and these are attached: (circle) YES NO

___ Material or an experiment of this type has been previously irradiated, IRF#____________________

___ A trial irradiation of 1 min or less will be performed.

*If neither blank is checked, Reactor Health Physicist approval to irradiate is required.

Known isotope(s) AND/OR estimated maximum dose rate on retrieval of sample, excluding std. container(s)

Primary isotopes produced:____

Maximum expected dose rate:__________ mR/hr @ 1 ft based on: ____calculations ____prior experience

The above information accurately describes the material to be irradiated.

Experimenter ______________________________ Date______________

The irradiation described above meets the requirements of the UVAR SOP's and Tech. Specs.

APPROVALS: Reactor Supervisor ______________________________ Date______________

Senior Operator ______________________________ Date______________

*Health Physicist ______________________________ Date______________

Two of three required

Comments____

Sample			Irradiation Time				Init. Disp.	Dose @ 1 ft mr/hr	Init.	Final Disposition		
#	Identification	Loc.	Date	In	Out	Total				Date	Location	Init.
1	Container + sample	Date of measurement:								XXXXXX	XXXXXXXXXXX	XXX
1												
2	Container + sample	Date of measurement:								XXXXXX	XXXXXXXXXXX	XXX
2												
3	Container + sample	Date of measurement:								XXXXXX	XXXXXXXXXXX	XXX
3												

T = Thermal pneumatic rabbit
E = Epithermal pneumatic rabbit
F# = Flux trap or irradiation basket and grid position
H = Hydraulic rabbit

CR = Counting room
HU = Holdup station
SP = Side of pool
SC = Shipping container
LS = Lead shield

UNIVERSITY OF VIRGINIA REACTOR FACILITY

ROUTINE IRRADIATION REQUEST FORM (RIRF)

IRF # ____________ page # 1 of ___

Requestor ______________________ ___Authorized, ___Qualified, ___Restricted

Supervisor of work ______________________ ___Authorized, ___Qualified

Work performed for ______________________ ___no direct charges, ___billable

Sample description ______________________

____

Irradiation time: ________(nominal), ________(maximum) Power level: ________(nominal), ________(max)

Location(s): ____________ Encapsulation: ____________ Reactivity worth: ____________

Special handling: ______________________

Additional QA/QC requirements are applicable and these are attached: (circle) YES NO

___ Material or an experiment of this type has been previously irradiated, IRF# ____________

___ A trial irradiation of 1 min or less will be performed.

*If neither blank is checked, Reactor Health Physicist approval to irradiate is required.

Known isotope(s) AND/OR estimated maximum dose rate on retrieval of sample, excluding std. container(s)

Primary isotopes produced: ______________________

Maximum expected dose rate: ________ mR/hr @ 1 ft based on: ____calculations ____prior experience

The above information accurately describes the material to be irradiated.

Experimenter ______________________ Date ____________

The irradiation described above meets the requirements of the UVAR SOP's and Tech. Specs.

APPROVALS: Reactor Supervisor ______________________ Date ____________

Senior Operator ______________________ Date ____________

*Health Physicist ______________________ Date ____________

Two of three required

Comments ______________________

Sample			Irradiation Time				Init. Disp.	Dose @ 1 ft mr/hr	Init.	Final Disposition		
#	Identification	Loc.	Date	In	Out	Total				Date	Location	Init.
1												
2												
3												
4												
5												
6												

T = Thermal pneumatic rabbit
E = Epithermal pneumatic rabbit
F# = Flux trap or irradiation basket and grid position
H = Hydraulic rabbit

CR = Counting room
HU = Holdup station
SP = Side of pool
SC = Shipping container
LS = Lead shield