

UNITED STATES ATOMIC ENERGY COMMISSION
COMPLIANCE INSPECTION REPORT

1. Name and address of licensee American Metal Products Co. 2601 S. State Street Ann Arbor, Michigan	2. Date of inspection March 2, 1960
	3. Type of inspection Initial
4. 10 CFR Part(s) applicable 20 and 40	

5. License number(s), issue and expiration dates, scope and conditions (including amendments)

C-4069	11-19-58	4-30-59	See report details
Amendment 2			
C-4812	7-20-59	7-31-60	
C-4090	5-15-58	5-31-59	

6. Inspection findings (and items of noncompliance)

The inspector was unaccompanied during an announced initial inspection carried out on March 2, 1960. The information contained in this report was supplied by Mr. Donald W. Banks, Business Manager and Security Officer, and Mr. Donald Thies, Assistant Manager of Research and Development.

The licensee holds Licenses No. C-4090, C-4069 and C-4812. License No. C-4812 expires March 31, 1960. Licenses No. C-4090 and C-4069 have expired.

The licensee provided the following information with respect to the licenses.

License No. C-4090 had been obtained in order that source materials might be fabricated at the Detroit address, listed on the license, namely, 5959 Linsdals Avenue, Detroit 4, Michigan. This plant had at the time certain equipment necessary to produce particular preparations for research and development purposes. However, a change in program occurred with the result that no source materials were purchased or used under this license at the Detroit address. The license was then allowed to expire.

License No. C-4069 was a license under which source materials, not exceeding 100 pounds of uranium, were purchased and used for experimental purposes at 1355 North Main Street Ann Arbor, Michigan - the licensee's central research facilities until 1959.

(CONTINUED)

7. Date of last previous inspection	8. Is "Company Confidential" information contained in this report? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> (Specify page(s) and paragraph(s))
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DISTRIBUTION

W. M. Mann, Assistant Director
 Division of Inspection
 Washington (D.C.)

Approved by: *RHJ*
 Roy C. Hageman, Director
 Inspection Division
 (Operations office)

March 10, 1960
 (Date report prepared)

If additional space is required for any numbered item above, the continuation may be extended to the reverse of this form using foot to head format, leaving sufficient margin at top for binding, identifying each item by number, and noting "Continued" on the face of form under appropriate item.

RECOMMENDATIONS SHOULD BE SET FORTH IN A SEPARATE COVERING MEMORANDUM

UNITED STATES ATOMIC ENERGY COMMISSION
COMPLIANCE INSPECTION REPORT

1. Name and address of licensee American Metal Products Co. 2201 S. State Street Ann Arbor, Michigan	2. Date of inspection March 2, 1960
	3. Type of inspection Initial
	4. 10 CFR Part(s) applicable 20 and 40

5. License number(s), issue and expiration dates, scope and conditions (including amendments)			
<u>C-4069</u>	11-19-58	4-30-59	See report details
Amendment 2			
<u>C-4812</u>	7-20-59	7-31-60	
<u>C-4090</u>	5-15-58	5-31-59	

6. Inspection findings (and items of non-compliance)

The inspector was unaccompanied during an announced initial inspection carried out on March 2, 1960. The information contained in this report was supplied by Mr. Donald W. Jenks, Business Manager and Security Officer, and Mr. Donald Thies, Assistant Manager of Research and Development.

The licensee holds Licenses No. C-4090, C-4069 and C-4812. License No. C-4812 expires March 31, 1960. Licenses No. C-4090 and C-4069 have expired.

The licensee provided the following information with respect to the licenses.

License No. C-4090 had been obtained in order that source materials might be fabricated at the Detroit address, listed on the license; namely, 5959 Linsdale Avenue, Detroit 4, Michigan. This plant had at the time certain equipment necessary to produce particular formulations for Research and Development purposes. However, a change in program occurred with the result that no source materials were purchased or used under this license at the Detroit address. The license was then allowed to expire.

License No. C-4069 was a license under which source materials, not exceeding 100 pounds of uranium, were purchased and used for experimental purposes at 1355 North Main Street Ann Arbor, Michigan - the licensee's central research facilities until 1959.

(CONTINUED)

7. Date of last previous inspection	8. Is "Company Confidential" information contained in this report? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> (Specify page(s) and paragraph(s))
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<p>DISTRIBUTION:</p> <p>W. M. Mann, Assistant Director Division of Inspection Washington (D.C.)</p> <p>W. C. Hageman, Director Division of Licensing and Regulation Washington (D.C.)</p>	<p><i>[Signature]</i> Endolph M. Jezik (Inspector)</p> <p>Approved by <i>[Signature]</i> Roy C. Hageman, Director Inspection Division (Operations office)</p> <p>March 10, 1960 (Date report prepared)</p>
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RECOMMENDATIONS SHOULD BE SET FORTH IN A SEPARATE COVERING MEMORANDUM

Continuation Sheet #1
American Metal Products
Company
Ann Arbor, Michigan

March 2, 1960

6. Inspection Findings (continued)

License No. C-4812 now in effect, is a license under which the licensee now carries out research and development at 2601 South State Street in Ann Arbor, Michigan, having moved from the North Main Street address to the new facilities in the latter part of December, 1959. All materials held under License No. C-4069 are now held under No. C-4812.

The licensee stated that he has in possession approximately 77 kilograms of depleted uranium for research and development purposes. The licensee maintains a complete inventory record showing the amount of materials received, the amount of materials transferred, and the amount of materials actually on hand. A copy of these inventory records entitled "Nuclear Material Accountability Records" and dated March 7, 1960 was forwarded to the inspector by Mr. Jenks and copies are included in this report as Exhibit A.

The licensee requires that where transfers of source materials are concerned, the requestor supply his AEC license number.

In the attached inventory records (See Exhibit A) you may note transfer dates, the quantity of materials shipped, to whom, and the AEC license number held by the party. Where radioactive waste transfers are concerned, the licensee employs the services of Nuclear Engineering Company, Inc., a waste disposal agency. Inventory records include the amount of waste materials transferred. Suppliers of source material to the licensee are Oak Ridge who supply UF-6, Mallinkrodt, Nuclear Corporation, Spencer Chemical Company and M & C Nuclear.

With respect to personnel monitoring, no film badges are deemed necessary. However, the licensee does require bio-assay samples of all individuals working with radioactive materials. Samples are collected on a monthly basis and have, to date, produced negative results.

The licensee carries out research and development in several large laboratories which contain numerous work benches and fume hoods and electric vacuum furnaces. Research is centered principally around the fabrication of uranium for fuel elements and related usages. It is the licensee's intent to obtain fissionable materials for research and development purposes. The licensee informed the inspector that Mr. T. F. Nolan, Security Division, Chicago Operations Office had visited with them on February 19, 1960, in order to discuss their anticipated program.

No items of noncompliance were noted or otherwise observed other than those set out below:

10 CFR 20, Section 20.203(f)(1) - Containers - The licensee failed to display on storage containers a sign bearing the conventional radiation symbol in maroon on a yellow field and stating the words "Caution - Radioactive Materials."

10 CFR 20, Section 20.203(f)(4) - Containers - The licensee failed to state the material content in kind, quantity and date of measurement.

All items of noncompliance were discussed with the licensee and sample signs were provided. The licensee stated that these items would be rectified as quickly as possible.

Enclosure:
Exhibit A

PROCEDURES FOR UF HANDLING **
6

** A Brief Guide to UF Handling, by J. W. Arendt, L. W. Powell and
H. F. Saylor, K-1323, Oak Ridge.

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DUCKETED
APR 17 1954
U.S. DEPARTMENT OF ENERGY
OFFICE OF THE GENERAL INVESTIGATOR
WASHINGTON, D.C.

INTRODUCTION

It is planned to utilize gaseous NS-40 grade UF_6 in experimental work. Because of its criticality and toxicity considerations, UF_6 must be handled with care. It is the purpose of this report to outline the necessary precautions employed in the receipt and use of UF_6 .

PHYSICAL AND CHEMICAL PROPERTIES OF UF_6

Sublimation point (14.7 psia)	133.5°F
Triple point (22 psia)	147.3°F
Density, solid (68°F)	292 lbs/ft ³
liquid (147.3°F)	229 lbs/ft ³
liquid (300°F)	192 lbs/ft ³
Heat of sublimation (147°F)	58.7 BTU/lb
Heat of fusion (147°F)	23.4 BTU/lb
Heat of vaporization (147°F)	35.3 BTU/lb
Heat of solution in water (77°F) - heat evolved	90,900 BTU/lb-mol
Critical pressure	45.5 atm.
Critical temperature	446°F

At room temperature, UF_6 is a white, volatile solid which forms transparent crystals that sublime slowly at atmospheric pressure; at higher pressures, they melt to form a clear, colorless liquid of high density. Uranium hexafluoride is a highly reactive substance. It reacts chemically with water, ether, and alcohol forming soluble reaction products. It reacts with most organic compounds and many metals. Most saturated halocarbons are of low reactivity or inert to UF_6 . It does not react with oxygen, nitrogen,

and dry air. It is sufficiently inert to copper, nickel, aluminum, teflon, monel, and aluminum-bronze that they can be exposed to UF_6 without excessive corrosion. Low silicon steel is sometimes used where service is mostly at room temperature.

HAZARDS

Criticality - NS-40 grade is non-critical at normal assay or below. Enriched material, if limited to 5" cylinders, and less than 300°F, will be non-critical.

Explosive - Reacts with hydrocarbons and many other organic compounds; under confinement these mixtures produce explosive pressures. Cylinders of UF_6 -hydrocarbon oil mixtures have exploded and ruptured the cylinders.

Flammable - Not flammable.

Corrosive - UF_6 and UF_6 -hydrolysis products are highly corrosive to most materials, including

1. Body tissues - causes severe burns
2. Organic compounds
3. Many metals

Toxic -

1. UF_6 reacts with moisture in air forming a white fog consisting of UO_2F_2 , which is toxic, and HF, which is highly toxic and corrosive.
2. Internal toxicity of uranium compounds varies with the method by which they reach the inside of the body. Inhalation is far more serious than ingestion. The primary action of uranium chemical poisoning is on the kidney.

GENERAL SAFETY CONSIDERATIONS

Note: Avoid physical contact with or inhalation and ingestion of UF_6 , or its reaction products.

Design -

1. Use closed system or container.
2. Adequate means for control of possible accidental releases, including necessary hooding and exhaust devices, and treatment of floor and work surfaces for ease of removal.
3. Adequate control of vent gases.
4. Avoid rupture of container due to overheating or overfilling.
5. Use clean equipment to avoid explosive reactions.

STORAGE OF URANIUM HEXAFLUORIDE

Aside from critical mass considerations, the storage of UF_6 poses few problems. Requisites for satisfactory storage are as follows:

1. Approved containers, properly spaced and secured. Cap on valve outlet port.
2. Avoidance of mechanical damage to containers or container valves.
3. Cool, well-ventilated, isolated locations.
4. Protection from fire or excessive heat.

The installation under consideration here will be such that the UF_6 cylinder and auxiliary equipment will be located out-of-doors in an isolated location. Only the heated transfer line from the cylinder will actually be located within the building where the experiments will be conducted.

THE UF₆ TRANSFER SYSTEM

The basic elements of a UF₆ transfer system are shown in Figure 4.

Manifold - The manifold is made of copper tubing or pipe. More expensive welded monel pipe is sometimes used for permanent installations. The manifold will have a minimum volume consistent with flow requirements.

Pigtail - The pigtail or cylinder adapter, as illustrated in Figure 5, is used to connect the cylinder to the manifold. It is made of copper tubing with brass or monel fittings. Teflon gaskets are normally used. Aluminum or copper gaskets will be used. Excessive torque is required to seat them.

Pressure Indicator - The pressure indicator is a compound pressure gauge with a range of 30 inches Hg to 100 psi. Where remote indication is desired, the use of pneumatic pressure transmitters would obviate the necessity for heated lines.

Vacuum System - Two types of vacuum systems are used in handling UF₆. One consists of a positive displacement corrosion-resistant pump capable of obtaining a low suction pressure with a fully fluorinated lubricating oil. The UF₆ passes directly through this system and may be discharged to a UF₆ process system. The evacuation system planned, as indicated in Figure 4, consists of a vacuum pump containing regular hydrocarbon oil preceded by one or more cold traps and a chemical trap in series to remove the UF₆ before entering the pump.

Cold Trap - The cold trap is used to trap UF₆ from the system before opening the system to atmosphere for maintenance, and to collect any UF₆ from the cylinder or system that has to be removed by evacuating the

cylinder. The cold traps will be cooled by mechanical refrigeration, dry ice in trichloroethylene, or with liquid nitrogen. The cold traps will have valves on inlet and outlet to facilitate changing. Baffles could be installed in traps to increase thermal transfer.

Chemical Trap - The chemical trap is always used to collect trace quantities of UF_6 which may not have been collected in prior operations. This prevents UF_6 from sludging the vacuum pump oil or from escaping to the atmosphere. Activated alumina of 4 to 8 mesh will be used in the chemical trap. Calcium sulfate is sometimes used instead of alumina in processing medium or highly enriched material. A heavy screen inside the trap, supported just above the inlet, aids flow distribution and prevents the chemical from getting into the inlet line. A flanged top will facilitate removal of the chemical.

Purge Gas Supply - A purge gas will be used to sweep out residual wet air or UF_6 and to pressure up systems to locate leaks. A high pressure nitrogen cylinder with a pressure reducing valve is a satisfactory simple purge gas system. Dry air is also satisfactory. Pressure will be maintained in the purge gas system higher than the pressure in UF_6 systems to prevent possible escape of UF_6 into the purge gas system.

Valves - A valve found satisfactory for both liquid and gaseous UF_6 service is the B-1 (C-100 Series Model 1). This valve has a specially forged metal body, socket ends of nominal pipe size, a seating surface machined in the material, a stem sealed by double bellows, and a rising stem which indicates the valve opening. This valve is demountable and has a metal seat.

Similar valves such as SM (Crane Drawing K-4144) have a special plastic seat and can be used with gaseous UF₅. A small bar stock monel body, plastic-seated, bellows-sealed, stemless valve (HGP-Fulton-Sylphon Drawing 96415) is sometimes used in the 1/2-inch size for a purge valve.

Globe valves will be installed in such a manner that the higher pressure is under the valve seat. In cases such as the purge and evacuation valves, where the high pressure side is reversed during the operating cycle, the underside of the seat will be directed toward the UF₅ manifold. When welding the valves to the lines, the valve will be fully open but not back-seated. The use of excessive heat in welding will cause distortion of the seat and melt the solder from the bellows. For this reason, it is advisable to disassemble the 1/4-inch, 1/2-inch, and 3/4-inch valves prior to welding; and, as a further precaution, the valve body will be wrapped with asbestos tape and kept wet during the welding operation. Sulphur-free asbestos will be used when welding monel to prevent cracking of the metal. After welding, a valve will not be closed until the body has reached ambient temperature.

The maximum handwheel torques shown below will be used only when necessary since vacuum tightness can normally be obtained at a lesser pressure.

MAXIMUM HANDWHEEL TORQUES IN FOOT POUNDS

Inches	OSD Valve	... D Valve
1/4	25	20
1/2	45	20
3/4	57	27
1	68	30
1-1/2	92	40
2	110	50
3	135	75

TRANSPORT OF CYLINDER FROM LOCATION OF RECEIPT TO LOCATION OF OPERATION

It is assumed that the point of receipt will be different from the location of operation. For this reason, it is necessary to outline a procedure for the transport of the cylinder, which will be the 5" size, to the point of operation.

Since the only cylinder under consideration is the 5" I.D. x 34-3/4" I size, the discussion will be limited to this case. The maximum weight of the cylinder will be 109 pounds (55 pounds of UF_6 + 54 pounds empty cylinder). This eliminates the necessity of mechanical handling and allows the use of manual handling.

Upon receipt, the cylinder will be given a visual examination for leaks and mechanical damage to container or container valves. A leak in a cylinder containing UF_6 will be indicated by a white fog issuing from the leak even at room temperature. In time, a small leak may build up yellow or light green deposit at the leak.

When transporting the cylinder from the railroad car, truck, etc. to the vehicle to be used, care will be taken to avoid mechanical damage to container or container valves. It will be placed in a vertical position, properly spaced from other containers, and secured. Some type of shock-absorbing material will be employed to prevent damage while in transit. The cap will be on the valve outlet port. The cylinder will be protected from fire or excessive heat.

Upon arrival at location of operation, the same care will be shown regarding container and container valves. The cylinder will be stored in accordance with the instructions cited in the section, "Storage of Uranium Hexafluoride."

VAPOR TRANSFER OF UF₆

Operation of Cylinder Manifold

A manifold system, as depicted in Figure 4, will be used in removing UF₆ from cylinders in the gaseous state. After connecting the cylinder to the manifold, the connector will be checked for absolute tightness by evacuating and isolating the system and observing for pressure rise. Further checks for a tight system may be warranted depending on the value of the material handled. During a transfer of UF₆ from a cylinder, the system block valves and the cylinder valve will be open for the material to flow between the cylinder and the system. To disconnect the system, the cylinder valve and the system block valve No. 2 will be closed and the manifold purged by alternately evacuating and pressuring until the residual UF₆ concentration is diluted to less than 10 parts per million. The pressure indicator will be used to detect possible line restriction and to monitor the purging operation. The desired UF₆ content can be obtained by five "purges" if the evacuation system is capable of evacuating the system to 5 psia, and the dry air or nitrogen pressure is maintained at 10 psia.

Condensation in the lines increases the difficulty of purging the system, the amount of UF₆ entrained in the cold lines, and the danger of UF₆ being led in the manifold system. The residual UF₆ concentration left in the system may be released to the atmosphere, creating a health hazard, and resulting in a loss of UF₆. UF₆ which is hexafluoride, not purged from the system or released to the atmosphere, may be hydrolyzed by atmospheric moisture and decomposed to form a deposit on the manifold lines and the cylinder valve, which may result in a

varying isotopic assays is processed, any material of one assay left in the manifold may mix with UF_6 of another assay processed later resulting in isotopic discrepancies.

Cylinder Emptying Technique

The material will be vaporized by placing the cylinder in either a horizontal or a vertical vaporizer (preferably vertical) using a hot water bath, steam bath, or controlled electric heat. Vaporization temperatures will not exceed $300^\circ F$, since the specific volume of UF_6 at $300^\circ F$ is used to determine maximum net weight of UF_6 permissible in a given cylinder. Heating to temperatures in excess of $300^\circ F$ may produce high hydrostatic pressures resulting in cylinder rupture.

Care will be taken to insure that all lines, valves, and connections are heated to maintain a minimum temperature of $100^\circ F$ to keep the UF_6 in a gaseous condition.

Regardless of the method of transfer, some residual material remains in the cylinder. This "heel" is comprised of UF_6 vapor and in some cases non-volatile compounds. As previously mentioned, this will be left for processing by the distributor.

As an example, listed below is a typical transfer procedure:

Problem: To vaporize 50 pounds of UF_6 from a 5-inch cylinder into the process system. Assume the manifold is properly heated and temperature controlled.

1. Place cylinder in vaporizer.
2. Connect to manifold with clean pigtails and gauges.
3. Open all valves except cylinder valve, purge valve, and valve to process system.

4. Start the vacuum pump and evacuate manifold.
5. Close cold trap inlet valve.
6. Pressure system up to 5 or 10 psig by opening purge valve and then close purge valve.
7. Open cold trap inlet valve until system is evacuated; then close valve.
8. Observe pressure indicator as required for any significant pressure rise indicating a leak.
9. If a leak is indicated, the system is pressured to 5 psig, and the leak is located by brushing soap solution on possible leak locations such as welds, pigtail connections, etc.
10. After leak is repaired, the system can be pressured up and leak rated.
11. If leak rate is satisfactory, the manifold is evacuated and leak rated at a vacuum.
12. Close valve in line to cold trap.
13. Open cylinder valve. Heat should not be applied to cylinder before this step. Dangerous pressures could be built up if the cylinder is filled above the recommended capacity or contains impurities such as freon-114.
14. Heat cylinder until pressure in manifold is above process system.
15. Open valve into process system as required.
16. When cylinder is believed to be empty as indicated by weight loss or by pressure drop in the manifold, the valve to the

process system is closed. The cylinder is not empty if the pressure continues to rise.

17. If pressure does not rise, the manifold and cylinder are evacuated through cold trap for at least 15 minutes to remove residual quantities of UF_6 remaining in the cylinder.
18. Close valve to cold trap. Pressure manifold and cylinder to 5 psig with purge gas. Close purge valve and open valve to cold trap.
19. Close the cylinder valve and the valve on the manifold to the pigtail. There may still be some heel left in the cylinder, but this is left for the distributor to dispose of.
20. Disconnect the pigtail and remove the cylinder.
21. Place the cap on the valve outlet and valve protector cap on the cylinder.
22. Ship back to distributor.
23. Caution: In the operation of the manifold system, never shut down the vacuum pump against a vacuum in the manifold unless pump suction valve is closed. Oil may be pulled from the pump and through the chemical trap which could react explosively with UF_6 .
24. The same handling procedure as used in transporting the cylinder from the location of receipt to the operating location will be followed in returning the cylinder to location of reshipment.

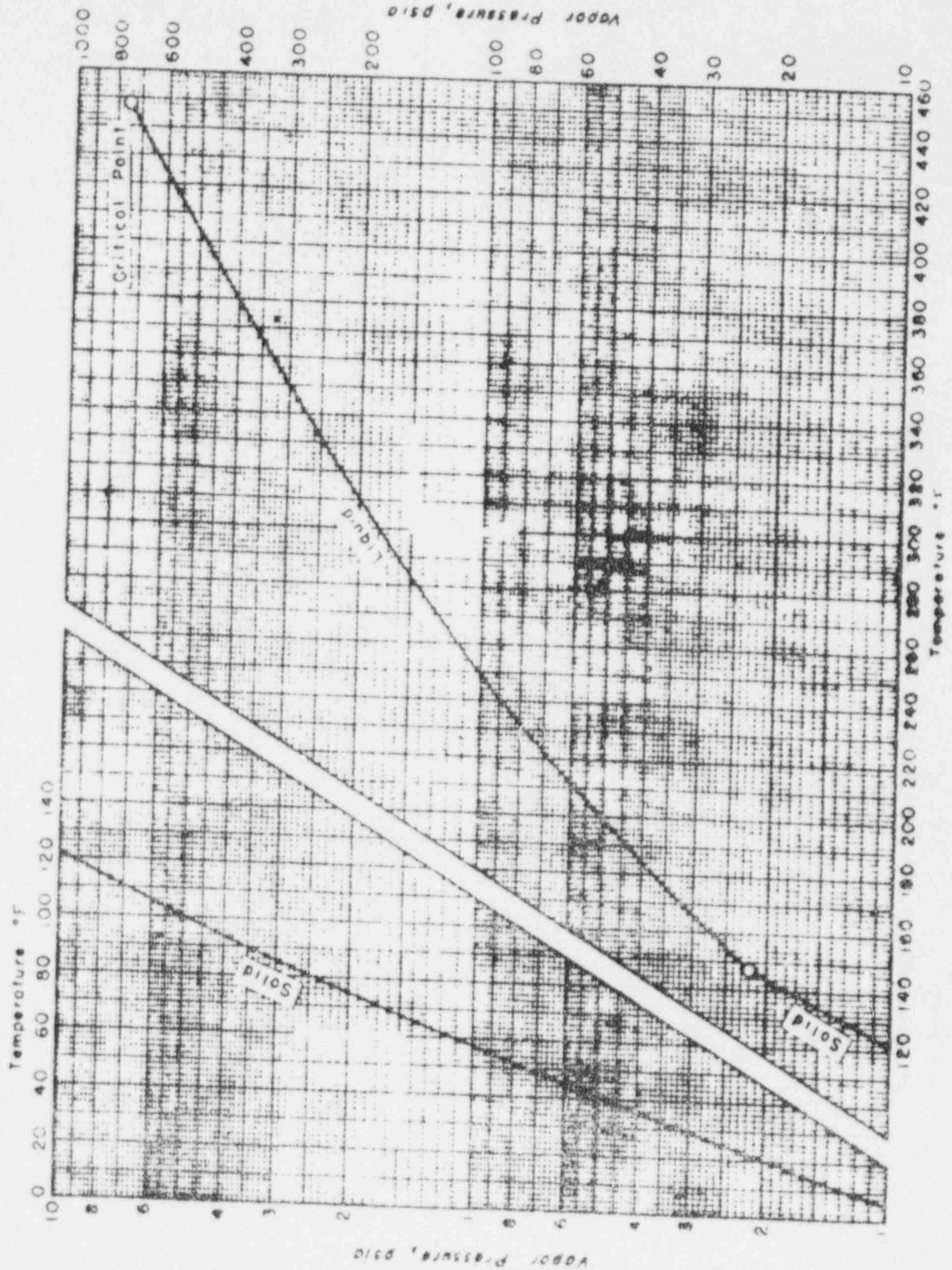
All personnel assisting in the experiments will be made aware of the dangers and problems of working with such toxic material and protective gloves and clothing will be worn at all times. As for the experiments, a description of the process itself has not been included, as it may vary, depending upon the experiment.

The uranium hexafluoride will not present any particular disposal problem because it will ultimately be converted to uranium carbide in graphite. Also, the equipment which contains UF_6 will be clear and present no disposal problem, since it will be flushed out with helium gas.

Fluorine detectors will be located in the vicinity of the experiments and a warning given when the concentration reaches a predetermined level. In such a case, or in event of any other emergency, the building will be immediately evacuated and all personnel remain outside until the F_2 level has decreased to a safe concentration. If it can easily be accomplished without danger to the person involved, during the evacuation procedure an attempt should be made to cut off the electrical power to the building. This can be readily accomplished as there are two adjacent electrical switches, easily accessible, which cut off all power to the building.

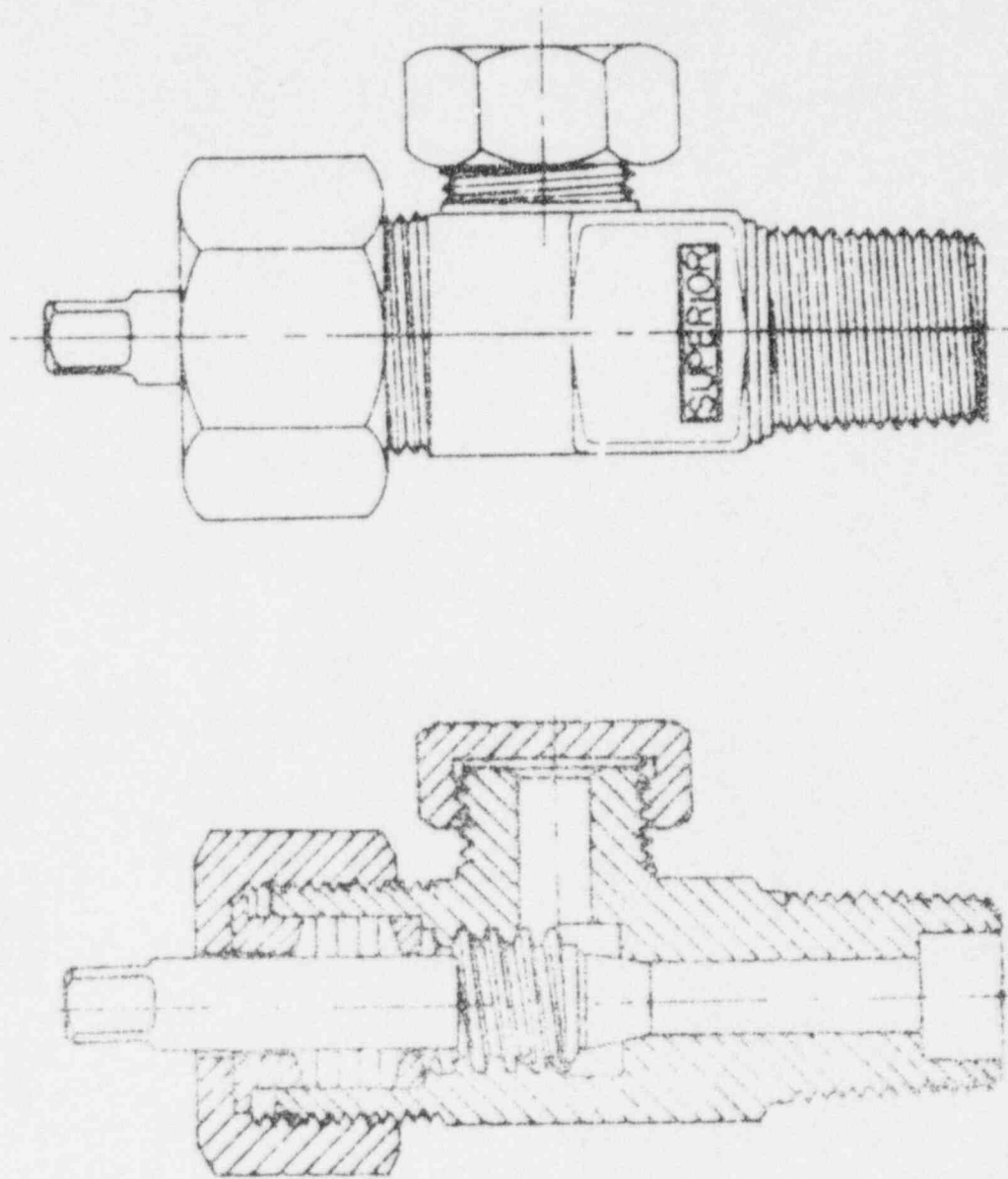
The building itself is somewhat isolated from other buildings in the vicinity, approximately 100 yards from nearest structure, and lessens the probability of an accident's affecting other buildings. Scrubbers and/or traps will be located in the building to collect any fluorine or hydrogen fluoride gas emitted, and respirators will be available also.

OF
URANIUM HEXAFLUORIDE

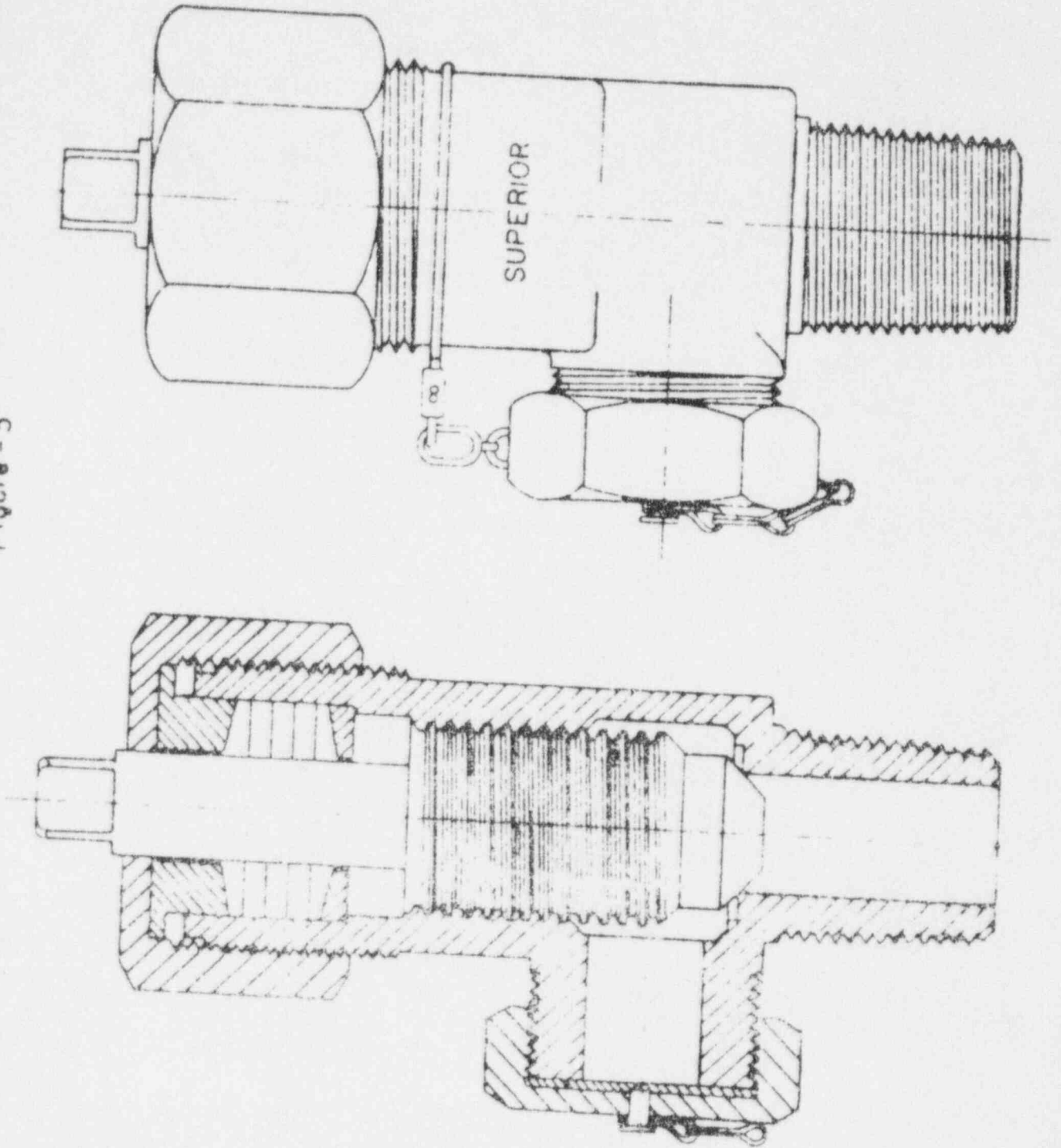


3/4" CYLINDER VALVE

Figure - 2

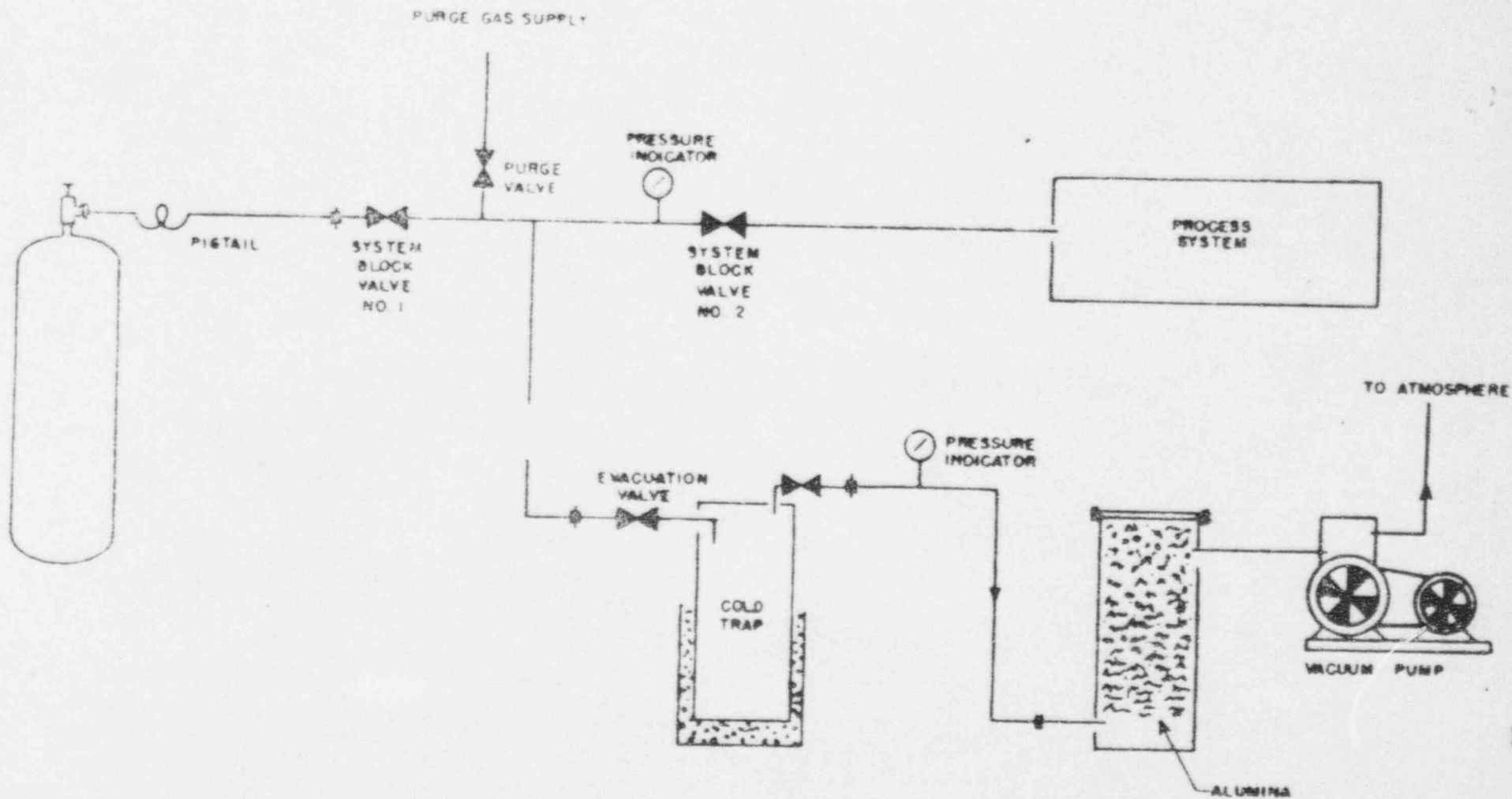


1" CYLINDER VALVE
Figure - 3



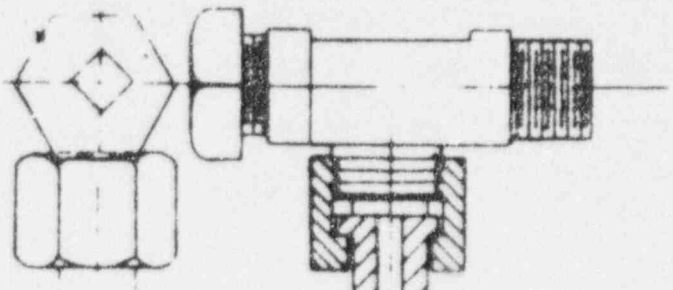
TYPICAL UF_6 TRANSFER SYSTEM

Figure 4



MK-3

MK-4

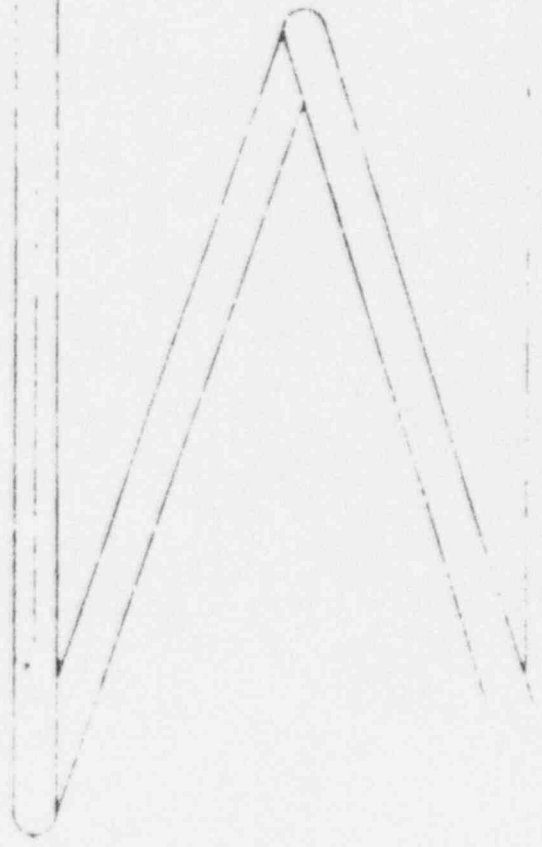
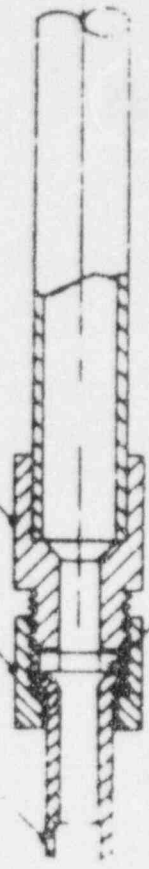


MK-1

MK-3

MK-4

MK-2



DETAIL HALF-SCALE

PIG TAIL

6 9 1 1 6