OPTIONAL FORM NO. 10

UNITED STATES GOVERNMENT

Memorandum

TO : M. M. Mann, Assistant Director - Compl. Division of Inspection - Hq.

DATE: May 6, 1960

FROM : Robert W. Kirkman, Director Inspection Division - NYOO

SUBJECT: REPORT OF RADIATION INCIDENT AT THE WESTINGHOUSE TESTING REACTOR AT WALTZ MILL, PENNSYLVANIA ON APRIL 3, 1960

CF-169

Transmitted herewith is the subject investigation report of a Type "A" incident. It is to be noted that lack of time has permitted the inclusion of only one copy of the exhibits.

Encl.
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Information in this record was deleted in accordance with the Freedom of Information Act, exemptions 6
FOIA- 2002-0248

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INVESTIGATION OF RADIATION INCIDENT

Westinghouse Test Reactor, Waltz Mill, Pa.

INTRODUCTION

The incident at the Westinghouse Testing Reactor, which occurred on April 3, 1960, was initially reported to the New York Operations Office Inspection Division by Westinghouse on April 4, 1960, by telephone and by a teletype. A written report of the incident was transmitted by Westinghouse to the Director, Division of Licensing and Regulation, on April 4, 1960. On April 13 and 14, Jack R. Roeder and John R. Sears of the NYOO Inspection Division, conducted a preliminary investigation of the incident. On the basis of this preliminary investigation, the incident was classified as a Class "A" incident, because of the estimated reactor down time, and the estimated cost of cleanup operations. An investigating committee was then established, consisting of the following:

Dr. Marvin M. Mann,	Assistant Director for Compliance Division of Inspection, Hq. Chairman
John R. Sears,	NYOO Inspection Division
Merson Booth,	Division of Licensing & Regulation, Hq.
Vincent A. Walker,	Division of Inspection, Hq.

The committee met at the reactor site at Waltz Mill, Pennsylvania on April 22, 1960. Mr. Richard Cunningham of the Division of Licensing and Regulation, was present during the committee's deliberations. The following Westinghouse staff members were interviewed during the investigation:

Mr. E. T. Morris, Manager, Westinghouse Test Reactor
Dr. M. A. Schultz, Engineering Manager, WTR
Dr. A. J. Bressesky, Manager, Scientific Support Section
Mr. R. J. Catlin, Manager, Health Physics Section
Mr. George Geisler, Plant Superintendent
Mr. E. H. Hemmerle, Supervisor Technical Assistance
Mr. L. Pollono, Shift Supervisor
Mr. Bianchi, Reactor Operator

Mr. D. Catlin, Health Physics Supervisor, Mr. D. Willhoit, Health Physicist on duty at the time of the incident, and Mr. D. Galm, Senior Scientist responsible for water cleanup, were interviewed by J. R. Roeder of the NYOO Inspection Division, in the preliminary investigation.

DESCRIPTION OF THE WTR

The WTR is a heterogeneous, water moderated and cooled, low pressure and temperature, general purpose test reactor, similar to the MTR. The original design power was 20 megawatts with a flux of about 10^{14} n/cm^2/sec. The reactor is now licensed to operate at 60 megawatts.

The reactor is housed in a 70-foot steel containment shell which is located in a relatively sparsely settled area 28 miles southeast of Pittsburgh. The reactor is approximately 1500 feet from

the nearest site boundary. The total population at a radius of one mile from the site is estimated to be 350 people.

The core structure of the reactor consists of two 6-inch thick aluminum tube sheets between which are welded closely-spaced aluminum shroud tubes. These tubes hold fuel elements and direct the coolant water through the elements.

Each fuel element consists of three concentric aluminum clad cylinders held together at each end by locking pins and a spider-shaped aluminum fitting. Each cylinder is made of an MTR-type plate. The cylinder consists of 13 weight percent highly enriched uranium-aluminum alloy meat section, which is 0.052" thick. The cladding is aluminum, 0.0365" thick. There is space inside the innermost cylinder for installation of a central aluminum-hollow mandrel in which small canned specimens may be irradiated. A diagram of the core is included as Exhibit D.

Reactor coolant water passes down through the core, reverses in flow direction, and passes up through annular spaces between the thermal shield. It is then piped outside the containment shell to a seal and surge tank, pump, heat exchanger, a head tank located 250' above grade, and finally back to the reactor. The surge tank vents to the head tank which in turn vents to atmosphere.

The nine control rods consist of aluminum clad cadmium cylinders connected to the drive shaft by underwater magnets. Scram is accomplished by gravity drop upon de-energizing the magnets. Rod drives are of rack and pinion type, two-phase motor driven, top mounted. The three center rods are safeties. Each of the six outer rods can be put on automatic control.

The reactor is equipped with conventional instrumentation consisting of an overlapping range system of 7 neutron detectors which control rod cutback and scram, appropriate process instrumentation, a radiation monitoring system, and an annunciator.

The temperature coefficient of the clean reactor at 20 megawatts is said to be $-0.8 \times 10^{-4} \Delta k/k/F°$. The void coefficient obtained in a critical experiment was $-3.36 \times 10^{-6} \Delta k/k/cm^3$. The void coefficient is said to have been obtained in the full reactor in a special experiment in which bubbles of known volumes of helium were injected into the reactor, and was said to be $-6.7 \times 10^{-6} \Delta k/k/cm^3$.

The principal test facility of the WTR consists of three, high-pressure, high-temperature, test thimbles capable of operating at pressures up to 2000 psi, and at temperatures up to 600° F. Approximately 60 testing holes are available around the periphery of the core for non-pressurized experiments which require no special environmental conditions. The investigating committee determined that no inpile experiments, either in the loops or in the reflector spaces, had any effect upon the reactor incident.

OPERATIONS ~~PREVIOUS~~ PRIOR TO THE INCIDENT

1. ~~Previous~~ PRIOR to this incident, an experiment had been performed in an attempt to determine the void coefficient of the reactor. A report entitled "Preliminary Report On An Experiment To Illustrate The Simulation And Detection Of Boiling In The Westinghouse Testing Reactor", WTR-SS-TA-258, Appendix I, was transmitted to the Director, Division of Licensing and Regulation on November 11, 1959. This report describes an experiment in which bubbles of helium gas were introduced into the reactor through two 1/8" O.D. aluminum tubes. Bubble size could be regulated by appropriate valving, and could be observed through a length of transparent tygon tubing into which the aluminum tubes discharged. The sensing instrumentation consisted of a compensated ionization chamber connected to a bucking circuit, and then into a high gain D.C. amplifier and a Brush recorder. The D.C. output of the chamber was biased out by the bucking circuit. Fluctuating signals due to voids passing through the reactor, appear as deflections on the Brush recorder.

2. The sensing instrumentation for the bubbler experiment was left ~~in the reactor~~ during the escalation in power from 20 megawatts to 60 megawatts. A series of reduced flow experiments had been made at various power levels and at various primary coolant flows, in order to determine the point at which there was the first indication of perturbations due to bubble formation. The traces of a number of these experimental runs are included as Exhibit A. It should be noted that during these runs, there is the notation, "Access Tubes - In". Dr. Schultz explained that these access tubes were capped thimbles which had been placed both in the core and in the reflector region, to hold some small experimental samples. The water in these tubes had been stagnant, and so it was felt that during these reduced flow experiments the water in the access tubes was indeed boiling. An experiment was done to prove this point. In one access tube in core position L-5-8, a thermocouple was lowered, and during the run temperature readings were taken as the thermocouple was raised through the access tube. It was said that these readings indicated that there was boiling inside the tubes during these runs. In view of this, the decision was made to repeat these ~~reduced flow~~ experiments with the access tubes removed from the reactor, and this is the type of experiment which was being run on the night of the incident. One of the purposes of these experiments was to attempt to verify experimentally the curve of a plot of "power to initiate boiling versus core flow", a theoretical, calculated curve. This curve is Exhibit E.

3. The minutes of the Westinghouse Testing Reactor Safeguards Committee meetings indicate that the reduced flow experiments had been reviewed by the Committee and had been approved. A test specification for the escalation in power from 20 to 60 megawatts was prepared and approved by the Chairman of the Safeguards Committee. This test specification No. 5-1, is included as Exhibit D. It places definite restrictions upon operation, in compliance with the Westinghouse license. This test specification, No. 5-1, also specified that, if rod motion

equivalent to 0.14% reactivity is suddenly required, this would indicate that these prescribed limitations had been exceeded, and that the reactor power level should be decreased by 10 MW. However, the investigating committee determined that these restrictions spelled out in test specification No. 5-1 were never translated into operating procedures for the reactor operator at the console. ~~During the incident, according to Dr. Schultz, a copy of the test specification was available at the console.~~

4. For the particular experiment being performed on the evening of the incident, test specification No. 5-2 had been prepared. ~~This spec details conditions for this particular run.~~ A copy is included as Exhibit C. Since in this experiment the flow was to be cut back to 5000 gpm, ~~while~~ the power level ~~went~~ to be 44 megawatts, the scram and cutback settings had to be readjusted. This specification did not spell out any anticipated abnormal conditions which might prevail in the reactor as a result of the experiment. A copy of the specification had been studied by the reactor operator and the experiment crew, and was available at the console. Specification 5-1 also was not said to be available at the console.

5. Examination of Westinghouse's log book indicated that there had been ~~considerable~~ difficulty in procuring acceptable fuel elements. A large percentage of elements had been rejected because of surface imperfections. Dr. Schultz said that the depth of imperfection which determined rejection, was 0.015".

6. ~~Previous to this run~~ Several weeks before the incident, a fuel element in Location L-7-6,* had been instrumented with aluminum sheathed thermocouples. These thermocouples had drifted up over a period of three weeks. A new element had been put in this location only two days before the incident. This was also instrumented with 4 aluminum thermocouples. ~~This second series of thermocouples in this same location, also drifted up.~~ Calculations of flow and heat conditions indicated that the thermocouple readings must be in error, and on April 1, 1960, the fuel element in position L-5-6, was installed with 6 thermocouples. These were stainless steel sheathed, magnesium oxide insulated thermocouples. These thermocouples were connected to read out on a data logger. Exhibit D is a reproduction of the thermocouple readings on these two fuel elements in locations L-7-6 and L-5-6, just prior to, and during the incident. The readings on L-7-6 went as high as 311° F., whereas the highest reading on L-5-6, at any point, was 245° F.

~~The~~ Test specification 5-1 ~~for this run~~ had placed an operating restriction ~~of a~~ the first fuel ring bulk water outlet temperature at ~~of~~ 220° F. The thermocouple readings of L-5-6, indicate that at no time, even during the incident, was this exceeded. ~~Dr. Schultz said he feels confident that the thermocouples on the first element, L-7-6, simply gave erroneous indications.~~

7. A final item which possible might have a bearing on the incident, was mentioned by Dr. Schultz during the investigation. About a week previous to the incident, welders had been at work inside the head tank. They had worn plastic shoe covers. Dr. Schultz mentioned the possibility that a shoe cover might have gotten into the primary water. However, he also said that there is a strainer in the line before the reactor, and that it should keep ~~out any~~ foreign material from the reactor.

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* Subsequently the fuel element was moved to other positions.

THE APRIL THIRD INCIDENT

On April 3, 1960, the reactor had been operated at a steady state for approximately one and a half days at 40 megawatts with the primary cooling flow at 15,000 gpm. At approximately 6:30 p.m., a meeting had been held in the control room to outline the experiment to be done that evening. The conditions for scram and cutback settings, as specified in test specification No. 5-2, were set forth. At 7:00 p.m. the reactor power was reduced to 30 megawatts, and scram and cutback settings were adjusted to permit experiments at a flow of 5000 gpm.

In the control room at the time were Mr. Bianchi, a licensed reactor operator, at the console, and Mr. Pollono, the Shift Supervisor. Dr. A. Pressesky, Manager, Scientific Support Section, was also in the control room for the purpose of making some calculations during the run. Mr. George Geisler was in the Shift Supervisor's office behind the control room. Dr. Schultz was observing the Brush recordings ~~on the instrument~~ from the void coefficient instrumentation on the balcony within the containment shell. Mr. Nick Shorich, a licensed pile operator, was in the containment shell observing temperatures on the only operating loop. The neutron power level was being recorded in the control room, and reproduction of the chart is attached as Exhibit ~~#~~ 6. At approximately 8:00 p.m., the flow was reduced to 5250 gpm. This was done by the operator at the console. As the flow was reduced, the temperatures increased and the negative temperature coefficient reduced the power slightly, and the automatic controller brought the power back at a level of 30 megawatts. At 8:20 p.m., the operator was instructed to raise the power level to 35 megawatts. This he did by the auto power demand. The thermal power was calculated to be 37 megawatts, and the Shift Supervisor (Pollono), instructed the operator (Bianchi) to lower the power to 35 megawatts. This he did. ~~with the reactor still on automatic.~~ At approximately 8:33 p.m., the operator was instructed to raise the power level to 40 megawatts. He set the automatic power demand, and the reactor started up. As the neutron power level recorder went to approximately 37 megawatts at about 8:34 p.m., the recorder pen ~~suddenly~~ dropped within a few seconds to approximately 17 megawatts. The #9 rod, ~~which had been on automatic,~~ ~~came full out,~~ and the operator switched to #8. The #8 rod also ~~came full out~~, and the operator attempted to regain reactivity by withdrawing the #1 rod manually. Both Pollono and Bianchi stated that they saw the drop in power level on the recorder. Bianchi stated that at the time he thought that the drop may have been due to the effect of either a temperature or a void coefficient. The power recorder ~~pen started up again~~ and Bianchi said that the period indicator on the console indicated an approximate 60 second period.

Bianchi recalls that as the ~~pen trace~~ trace came up, a radiation monitor sounded. He said that he had been puzzled by ~~losing all~~ both the #8 and #9 rods, and he had been instructed to help in returning the power level to its former value by pulling #1. He claimed that he did not pull any more rods during the ~~ascension~~ to power. The reactor was evidently responding to

the power demand setting on the auto controller. During the last part of the climb back to power, more radiation monitors went off, and Bianchi was instructed by Pollono to cut back manually at about 8:40 p.m. The indicated reactor power was then approximately 38 megawatts. The reactor power was cut back to about 15 megawatts, and then as still more radiation monitors alarmed, Pollono instructed Bianchi to scram the reactor at 8:44 p.m.

HEALTH PHYSICS

Mr. Donald Willhoit was the Health Physicist on duty on the night of the incident. He said that approximately 12 people were working in the WTR facility. Willhoit was in the health physics office at about 8:36 p.m. when he heard the first alarm, which subsequently turned out to be ~~(channel #8)~~ the reading at the monitor on the reactor top. He very soon after heard another alarm go off, ~~channel #14,~~ and immediately called the control room to determine what had happened. At this point, all of the alarms sounded practically simultaneously. Willhoit then took a Cutie Pie survey meter, and proceeded to the control room.

The following radiation monitor readings were obtained from Mr. George Geisler. He said that these readings had been ~~taken from the records~~ ~~scribbled down on a piece of paper~~ at about 8:45 p.m., ~~evidently~~ in the control room ~~by one of the persons in the control room~~.

Channel No.	Description	Approximate Reading in C/S
1	Critical Test Station	100
2	Gamma Radiation Station	40
3	Canal Floor Area	100
6	Waste Disposal Facility	300
8	Reactor Top	1000
9	Beam Hole	600
10	Rabbit Facility	50
11	Elev. 32 - North	600
13	Elev. 16 - South	25
14	Demineralized H_2O	700
17	Stack Particulate	1000
18	Reactor Particulate	>1000

Immediately after the scram, Willhoit left the control room and began taking readings in various parts of the building. He then proceeded to the reactor building, only to be met by the reactor personnel, who were evacuating the building.

Mr. Donald Collins, Health Physics Supervisor and Willhoit's immediate supervisor, said that he received a telephone call at his home at about 9:45 p.m., ~~from either Geisler or Pollono.~~ He was informed of the situation, and reportedly recommended that the building be evacuated. He arrived at the site at about 9:00 p.m.

At about 8:45 p.m., according to Willhoit, the evacuation order was sounded over the Femco intercom system. Willhoit took some readings in the reactor building, and then went out the south door of the reactor building to the Process Building. He recalled that he obtained a reading of about 80 mr/hr in this area which he erroneously believed was due to Argon[41] coming from the head tank. In the process building, he found three men working (two in the machine shop, one in the boiler room), who had not heard the Femco alarm due to the noise of the machines in the building. He directed them to evacuate to the control room. Immediately thereafter, the general evacuation alarm was sounded in all of the buildings. Willhoit stated that this could be clearly heard over the noise of the machinery in the Process Building. He then proceeded to the head tank monitor and at two meters away, obtained a reading of 5 r/hr. He went to the main gate at about 9:00 p.m., where the reading was about 200 mr/hr. He next went back to the control room where all personnel had assembled prior to leaving the site. All persons, with the exception of Willhoit and the reactor supervisors, evacuated the site, and assembled at the main gate. Willhoit took some more readings shortly after 9:00 p.m., the results of which follow:

Area	Reading in mr/hr
H. P. Office	2
H. P. Lab	5
Hallway outside H. P. Office	5
Outside South Door	50
At Decontamination Pad	200
Two Meters from Head Tank Monitor	5000
Reactor Control Room	40
Main Gate	200
WREC	500
Head Tank Exclusion Fence	4000
Film Badge Rack *	2
Reactor Top	1000

*At about 9:00 p.m., it was reported that all film badges from the film badge rack were removed and stored in a radiation-free area.

It should be noted that all of the readings noted above were subsequently determined to be from direct radiation emanating from the elevated head tank. Subsequent calculations determined that this tank housed approximately 5000 curies of fission products, all of which was contained in the primary coolant water. However, inasmuch as the source of radiation was not known at the time of the incident, Willhoit and Collins reported that all persons in the building were immediately required to wear canister-type masks.

Because the reading at the main gate (the first assembly area), was 200 mr/hr, it was decided that all personnel, with the exception of Willhoit and Collins, should get in their cars and drive to a guest house, owned by Westinghouse, about 1/3 of a

mile away, known as the "Seubert House". Readings taken there by some of the evacuated personnel were found to be normal background. In the meantime, Collins and Willhoit, both wearing masks, began 1) taking air samples throughout the buildings, 2) taking smear samples throughout the buildings, and 3) assembling instruments for the purpose of setting up a counting area in the "Fabian House", a second guest house that is about 1/4 of a mile away, and also owned by Westinghouse. At about 9:30 p.m., they were joined by R. J. Catlin, Manager of the Health Physicist Group, who had been informed of the incident by telephone.

In the meantime, presumably between 9:00 and 9:30 p.m., the security guards set up roadblocks and flares on all roads leading to the reactor site. Acting on orders from the supervisory personnel, the guards re-routed traffic. In addition, they were instructed to inform all non-essential personnel, who would be arriving in a few hours to begin the third shift, to ~~return to~~ remain at their homes.

At the same time, the first air samples were taken outside the buildings, as were more direct reading surveys. Portable instruments and counting equipment were set up at the Fabian House. In addition, arrangements for the taking of urine samples of all persons were completed. Catlin reported that it was decided that all persons who were still at the Seubert House should proceed by car to the Fabian House. Upon arrival at the Fabian House the following steps were taken: 1) direct reading surveys were taken of all employees' cars. These included readings taken on the outside, on the seats, on the steering wheel, the clutch, the brake, and the gas pedal; 2) smear samples were taken on the tops, the hoods and the trunks of all cars; and 3) urine samples were taken from all persons who had been in the buildings at the time of the incident.

The above surveys were reportedly conducted by Carl Fritz and the results of the smear and air samples were counted in the Fabian House. The results of these surveys were negative: the direct reading surveys showed no increase in normal background count, and the smear samples indicated no removable contamination.

At some time during the survey, Willhoit stated that he discovered a company car that had been parked near the head tank and the exhaust stack at the time of the incident, but had been overlooked. He immediately checked it for contamination, but none was found.

Under the direction of the H.P. personnel, various teams, in their own cars, set out at about 10 P.M. to conduct direct reading surveys in outlying areas. ~~These presumably were performed sometime between 10:00 and 12:00 p.m.~~ It was reported that one team went north to Madison, Pennsylvania, a second went southeast to New Stanton, and a third went west to Yukon. The results of all of these direct reading surveys were negative. At the same time, air samples were taken in the downwind direction, the results of which also revealed no detectable airborne activity. (It should be noted, at this point, that at the

time of the inpident, the wind was from the Northeast at about 3 to 5 miles/hr. There was also a slow drizzle of rain. Collins and Willhoit stated that the actual wind velocity was not obtained until the next day inasmuch as the indicating device was not working. They added that the 3 to 5 mile/hr figure was obtained the next day from the Pittsburgh Airport).

Collins and Willhoit reported that the time from 12 midnight on was spent taking various environmental surveys, and analyzing results. Surveys were also conducted in the buildings as personnel were beginning to re-enter to begin evaluation and cleanup operations. The results of two direct reading surveys conducted during the morning of April 4, 1960 follow:

3:15 A.M.

Area	Reading in mr/hr
Gate	11
Outside South Door of RSB	15
Road #2	35
Road #3	55
Outside WREC Door	45
Outside Rear of Shop	170
On Road Adjacent to Head Tank Fence	800
On Road in Passageway Between Annex and Boiler Room	80-90

5:30 A.M.

Gate	17
Road #1	20
South Door (RSB)	20
Road #2	28
Road #3	44
10' NW of WREC Door	38
At Outside of WREC Door	32
On Road #3, Rear of Shop	150
On Road #3, SE of Head Tank	700
On Road #3, NE of Head Tank	700
On Road NW of Process Building	90
On Road, Main Passage Between Boiler Room and Annex Area	85

TREATMENT OF CONTAMINATED WATER

As was previously noted, all of the radiation levels emanated from the head tank, which was estimated to house about 5000 curies of fission products in approximately ~~250,000~~ 6[illegible]0 gallons of water

During the preliminary investigation, the inspectors contacted Mr. David Calm, Senior Scientist, who had been given the responsibility of analyzing, storing, and eventually disposing of the ~~above mentioned~~ 250,000 gallons ~~of~~ water. Calm stated that he ~~first heard of the incident when he~~ received a phone

the total of which [illegible] to [illegible]

call at his home at about 11:30 p.m. on April 3, 1960. He stated that he arrived at the Seubert House at approximately 12:00 p.m. He stated that it was immediately decided to obtain some H+ and OH- ion exchange resins. At approximately 1:00 a.m., a local representative of Rohm & Haas was contacted in order to have this resin for a PC deionizer ready in Philadelphia at about 8:00 a.m. At about 2:00 a.m., a truck was dispatched to Philadelphia in order to pick up the resin. ~~The following is a chronological summary of the action taken by Westinghouse personnel to begin processing of this water:~~ omit

Monday, April 4, 1960

1. Approximately 1:00 a.m. arrangments made with local representative of Rohm & Haas to have resin for PC deionizer ready in Philadelphia at factory at 8:00 a.m.

2. Truck dispatched to Philadelphia about 2:00 a.m.

3. 0030 - Attempt made to sample PC system in shutdown pump room. P.C. pipe read 10 r at contact - - attempt abandoned.

4. 0130 - Vapor container entered to check No. 1 loop for satisfactory cool-down operation. Radiation reading at 16' elevation about 15 mr. At about same time boiler room entered to check equipment. All OK.

5. 0300 - Boiler room checked. OK.

6. 0328 - Ion exchanger cubicle entered to check valvings. Found equipment valved out, a favorable circumstance. Reading in cubicle 100 mr top to bottom, except at contact with bottom of tank and filter. Reading here 3-4 r.

7. 0445 - Boiler room checks being made every hour. No. 1 loop also being checked each hour.

8. 0600 - Drained 50 gallons of water from bottom of PC ion exchanger into waste resin tank. Radiation level at top of ion exchanger 50-7 mr.

9. 0700 - Started removal of bolts from head of ion exchanger preparatory to introduction of resin for clean-up of system. Completed loosening all bolts 0730.

10. 0800 - 1600 - Supervisory and engineering personnel spent full time analyzing incident and making necessary plans for repair and clean-up of plant. Operating personnel (M.O., H.P., and N.P.) involved in continuous radiation monitoring, setting up of radiation and contamination zones, and any other activity related to the immediate situation.

11. 1600 - 2400 - Operating personnel completed necessary preparations for installation of new P.C. ion exchanger resin.

Tuesday, April 5, 1960

1. 0320 - Resin for P.C. ion exchanger arrived by truck. Immediately set up loading operation.

2. 0415 - Loaded 15 barrels resin.

3. 0730 - Completed loading, cleaned gasket for head and set in place.

4. 1015 - Surge tank blower in operation.

5. 1124 - Flow through ion exchanger started 95 gpm filling surge tank.

6. 1401 - No. 3 PC pump on one hour total. (Started 1401). Object here was to decontaminate PC water through PC ion exchanger.

7. All day operation consisted in passing PC water from head tank to ion exchanger and surge tank to head tank.

8. No. 3 pump in operation two hours, total remaining crew spent all their time decontaminating and cleaning.

Wednesday, April 6, 1960

1. Continued flow of water from head tank to surge tank and through ion exchanger, pumping back to head tank periodically.

2. Removed unnecessary items from all operating area and cleaned and mopped up.

3. PC system being operated at lowest possible flow.

4. Continued fabrication of drum demineralizers.

5. Continued passing PC water from head tank and ion exchanger to surge tank to head tank. PC pump No. 3 in operation 8 hours, remaining crew cleaning and decontaminating.

6. Continued established procedure for cleaning PC water all day. PC pump No. 3 in operation 8 hours.

7. Rod seal system turned on 1751 10PM.

8. Remaining crew assembled barrel ion exchanger in process area.

Thursday, April 7, 1960

1. Continued established procedure for cleaning PC water all day. PC pump No. 3 in operation 6 hours.

2. RM monitor now about 70 cps.

3. Continued established procedure for cleaning PC water.

4. Heater jacket on PC return line and supply (head tank) put into service and heat PC water.

5. Put barrel ion exchanger into operation.

6. Continued established procedure for cleaning PC water.

7. Pump No. [illegible] on 6 hours.

8. Remaining crew on clean-up.

Galm stated that the first sample from the head tank was taken at 9:30 a.m. on April 4, 1960. The sample was counted in a well-type counter which had an efficiency of about 30%. The results of this analysis (which is also listed below) revealed 681,406 counts/5 sec./ml. Conversion of this figure revealed an activity of about 2.4 x 10[illegible] dpm/ml.

There follows a summary of the results obtained upon further analysis of this water:

		counts/5 sec./ml
April 4, 1960		
Fission Product Detector	9:30 a.m.	557,888
Head Tank	9:30 a.m.	681,406
Head Tank	12:00 noon	663,756
April 5, 1960		
PC Ion Exchange Inlet	2:00 p.m.	650,216
PC Ion Exchange Outlet	2:00 p.m.	25,626
PC Ion Exchange Inlet	9:15 p.m.	575,213
April 6, 1960		
PC Ion Exchange Inlet	10:00 a.m.	659,800
PC Ion Exchange Outlet	10:00 a.m.	16,000
PC Ion Exchange Inlet	8:00 p.m.	545,000
PC Ion Exchange Outlet	8:00 p.m.	83,000
April 7, 1960		
PC Ion Exchange Inlet	9:30 a.m.	258,000
PC Ion Exchange Outlet	9:30 a.m.	5,500
Retention Tank		900
PC Ion Exchange Inlet	12:00 noon	213,000
PC Ion Exchange Outlet	12:00 noon	25,000
PC Ion Exchange Inlet	3:45 p.m.	208,000
PC Ion Exchange Outlet	3:45 p.m.	4,500
Retention Tank	3:45 p.m.	1,000
PC Ion Exchange Inlet	8:15 p.m.	108,000
PC Ion Exchange Outlet	8:15 p.m.	700
Retention Tank	8:15 p.m.	200
April 8, 1960		
PC Ion Exchange Inlet	0030 a.m.	113,000
PC Ion Exchange Outlet	0030 a.m.	2,300
Retention Tank	0030 a.m.	1,000
PC Ion Exchange Inlet	4:30 a.m.	106,000
PC Ion Exchange Outlet	4:30 a.m.	1,500
Retention Tank	4:30 a.m.	1,300
Reactor Top 6" Line	6:30 p.m.	50,200
Reactor Top - 10" Line	6:30 p.m.	70,106

April 9, 1960		counts/5 sec./ml
PC Ion Exchange Inlet	10:00 a.m.	84,600
PC Ion Exchange Outlet	10:00 a.m.	3,450
April 11, 1960		
Evaporator Feed Tank	2:00 p.m.	3,700
April 12, 1960		
Condensate Tank	2:30 p.m.	100

On the afternoon of the date of the initial investigation (April 14, 1960), Galm provided the inspectors with the results of the latest analysis, which revealed that the activity had been decreased to approximately 4×10^{-3} uc/ml. Galm stated that this activity was still too high for release of the water and added that twelve 20,000 gallon tanks (which were on order) would be used to store the water.

STACK EFFLUENT DISCHARGE

The rated capacity of the blower for the surge and head tanks is about 2000 $ft.^3$/minute, and the concentration of the effluent is evaluated by a Yenne Chamber ~~which reads in amps. (Conversion to uc/ml can be obtained by dividing by a constant.)~~ At the time of the incident, the ~~non~~ recorder of the Chamber was on the 10^{-9} amps scale. Immediately after the fission product release, the pen went off scale and ~~due to the evacuation procedures, etc.,~~ it remained off scale until the selector switch was changed by a factor of 1000 to the 10^{-6} amps scale, some five minutes later. At this point, it immediately began recording and ~~was kept~~ on this scale for about 35 minutes at which time the fan was shut off. All of the activity released was believed to be due to A^{41}, Kr^{85} and $Xe^{133-135}$ inasmuch as environmental studies have been negative.

Catlin said that he had attempted to calculate the amount of activity released from the head tank vent in the first burst by working back from analyses of activity in water samples taken after the incident. He put an upper limit of 350 curies on this release, but said that he believed that the actual amount should be closer to 200 curies.

ENVIRONMENTAL STUDIES

As was previously noted, preliminary environmental studies taken between approximately 9:00 p.m. on April 3, 1960, and 9:00 a.m. on April 4, 1960, revealed no contamination. It was reported that on the morning of April 4, 1960, H.P. personnel began taking further environmental samples and analyzing them. Willhoit and Collins stated that approximately 25 vegetation samples, 25 mud samples, and 12 standing water samples (resulting from the drizzling rain) were taken and analyzed. In addition, the licensee's fallout detectors (consisting of gum paper) were analyzed. Analyses of all of these samples were negative.

On April 4, 1960, Nuclear Science and Engineering Company was contacted and informed of the incident. It was reported that this company was chosen to perform an independent environmental survey for two reasons: (1) NS&EC had performed a preliminary on-site and off-site study, and (2) Westinghouse wanted an independent study taken.

Direct reading surveys were conducted between 9:00 a.m. and 11:30 a.m. on April 4, 1960. The following are the results of these surveys:

April 4, 1960

0900

RADIATION LEVELS

Machine Shop (No.)	30 mr/hr
Machine Shop (So.)	40 mr/hr
B.R. Desk	35 mr/hr
B.R. (NE) Door	180 mr/hr
B.R. (W) Door	25 mr/hr
Kanne	130 mr/hr at contact
Sample line	60 mr/hr
Fan Room (E) Door	60 mr/hr
W.D. East Door	210 mr/hr
Oper. G.A.	40-50 mr
Ion wall out	5-15 mr
Tank (Ion)	100-4000 mr
Heat X Opening	270 mr
Annex 32'	10 mr/hr
Loop PC line	2.5 R/hr
Beam hole	45 mr/hr E
Ele. 51'	35 mr/hr E
Top - Thermionic Port	2 R/hr
E. Rail	65 mr/hr
E. Ports	4.2 R/hr
Rod drive	1.5 R/hr
Gen. Area	750 mr/hr
Trench	1 R/hr
Gate	13 mr/hr
Road #2	19 mr/hr (So) 70 mr (No)
Road #3	36 mr/hr
WPEC Door	30 mr/hr
WPEC Shop	5 mr/hr
CRS Door	21 mr/hr
CRS Console	2 mr/hr
Shop near	115
Tank Range	500-700
Road	300-400
Pump Rooms	200 at door (3)
Pumps	>5 R at ion
	35 mr at door (2)
	1.5 R at cont.
	100 mr at door
	5 R at 6" (1)
	1 R at door open
	20 at door closed
B.R. & Annex Road	70 mr/hr
S.R. at WPEC	~150 mr

RADIATION LEVELS AS OF 0900 ON 4-4-60

Reactor Top

East Railing	65 mr/hr
Thermionic Access Port	2 R/hr
East Access Port	4.2 R/hr
Over Rod Drives	1.5 R/hr

Beam Hole

East rail	45 mr/hr
Step-off pad	10 mr/hr

16' Elevation

Normal radiation zone from filter on Loop #1
Between Loops 2 & 3 >100 mr/hr due to PC piping used for cooling.

Operating Area, Pump Rooms 45 mr/hr

Head Tank Area

At fence	1 R/hr
At North rd.	500 mr/hr

Fan Room 40-80 mr/hr

Shop Area 40-80 mr/hr

Entrance to HX Room 270 mr/hr

Waste Disposal Room

First floor	20 mr/hr gen. background
Second floor	10 mr/hr

Annex

General Area	10 mr/hr
Truck Loading Platform 321	22 mr/hr

Service Building

Project Engr. Room	10 mr/hr at window 5 mr/hr gen. background
Cafeteria	15 mr/hr at window at South end 5-10 mr/hr gen. background

WRFC

At doors	30 mr/hr
GPS door	22 mr/hr
Miller's Fence	5 mr/hr
Davison window	20-22 mr/hr
Davison office	5-10 mr/hr

RADIATION LEVELS AS OF 0900 ON 4-4-60

Receiving Department

Outside at door	10 mr/hr
Inside at desk	5 mr/hr
At Guard House	10 mr/hr
County Road	3 mr/hr

4/4/60

1130

RADIATION LEVELS

FIRST FLOOR SERVICE BUILDING

SOUTH

Lobby	N 1 mr/hr W 1 mr/hr
Cafeteria	Windows - 10 mr/hr
Cash Register	7 mr/hr
Cafeteria windows - side rear	15 mr/hr
Cafeteria rear	5 mr/hr
Kitchen	1 mr/hr
Hall - South	1 mr/hr
Room 122	< 1 mr/hr

NORTH

Drafting	< 1 mr/hr
Library	5 mr/hr
SS main office - windows	6 mr/hr
General area	2.5 mr/hr
Secretary's office - SS	4 mr/hr - windows
Gen. area - secretary	2.5 mr/hr
South door	1.5 mr/hr
Medical - examining room	1 mr/hr at window

When questioned about some of these high readings, Willhoit and Collins stated that all of the areas were considered restricted. They added that several areas were closed down completely (among these the library) and entrance into the areas was permitted to authorized personnel only.

PERSONNEL MONITORING

The licensee employs a weekly beta, gamma and a weekly neutron badge that is supplied by R. S. Landauer and Company. In addition, pocket chambers are also used. ~~Approximately~~ 225 ~~Westinghouse employees subscribe to the service~~.

Willhoit and Collins presented the inspectors with copies of film badge and pocket chamber results for the period involving the incident. The ~~only~~ exposures listed below are those involving persons who received an excess of 150 mrem.

Name	Badge Reading For Period 3/28-4/6/60	Pocket Chamber Reading	7-Day Total For 4/2-4/8/60
[redacted]	320 mrem	55 mr	55 mr
	190 "	219 "	254 "
	185 "	191 "	191 "
	155 "	141 "	136 "
	185 "		196 "
	195 "	195 "	150 "
	195 "	150 "	265 "
	240 "	181 "	206 "
	150 "	125 "	106 "

Ex 6

In addition, personnel were given medical examinations by Westinghouse's Medical Department. These examinations included a routine physical, a blood test, a urinalysis, a thyroid scan, and a nasal swab count. All results were reportedly negative. (See Exhibit "H".)

INFORMATION GATHERED DURING COMMITTEE MEETINGS

At the investigation committee meeting with the WTR staff, further information relative to the incident developed.

1. Dr. Schultz exhibited the Brush recordings taken immediately prior to, and during the incident. Exhibit "A" had been taken prior to this incident. The greatest amount of noise seen in previous runs had occurred during a 40 megawatt run at a flow of 7000 gal/min. On the evening of the incident when the pile power initially reached 35 megawatts at the flow of 5250 gpm, the perturbations on the Brush recorder were approximately equal to those achieved in the 40 megawatt, 7000 gpm operation. When the power level went initially to 38 megawatts, the Brush recorder perturbations increased to 600 kw for approximately 6 seconds. ~~The recorder then indicated a level off in power.~~ For approximately 2½ minutes, the Brush recorder indicated, at first, very little perturbations, and then a gradual increase again, and as the reactor power rose to 38 megawatts for the second time, the Brush recordings indicated 500 kw perturbations.

2. Both Bianci and Pollono were of the opinion that the power had more or less leveled off at approximately 17 megawatts for a short period of time before it started up for the second time.

Bianci said that during the experiment, the supervisor had been calling out temperatures from the instrumented thermocouples. During the dip in power and the climb back up, however, no readings of temperature were called out, and he was unaware of any abrupt temperature changes.

3. Both Bianci and Pollono said that they had not been given any special instruction prior to this experiment with respect to sudden re-activity changes.

Pollono had been at the WTR for only about three months. He had formerly been at the Westinghouse plant in Kansas City and had been in charge of a testing operation there. When he originally came to the WTR, he was put on shift for approximately one month with Mr. George Geisler, who was then acting as a shift supervisor. Geisler said that he had given Pollono various startup problems, and that he had had three reactor startups. In answer to the question whether he had any qualms about Pollono's qualifications, Geisler replied that he had confidence in Pollono since Pollono followed instructions explicitly when he (Pollono) did not know the answer himself.

Bianci's background consisted of four years working as both an electronic technician, and as an extra operator at Bettis criticals, the production test facility, and the reactivity facility. He has been at the WTR site for approximately 1½ years and has been licensed to operate the WTR since October, 1959.

Bianci said that during normal operation, if he observed such a drop in power on the neutron power level recorder, he would not have brought the reactor back to power.

All of the members of the WTR management staff agreed with the committee that an error had been made in returning the reactor to power after the sudden drop. They further admitted that the standard operating instructions contained no provision, procedure, or instruction for the pile operator in such a situation. They further agreed that there was a fault in the lack of communication between the Technical Support Group and the Operations Group in that the Technical Support Group had written Test Specifications for the experiment but had not followed through to insure that these specifications were translated into step-by-step procedures and precautions in the console operator's manual.

4. After the incident, circulation of purge water through the primary system brought the radiation levels at the pile top down to acceptable working limits. The reactor head was removed, and cleaned, and bagged. Protective paper and polyethylene sheets were placed over all the equipment inside the containment shell. A photograph was taken of the top of the core (Exhibit [illegible]). Discharge operations were initiated, and when element No. I 5-6 was discharged, only the top half of the element came out. It was placed in the canal and then into a hot cell. The committee examined the piece of this element. The bottom part of it [illegible] resembled stalagmites. The cladding of the outer cylinder appeared as though it had peeled back from the meat, indicating the possibility of a poor metallurgical bond between the cladding and the meat.

In the center of this element, there had been a 1-1/8" O.D. basket containing a 1/2" O.D. aluminum rod with 1/8" O.D. quartz capsules. These capsules held clippings of nickel wire which were being used to get a flux profile through this element. There was no evidence of this material in the portion of the fuel element observed in the hot cell.

The specifications for the fuel elements were examined by the committee. They call for a surface finish free from scratches more than .003" deep, and a deviation from straightness of no more than .015". They further specify that the bond cladding shall be free of blisters following a standard 930° F, 3-hour blister anneal.

The shop inspection procedures state that outside diameter measurements and wall thickness measurements shall be taken every six inches. Finally, there shall be a measurement of the amount of straightness or bowing of the element.

The fuel element records indicated that this element had been received on November 20, 1959, and it had been inspected and approved by Westinghouse.

Mr. Rice said that initially, in the elements made by Clevite, there had been voids in the braze ~~of~~ as long as 10"-12". However, he said that this problem had been solved and a new process employed. He stated that he had personally inspected several elements made with the new process and that these had been approved. Mr. Rice continued that he had on two occasions made an unannounced inspection in Clevite's plant to check on the fuel fabrication. ~~This element, #B 62, had been made after the braze problem had been solved.~~

Mr. Rice said that in the first shipment of 8 elements, there had been marked bowing noted, that is, more than .020". These elements had been inspected in Clevite's plant prior to shipment, and had been certified to be straight. In a simple experiment, it was then determined that dropping the elements a short distance could bow them since the elements are made of soft aluminum.

As a result of the bowing of the elements in this first shipment, further shipments were made by station wagon rather than by public carrier, and an inspection was made just prior and immediately after the shipment. Mr. Rice was of the opinion that this element was a satisfactory element as far as Westinghouse's inspection was concerned.

The committee considered the possibility that the element might have missed being blister-annealed, and a call was made to Mr. Weber of Clevite during the committee meeting. Mr. Weber repeatedly stated to Mr. Rice that every plate is blister-annealed as part of the regular manufacturing process, and he felt that there is no way that any one plate could have missed the annealing operation. ~~He was asked~~ that no records of such inspection that would verify that each plate is annealed.

2. Mr. Hammerle has done some preliminary calculations that indicate that the initial drop in power was due to a sudden void being formed in the reactor equivalent to approximately the total volume of one fuel element. He has checked his calculations of the loss in reactivity due to this void formation against the worth of the rod withdrawal necessary to stop the descent in power and to bring the reactor back up to power again. He said that these two effects are about equal and opposite in magnitude. The rod movement was worth approximately .4%, whereas voiding a channel equals approximately -.5% and the displacement of fuel in the channel may be worth another -.1%.

The WTR staff stated that at this time they cannot be sure of the effect on the initial melting of the fuel element of the return to 38 megawatts for the second time. They are considering the possibility that this return may have re-melted and then re-solidified the broken half of the element.

WESTINGHOUSE PLANS

To insure that this particular accident does not occur to this reactor in the same fashion again, the WTR staff is planning the following steps:

1. Dr. Schultz said that he does not plan to recharge any of the fuel elements into the reactor which had been there at the time of the incident. He said that there exists the possibility that in the discharging operations, the elements may become scratched or damaged in some fashion, and that he will not risk the possibility of placing a damaged fuel element in the reactor.

~~He continued that~~ There are approximately 100 new fuel elements manufactured by Clewite in the WTR storage vault. ~~He said that~~ Before installing any of these elements into the reactor, ~~he will remove~~ the locking pins and the end spiders ~~from each element,~~ and ~~will examine~~ all of the fuel cylinders of all ~~of these~~ elements.

~~He also said that, in all~~ In the future ~~orders of fuel elements for this reactor,~~ he ~~intends~~ having a resident inspector at the fabricator's plant. ~~It will be the responsibility of this inspector to see that every element is within tolerance on every specification.~~

2. Dr. Schultz stated that he is inviting a number of heat transfer and fluid flow experts to examine all of the data associated with this incident. A committee of these people will be formed. ~~The committee will include people like Frank Rinford of ORNL, and Messrs. Latourneau, Johnson and Butler from Battis.~~ This committee will explore the question of just how far away this element was from burn-out heat flux during the experiment.

Dr. Schultz also said that he intends having metallurgists ~~from Battis~~ examine the discharged fuel element in an effort to determine whether there had been more than the specified amount of uranium in this element, or whether there had been a good metallurgical bond between the cladding and the meat, or whether there is any evidence of any foreign material which might indicate a flow blockage.

3. Dr. Schultz said that the procedure manual used by the operating group would be reviewed and brought up to date so that supervisors and operators are aware of the dangers in bringing a reactor back up to power after a drop in power from an undetermined cause. He further said that he would see to it that in the future there is a better liaison between the Technical Support Group and the Operations Group.

4. The present plans for cleanup after this incident are being closely examined by WTR's insurers. ~~According to Dr. Schultz, the insurers are examining every step in the cleanup operations since precedence may be established by this case.~~ Westinghouse scientists and consultants from the insurance group are working together on the problem of disposal of approximately one quarter million gallons of contaminated water. At present, the water is being circulated from the retention basin through ion exchange columns to ~~some~~ holdup tanks. ~~Design exchange columns are made of 55 gallons which have been packed with ion exchange resin. The holdup tanks are twelve 20,000 gallon tanks.~~ The final cleanup of this water may have to be done by evaporation in order to bring the effluent down to the limits allowed by the State of Pennsylvania for discharge of radioactive waste.

Exhibits "J", "K", "L", "M", and "N" show some of the precautions taken to contain the spread of contamination during discharge operations. Exhibits "O" and "P" are views of the tank farm constructed to store the contaminated water.

PRELIMINARY CONCLUSIONS OF THE INVESTIGATING COMMITTEE

1. This committee is not now in a position to say whether the fuel element failure was due to a flow blockage brought about by some foreign material in the reactor or by a fuel element failure due to a defect in the manufacture. The committee intends keeping informed of further investigations which will be done by heat transfer consultants and by metallurgists of Westinghouse, and when a final report from these people is presented by Westinghouse, this information will be sent to the Commission as a supplement to this committee's report.

2. This committee is also unable to say at this time whether the melting of this fuel element was aggravated by the return to full power after the initial drop in power. This problem will also be examined by the heat transfer and fluid flow group being called together by Dr. Schultz. The Commission will be made aware of the results of their study.

3. Whether the return to power after the initial drop caused more damage than would have been done had the reactor been scrammed or leveled off after the initial drop, the committee feels that an important lesson in safe reactor operation should be learned from this incident. The lesson is a very simple one--a reactor which has lost power from some unknown cause should never be brought back up to power before the reason for the drop is established, because a reactor which loses re-activity suddenly may regain that re-activity just as suddenly. We feel that a question to this effect should be incorporated in every reactor operator's examination in the future, and that no operator should be licensed unless he understands this basic and fundamental precept of reactor operation.

This poses then a further question. Is a licensed operator responsible for the final safe operation or is he responsible instead for following the operating instructions which he has been given by his management? We hold that the responsibility must rest with the management, and that it is management's job to see that the reactor operator has sufficient detailed written procedures and instructions to operate the plant safely in any circumstance. This may mean that the whole operator licensing procedure should be re-examined, and that members of management who are responsible for detailing operating procedures should also be required to hold operator's licenses. [Otherwise, the situation may arise wherein a licensed reactor operator may want to proceed in a safe manner, but he is instructed by supervision to do something that he feels is unsafe. We feel that this whole situation should be examined and resolved by the licensing staff.]

SUPPLEMENTARY INFORMATION

Subsequent to the investigating committee's meeting, visits to the WTR site ~~on other business~~ by John R. Sears and phone calls from the WTR staff have disclosed the following information:

1. As of May 6, 1960, it is reported that the core has been completely unloaded of fuel, control rods and experiments. There had been four capsule experiments in the reactor at the time of the incident and one loop had been operating. The capsule experiments had been either in reflector or outer fuel ring locations. These have now all been discharged from the reactor and examined in the canal. There is no apparent damage, and the WTR staff reports that they are positive that the experiments were not involved in the incident.

2. The group of heat transfer and fluid flow consultants has met at the WTR site. This group included Messrs. Latourneau, Johnson and Butler from Bettis, Binford from ORNL, and others.

The group first calculated that a good fuel element, in this location at the stated conditions, would be a factor of 5 away from burn-out. The group then assumed the worst combination of variables; for example, they assumed the flow through this channel was cut by 50%, and they used 60% of the best values in the Savannah River correlations, and they still calculated that this element was a factor of 2 away from burn-out. It is reported that the group feels that the incident was due to a cladding failure.

3. The melted bottom quarter of the ruptured element has been drilled out of its shroud tube ~~by means of a hole-saw cutter~~, and is now in the hot cell. Elements from locations I-7-5, I-5-5, and I-7-6, from the center fuel ring, and the element from location I-6-4, adjacent to the ruptured element location, have been placed in the same hot cell. ~~A light has been held at the end of these elements and the channels observed.~~ It is reported that all channels in all elements appear clear and normal. Element from location I-7-6, which was the original ~~the~~ instrumented element and ~~so~~ had been in the reactor through a few cycles, is reported to have a slightly reddish-brown color. WTR people ~~claim that they~~ have seen such discoloration on elements before, however, and feel that it is due simply to some impurity in the water and is not related to any burning of fuel elements.

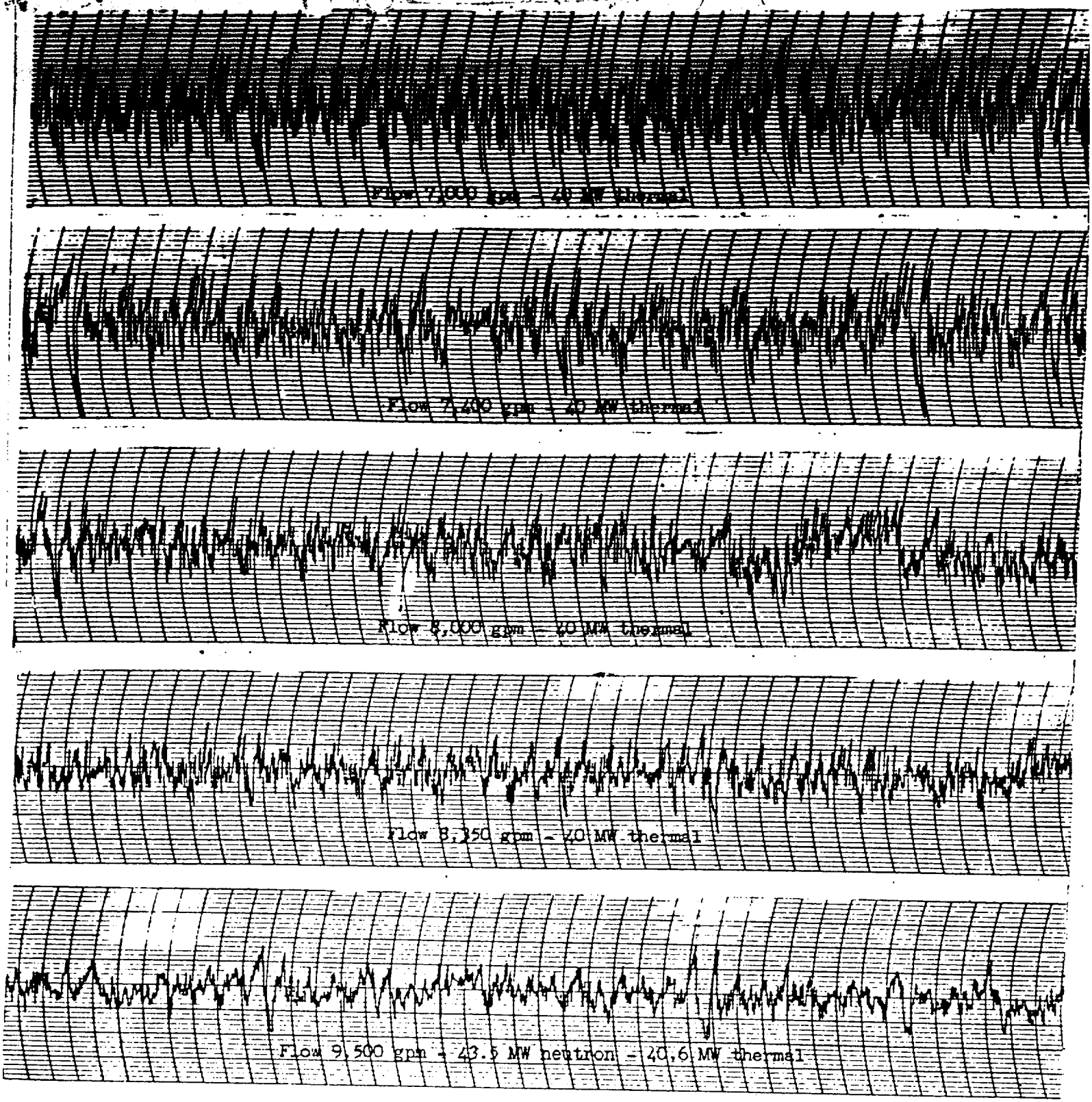
4. Messrs. Dan Thomas of Bettis and Jack Cunningham of ORNL have examined the elements in the hot cell. Cunningham will check the outside dimensions and the straightness of the four whole elements in the hot cell. ~~He will also section~~ the top half of the ruptured element will be sectioned to examine the bond between clad and meat. Further metallurgical studies may then be done on the remnants of the ruptured element. ~~at ORNL~~.

5. As of May 5, cleanup operations of the primary coolant system outside the containment shell had progressed to the point that this part of the system was considered clean. However, it is reported that some particles of highly active material have evidently become lodged in piping joints in the primary piping inside the containment shell, and further flushing will be necessary to clean up the system. ~~Dr. Schultz says that he is still hoping for a June 8 startup, which would mean a one month loss of time due to the rupture.~~

6. The WTP staff ~~also reports that they are~~ considering moving the location of the fission product monitor, so that it ~~sees~~ water ~~directly out of the reactor vessel~~ in an effort to improve its response.

They ~~also report that they~~ are considering methods for decreasing the amount of activity discharged from the head tank vent in an incident, but they have not yet arrived at ~~the best~~ a satisfactory solution.

EXHIBIT A

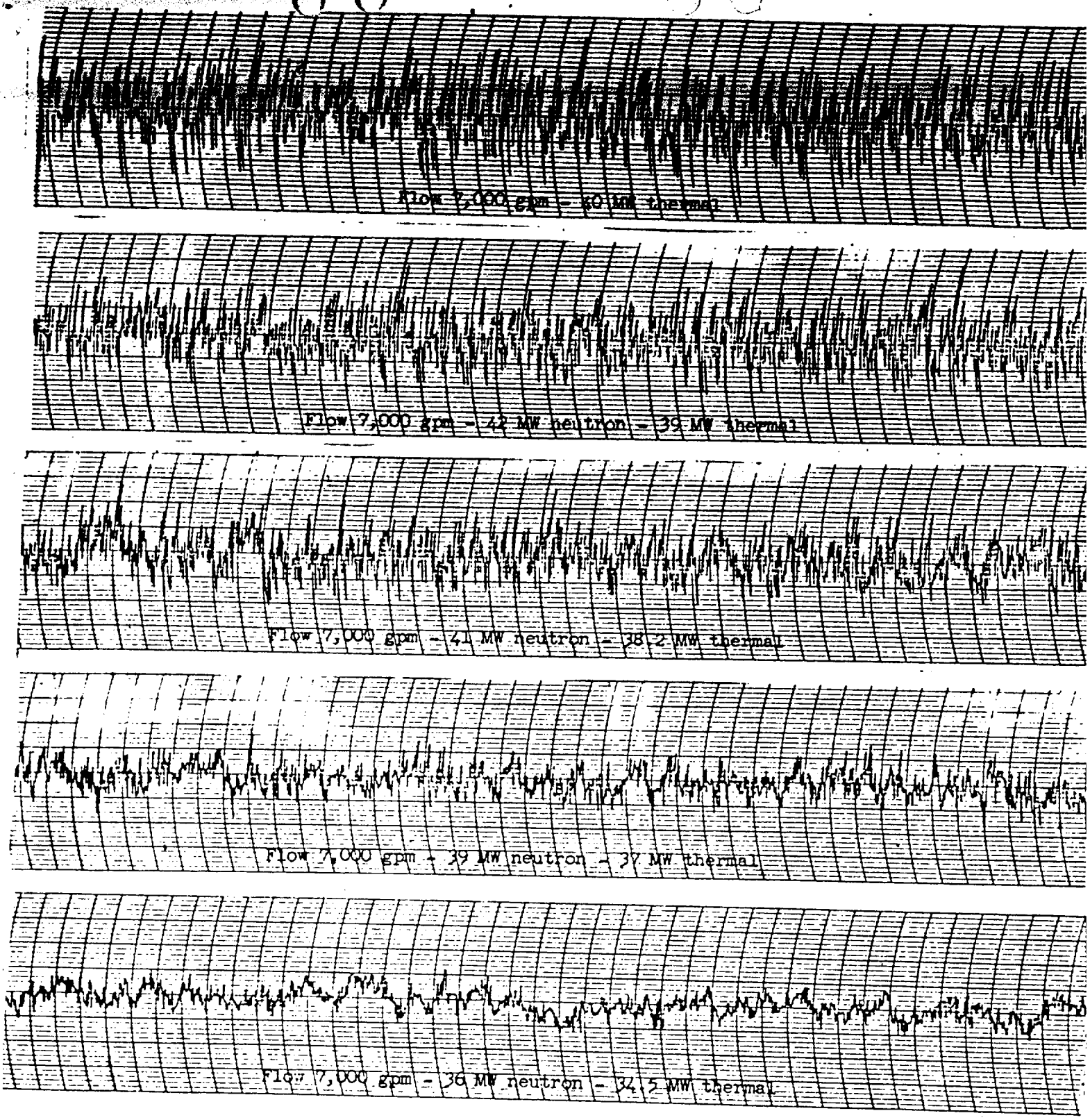


Noise Level as a Function of Flow

Constant Power 40 MW

Scale: 1 Large Block = 50 KW

Access. Tubes In

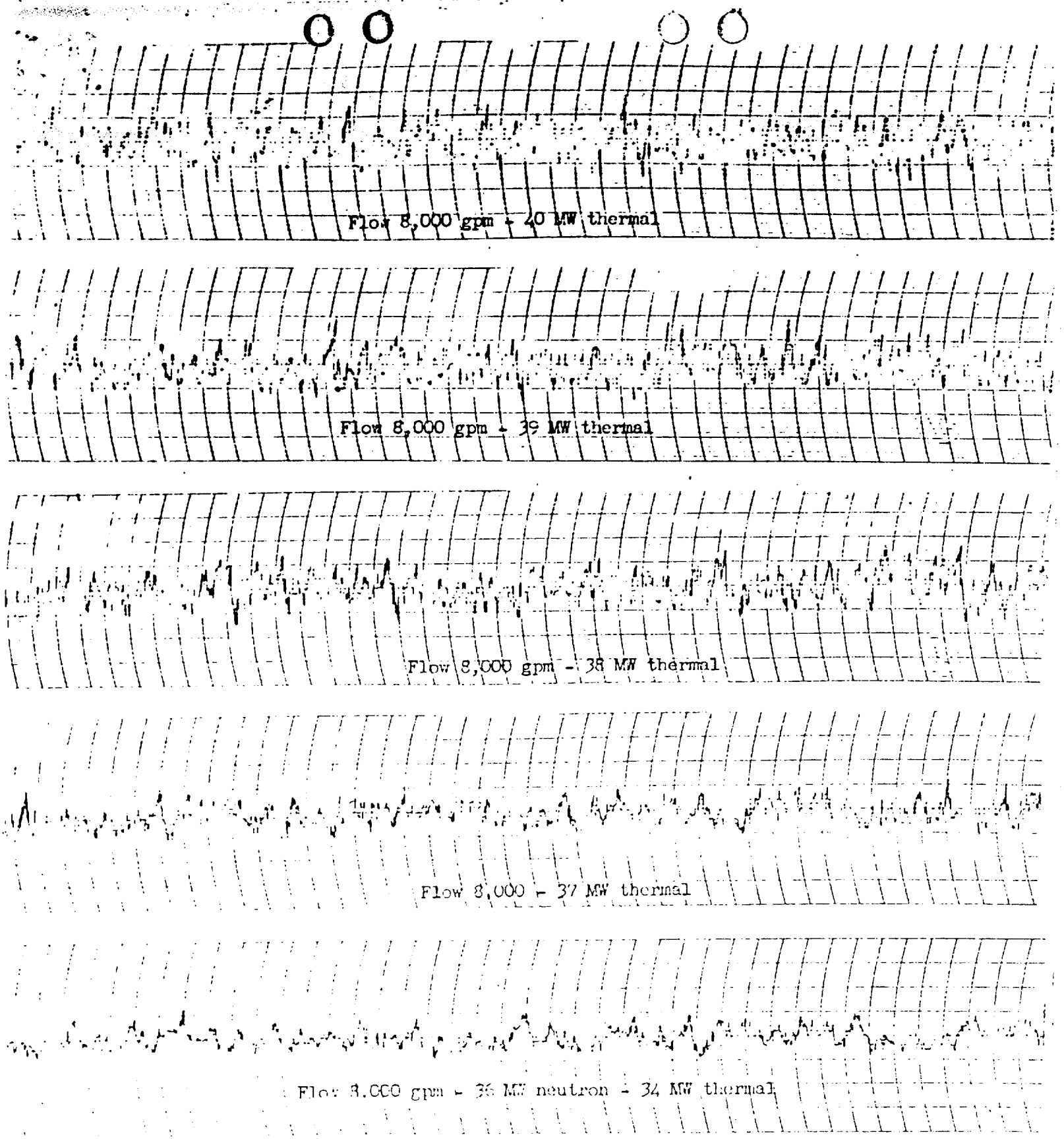


Noise Level as a Function of Power Output

Constant Flow at 7000 gpm

Scale: 1 Large Block = 50 KW

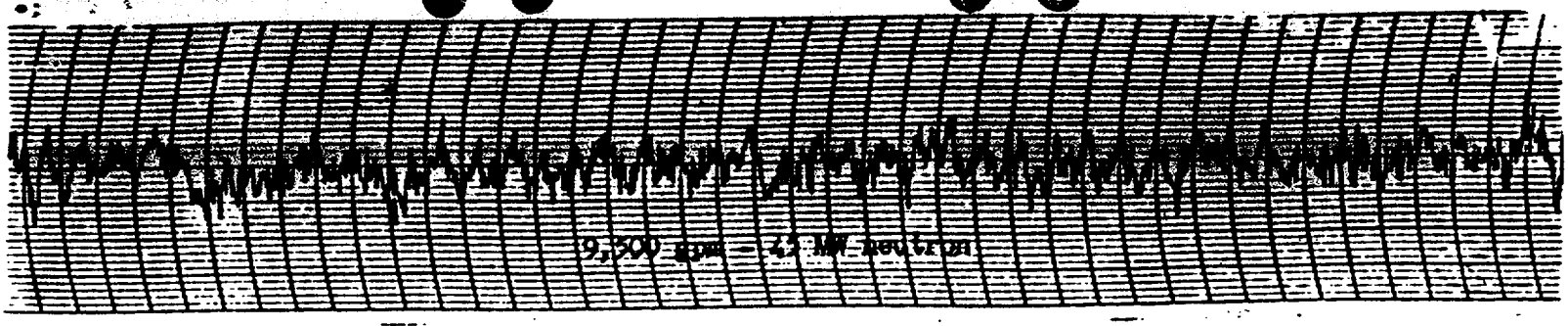
Access Tubes In

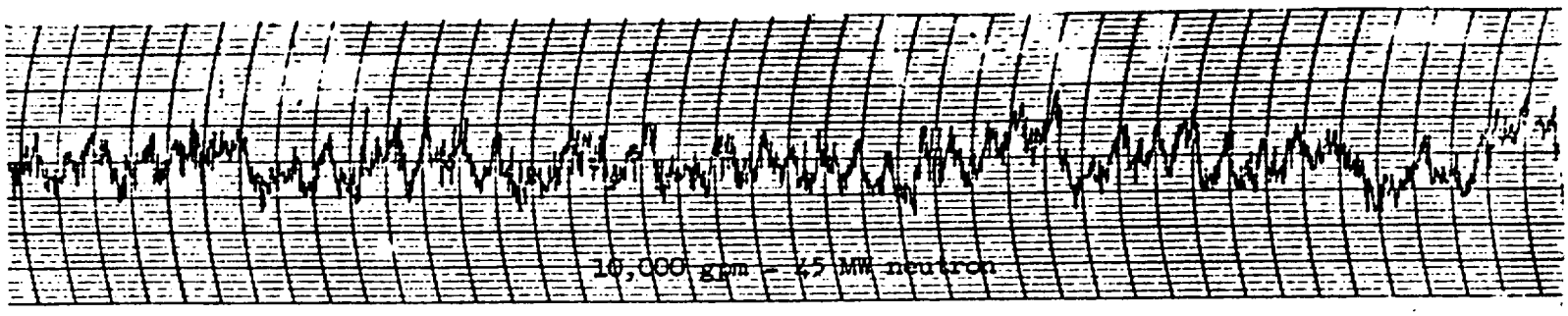


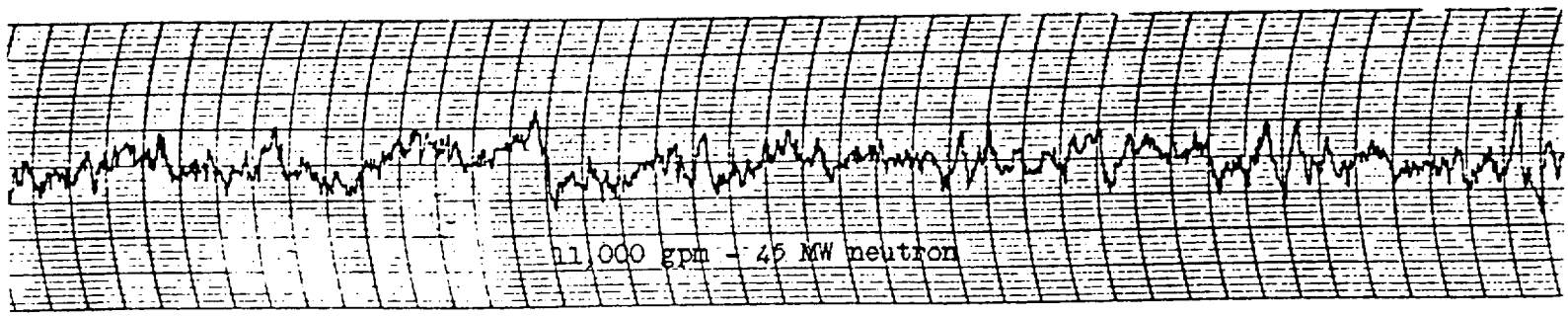
Noise Level vs Power
Constant Flow at 8000 gpm

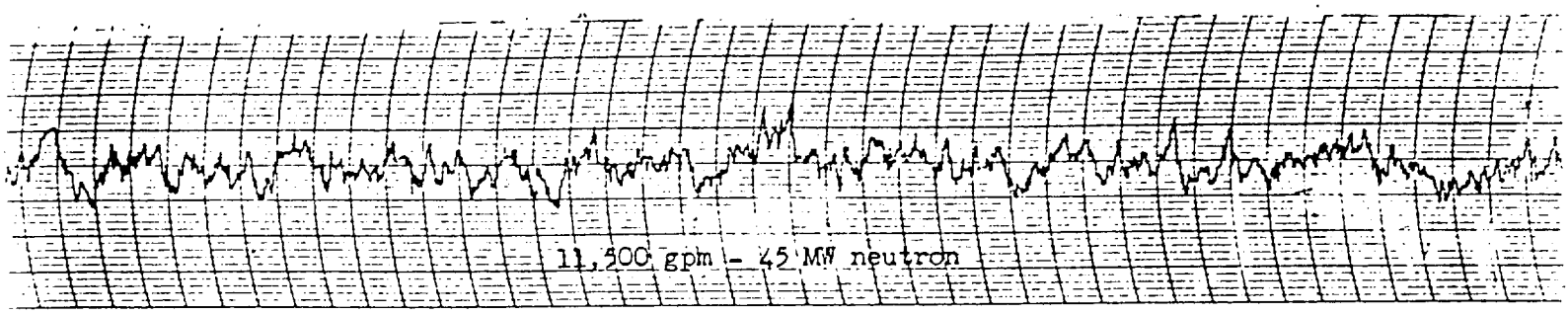
Scale: 1 Large Block = 50 KW

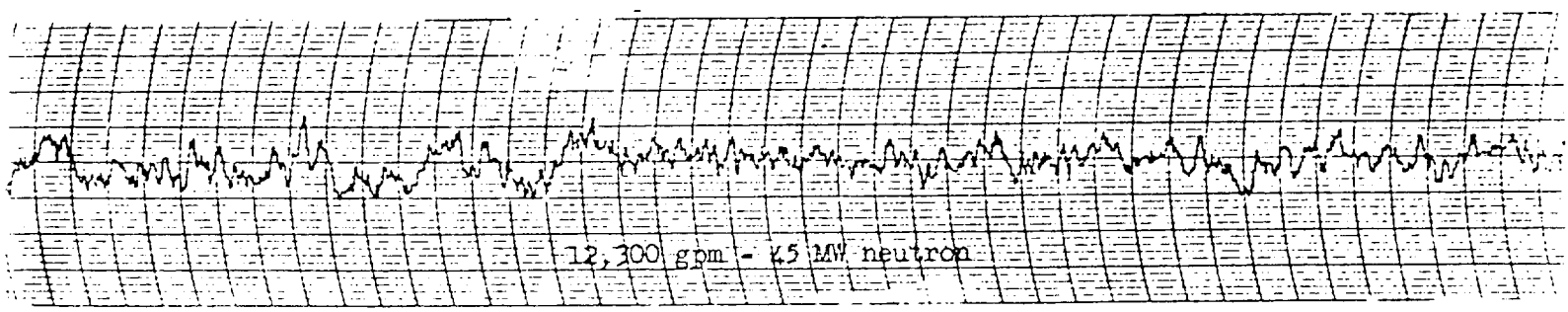
Access Tubes In









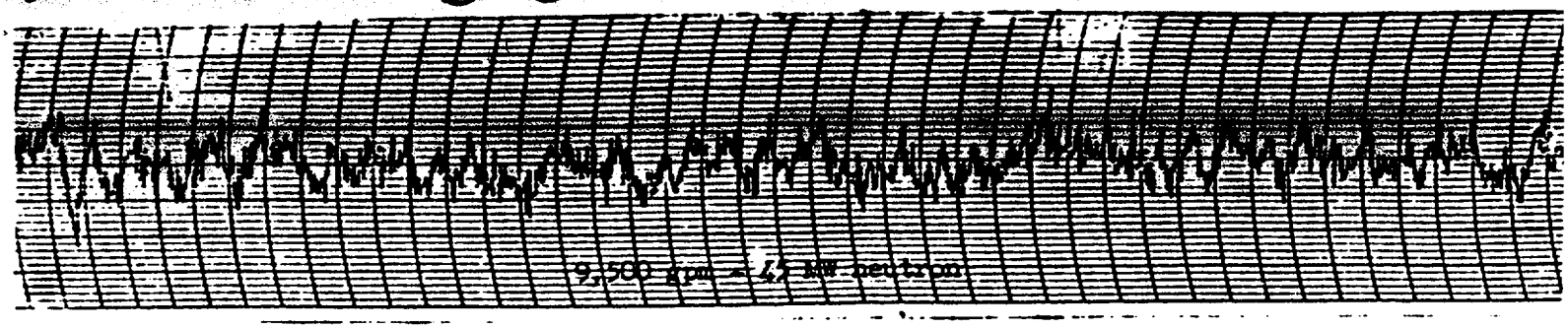


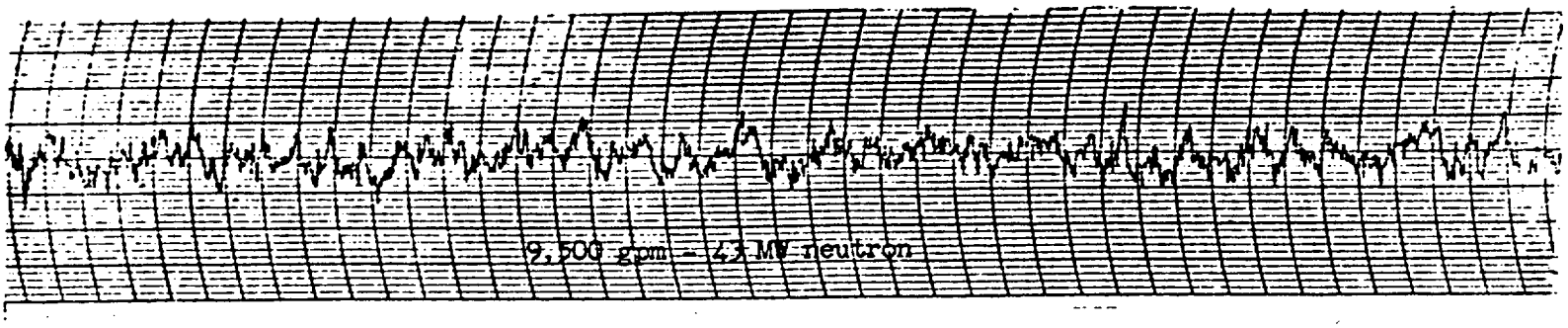
Noise Level as a Function of Flow

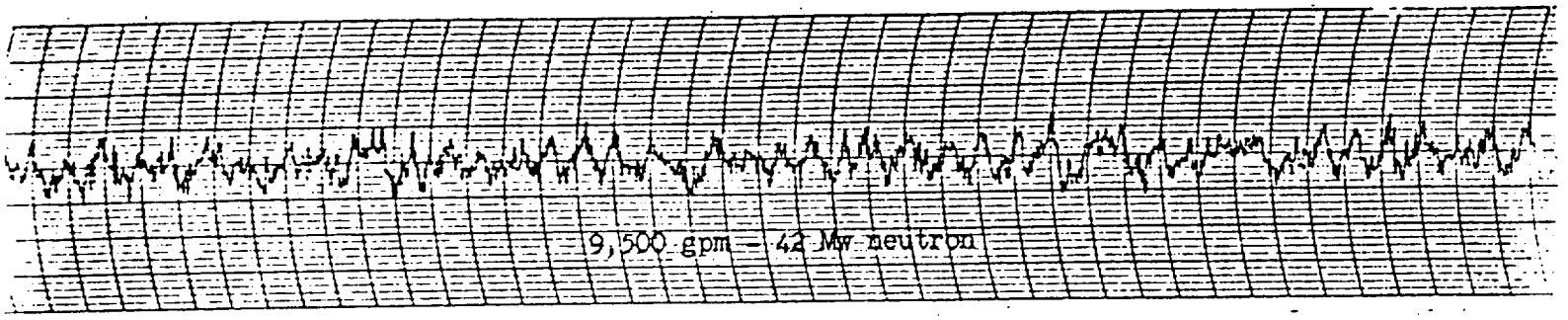
Constant Power 45 MW

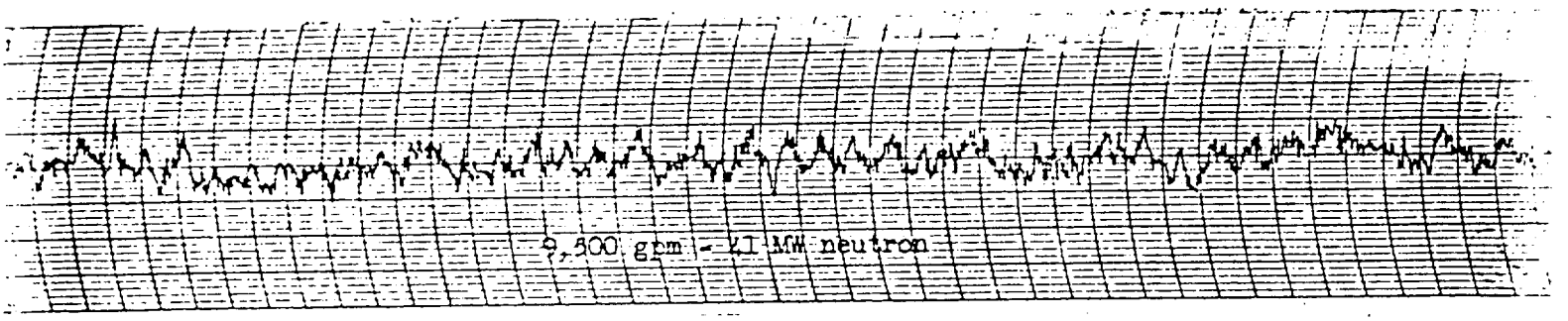
Scale: 1 Large Block = 50 KW

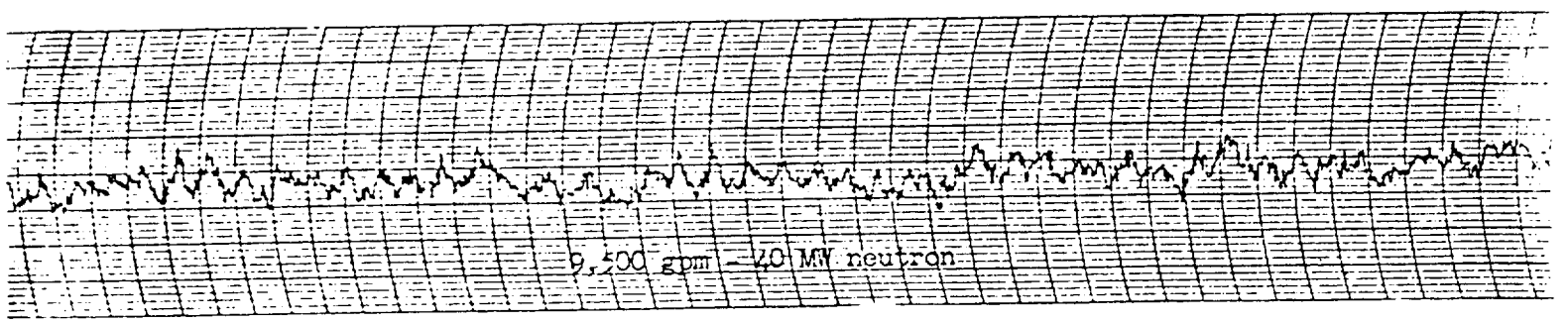
Access Tubes In











Noise Level as a Function of Power

Constant Flow at 9500 gpm

Scale: 1 Large Block = 50 KW

Access Tubes In

EXHIBIT B

TEST SPECIFICATION - - PHASE V

T-Spec No. 5-1

Attached is the copy of the Test Specification for increasing the reactor power to 60 MW.

Distribution List

M. A. Schultz
A. J. Pressesky
R. B. Rice (6)
R. J. Catlin (3)
G. C. Geisler
L. F. Kardos (3)
E. H. Hemmerle (2)
W. S. Johnson (6)
T. Spies
J. W. Sadler
M. Crane
A. de St. Maurice

T.S. V-1 Raising Power Level from 20 MW to 60 MW

The reactor power is to be raised from an operating level of 20 mw to 60 mw in incremental step of 5 mw. A set of operating parameters has been established for each power level and will be adjusted during the program, as the need arises. If plant limitations are exceeded, the program will stop until remedial action is taken. In general, the program consists of establishing that the reactor can be operated safely with a given set of conditions and then operating under these conditions for several days.

The criteria for safe operation have been established in the WTR License Application Amendment No. 14 and supplementary information issued to the AEC and in Amendment No. 1 to the WTR Operating License. They are:

1. First fuel ring bulk water outlet temperature. $< 220^{\circ}F$
2. Inlet primary coolant temperature. $< 140^{\circ}F$
3. Nuclear power level oscillation controlled with the automatic control system. $< \pm 5\%$
4. Radiation level at accessible portions of the face of the biological shield. < 1 mr/hr
5. Radiation level at accessible points in the primary loop < 1 mr/hr
6. Boiling will be detected by the "bubble experiment" described in WTR-SS-TA-258
7. Less than 1% voids will occur in the moderator due to boiling.
8. Maximum heat flux will not exceed one-half of burnout heat flux.

Table I lists the pertinent plant parameters establishing the safety of operating at a given power level. These conditions are obtained by establishing the required flow for a given power with the reactor at a power level 5 mw below that desired. A reference noise level should then be established on the bubble detection equipment. The reactor power should then be raised to the specified level. During this time particular attention should be given to the bubble detection equipment. The power should be reduced to the starting point if boiling is detected. If boiling is not detected the reactor should be operated with these conditions for 15 minutes or until boiling is noted. At the end of this period the flow should be increased to the value listed in Table II the special nuclear channel of the bubble equipment shutdown and operation continued at the power level for the period given in the schedule Table III. Two

exceptions will occur. The boiling check will be made prior to the twelve-day run at 40 mw and a second reduced flow experiment will be carried out after two-day operation at 60 mw.

Secondary coolant parameters and cooling tower operation are left to the judgement of the reactor operator. Standard records should be maintained of the temperatures and the flow rate but the actual values are not important if the required primary coolant conditions are maintained.

Radiation survey of the entire primary system will be required during the program to insure against excessive radiation levels.

Based on a void coefficient of -0.14% reactivity/% voids in the moderator, the loss of .14% reactivity will indicate that a prescribed limitation has been exceeded. This reactivity is equivalent to 3% motion of the peripherial control rod in its most sensitive position. This motion can also be caused by a core temperature increase of about 15°F. If this rod motion is suddenly required during an increase in power level or subsequently, the reactor power level should be decreased by 10 mw and the incident reported to Scientific Support for appraisal. It is assumed that temperature can be held constant to within ± 5°F.

The bulk outlet temperature of the first fuel ring will be measured by installing thermocouples in a "V" basket inserted in core position J 76.

Boiling will be detected by the "bubble detection" equipment described in WTR-SS-TA-258. A description of this equipment and its operation will be contained in an appendix to this test specification to be written after the installation is made and checked out.

Approved by Safeguards Subcommittee

A. J. Pressesky, Chairman of
Safeguards Committee

TABLE I

Power MW	P.C. Flow GPM	R.V. ΔT °F	Tin R.V. °F	Tout R.V. °F	ΔT. Alarm °F	Power Level Cutback MW	Power Level Scram MW	Low Flow Cutback GPM	Low Flow Scram GPM
20	6650	21	135	156	25	25	30	5650	5000
25	6650	26	130	156	31	28	30	5650	5000
30	6650	32	125	157	38	35	40	5650	5000
35	6650	37	120	157	43	40	45	5650	5000
40	7800	36	120	156	42	45	50	6650	5850
45	9150	34	120	154	40	50	55	7750	6850
50	10600	33	125	158	39	55	65	9050	7950
55	12300	31	125	156	36	60	70	10500	9200
60	14100	30	125	155	35	65	75	12000	10600
				SPECIAL RUN					
60	13000	32	125	157	17	65	75	11000	9750
40	7000	40	125	165	45	45	50	6800	6300

$36 \times \frac{78}{70}$

TABLE II

Power MW	P.C. Flow GPM	R.V. ΔT °F	Tin R.V. °F	Tout R.V. °F	ΔT Alarm °F	Power Level Cutback MW	Power Level Scram MW	Low Flow Cutback GPM	Low Flow Scram GPM
20	8000	18	140	158	21	25	30	6800	6000
25	8000	22	135	157	26	28	30	6800	6000
30	8000	26	130	156	31	35	40	6800	6000
35	8000	30	130	160	35	40	45	6800	6000
40	9400	30	130	160	35	45	50	8000	7050
45	11000	28	130	158	33	50	55	9350	8250
50	12800	27	130	157	32	55	65	10900	9600
55	14800	26	130	156	30	60	70	12600	11100
60	17000	25	130	155	29	65	75	14500	12750

TABLE III

Schedule for Increase in Power

February 18	20 MW	1 day
February 19-20	25 MW	2 days
February 21-22	30 MW	2 days
February 23-24	35 MW	2 days
February 25 - March 1	40 MW	7 days
March 11-23	40 MW	(480 MWD)
March 26-27	45 MW	2 days
March 28-29	50 MW	2 days
March 30-31	55 MW	2 days
April 1-2	60 MW	2 days

EXHIBIT C

TEST SPECIFICATION NO. 5-2
POWER ESCALATION PROGRAM
LOCAL BOILING IN THE CORE

Several changes have been made in the reactor core instrumentation which should aid in the detection of the beginning of local boiling. They are: (a) the removal of the core access tube, (b) insertion of the helium bubble tube into a fuel element V basket for the production of bubble in the P.C. flow, (c) instrumentation of the two (2) fuel element channels in addition to the bulk outlet of the element and (d) direct measurement of control rod position.

The reactor has previously operated at 40MW with 7000 GPM P.C. flow and an inlet temperature of 125°F with existence of only mild disturbance on the special nuclear instrumentation. Since then it has been established that there was some boiling in the core access tube installed in the core.

For the present test, the reactor will be brought to equilibrium at 30MW with a flow of 5000 GPM and a core inlet temperature (heat exchanger outlet temperature) of 130°F. A reference set of data will be taken. The reactor power will be raised successively to 35MW, 38MW, 40MW, 42MW and 44MW. Automatic control will be accomplished by one rod during the entire test. Data to be taken at each power level is: Tin R.V.; Tout R.V; Tout Heat Exchanger; Position of Control Rod on automatic control, temperature of the six thermocouples in the instrumented fuel element and the compensated power trace with the special nuclear instrumentation.

E. H. Hemmerle, Supervisor
Technical Assistance

Approved _____
A. J. Pressesky, Chairman
WTR - Safeguards Committee

April 3, 1960

SCRAM & CUTBACK

Setting -	Low Flow	Cutback	4000 GPM
		Scram	3000 GPM
	Power - Nuclear		
		Cutback	55 MW
		Scram	60 MW

Tout R.V. - Keep less than 180°F.

Tin R.V. - Tout of Heat Exchanger 130°F

L. P. Thimble - Alarm - Set to 200°F

Temp. out of fuel element - Less than 250°F, Call 240

Reactor ΔT Cutback 76°F

E. H. Hemmerle, Supervisor
Technical Assistance

EXHIBIT D

INSTRUMENTED FUEL ELEMENT TEMPERATURES

SUNDAY APRIL 3, 1960

	L-7-6 Fuel Element						L-5-6 Inst. Fuel Element					
Time	W	V	X	U	Beam Hole		#4	#6	#2	#1	#5	#3
16:46	270	276	295	276	081	082	174	161	150	150	163	179
17:01	271	275	296	274	082	082	175	161	151	151	164	179
17:16	270	274	295	274	082	082	174	160	150	150	163	179
17:31	269	274	294	274	082	082	175	160	150	150	163	179
17:46	269	274	298	274	082	082	174	160	150	150	163	179
18:01	269	274	306	274	081	082	174	160	150	150	163	179
18:16	268	273	302	274	082	082	174	160	150	150	163	178
18:31	268	273	306	274	082	082	174	160	150	149	163	179
18:46	268	274	306	274	081	082	174	160	150	150	163	179
19:01	267	273	303	274	082	082	174	160	150	150	163	179
19:16	223	227	254	225	082	082	160	149	142	141	151	164
19:31	210	214	233	211	082	082	153	143	136	136	145	157
19:46	208	212	230	208	082	082	149	140	133	134	142	154
19:55	206	210	223	206	082	082	148	139	131	131	141	152
19:57	206	210	223	206	082	082	148	140	131	131	141	153
20:00	206	210	223	205	082	082	147	139	130	130	140	152
20:02	217	222	238	219	082	083	166	152	140	140	156	174
20:04	234	244	260	240	082	082	200	176	156	157	184	206
20:07	250	262	276	260	082	082	218	191	165	168	201	224
20:09	256	267	282	262	082	083	219	192	164	168	201	224
20:11	251	266	275	259	082	083	218	191	164	166	200	221
20:13	248	259	268	254	082	083	218	189	162	164	195	219
20:16	244	262	268	251	082	083	214	186	161	164	196	217
20:18	241	256	266	248	082	083	212	186	160	162	194	216
20:20	244	255	262	247	082	083	212	186	160	162	195	220
20:22	266	280	290	272	082	083	233	200	168	173	212	237
20:25	281	293	306	286	082	083	238	204	172	176	214	240
20:27	274	290	301	283	082	083	233	200	168	173	212	236
20:29	274	289	298	279	082	083	232	201	169	173	211	235
20:31	271	284	296	280	082	082	233	202	169	173	210	235
20:34	279	294	306	288	082	083	249	211	174	179	212	227
20:36	184	189	202	185	082	082	173	157	141	143	164	180
20:38	285	295	311	287	082	083	245	210	175	180	220	245
20:40	240	203	187	156	082	082	117	116	114	114	116	117
20:43	118	118	129	117	082	083	114	114	113	113	114	114
20:45	116	116	124	116	083	083	113	114	112	113	113	113
20:47	116	116	124	115	082	083	113	113	113	113	114	114
20:49	116	116	123	116	082	083	114	114	112	113	114	114
20:52	115	116	122	115	082	083	113	114	113	113	114	114
20:54	115	115	122	115	082	083	113	113	113	113	114	113
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20:58	114	114	120	113	082	083	112	112	111	111	111	112
21:01	112	112	117	111	082	083	110	110	109	109	110	110
21:03	110	110	114	110	082	083	108	108	106	107	108	108
21:05	107	107	112	107	082	083	105	106	105	105	105	105
21:07	106	106	110	106	082	083	105	104	104	104	105	105
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21:12	103	103	106	102	082	083	102	102	101	102	102	102
21:14	102	102	105	102	082	083	100	100	100	100	100	100
21:16	101	100	102	099	082	083	098	098	098	098	098	098
21:19	10	100	102	099	082	083	100	100	099	099	101	101
21:21	102	102	104	102	082	083	101	100	099	099	100	100
21:23	102	102	104	101	082	082	101	100	099	099	100	100

#4 2 Channel
#6 Bulk Water
#2 Basket Channel
#1 Basket Channel
#5 Bulk Water
#3 2 Channel

Reduce Power to 30 MW

19:50 Reduce Flow start

P.C. Flow at 5250 (8 P.M.)

15 MW

20:44 Scram Reactor

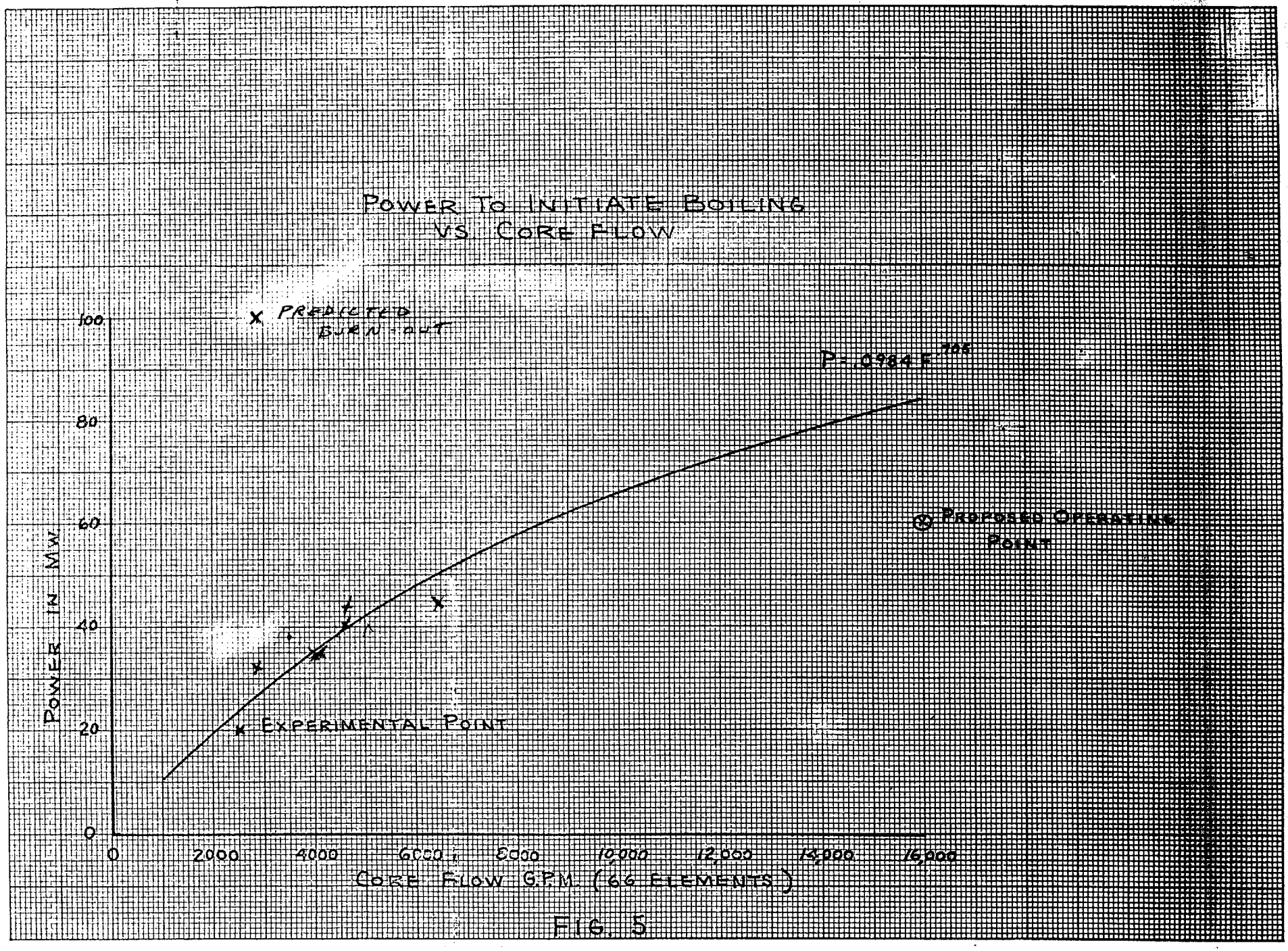

FIG. 5

EXHIBIT E

EXHIBIT F

INSTRUMENTED FUEL ELEMENT TEMPERATURES

SUNDAY APRIL 3, 1960

	L-7-6 Fuel Element					L-5-6 Inst. Fuel Element						
Time	W	V	X	U	Beam Hole	#4	#6	#2	#1	#5	#3	
16:46	270	276	295	276	081 082	174	161	150	150	163	179	
17:01	271	275	296	274	082 082	175	161	151	151	164	179	
17:16	270	274	295	274	082 082	174	160	150	150	163	179	
17:31	269	274	294	274	082 082	175	160	150	150	163	179	
17:46	269	274	298	274	082 082	174	160	150	150	163	179	
18:01	269	274	306	274	081 082	174	160	150	150	163	179	
18:16	268	273	302	274	082 082	174	160	150	150	163	178	
18:31	268	273	306	274	082 082	174	160	150	149	163	179	
18:46	268	274	306	274	081 082	174	160	150	150	163	179	
19:01	267	273	303	274	082 082	174	160	150	150	163	179	Reduce Power to 30 M
19:16	223	227	254	225	082 082	160	149	142	141	151	164	
19:31	210	214	233	211	082 082	153	143	136	136	145	157	
19:46	208	212	230	208	082 082	149	140	133	134	142	154	
19:55	206	210	223	206	082 082	148	139	131	131	141	152	
19:57	206	210	223	206	082 082	148	140	131	131	141	153	
20:00	206	210	223	205	082 082	147	139	130	130	140	152	19:50 Reduce Flow 5
20:02	217	222	238	219	082 083	166	152	140	140	156	174	
20:04	234	244	260	240	082 082	200	176	156	157	184	206	
20:07	250	262	276	260	082 082	218	191	165	168	201	224	
20:09	256	267	282	262	082 083	219	192	164	168	201	224	
20:11	251	266	275	259	082 083	218	191	164	166	200	221	P.C. Flow at 5250 (8
20:13	248	259	268	254	082 083	218	189	162	164	195	219	
20:16	244	262	268	251	082 083	214	186	161	164	196	217	
20:18	241	256	266	248	082 083	212	186	160	162	194	216	
20:20	244	255	262	247	082 083	212	186	160	162	195	220	
20:22	266	280	290	272	082 083	233	200	168	173	212	237	
20:25	281	293	306	286	082 083	238	204	172	176	214	240	
20:27	274	290	301	283	082 083	233	200	168	173	212	236	
20:29	274	289	298	279	082 083	232	201	169	173	211	235	
20:31	271	284	296	280	082 082	233	202	169	173	210	235	
20:34	279	294	306	288	082 083	249	211	174	179	212	227	
20:36	184	189	202	185	082 082	173	157	141	143	164	180	15 [illegible]
20:38	286	295	311	287	082 083	245	210	175	180	220	245	
20:40	240	203	187	156	082 082	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	117	
20:43	118	[illegible]	[illegible]	117	082 083	114	114	113	113	114	114	20:[illegible] Beam Rupture
20:45	116	116	124	116	083 083	113	114	112	113	113	113	
20:47	116	116	124	115	082 083	113	113	113	113	114	114	
20:49	116	116	123	116	082 083	114	114	112	112	114	114	
20:52	115	116	122	115	082 083	113	114	113	113	114	114	
20:54	115	115	122	115	082 083	113	113	113	113	114	113	
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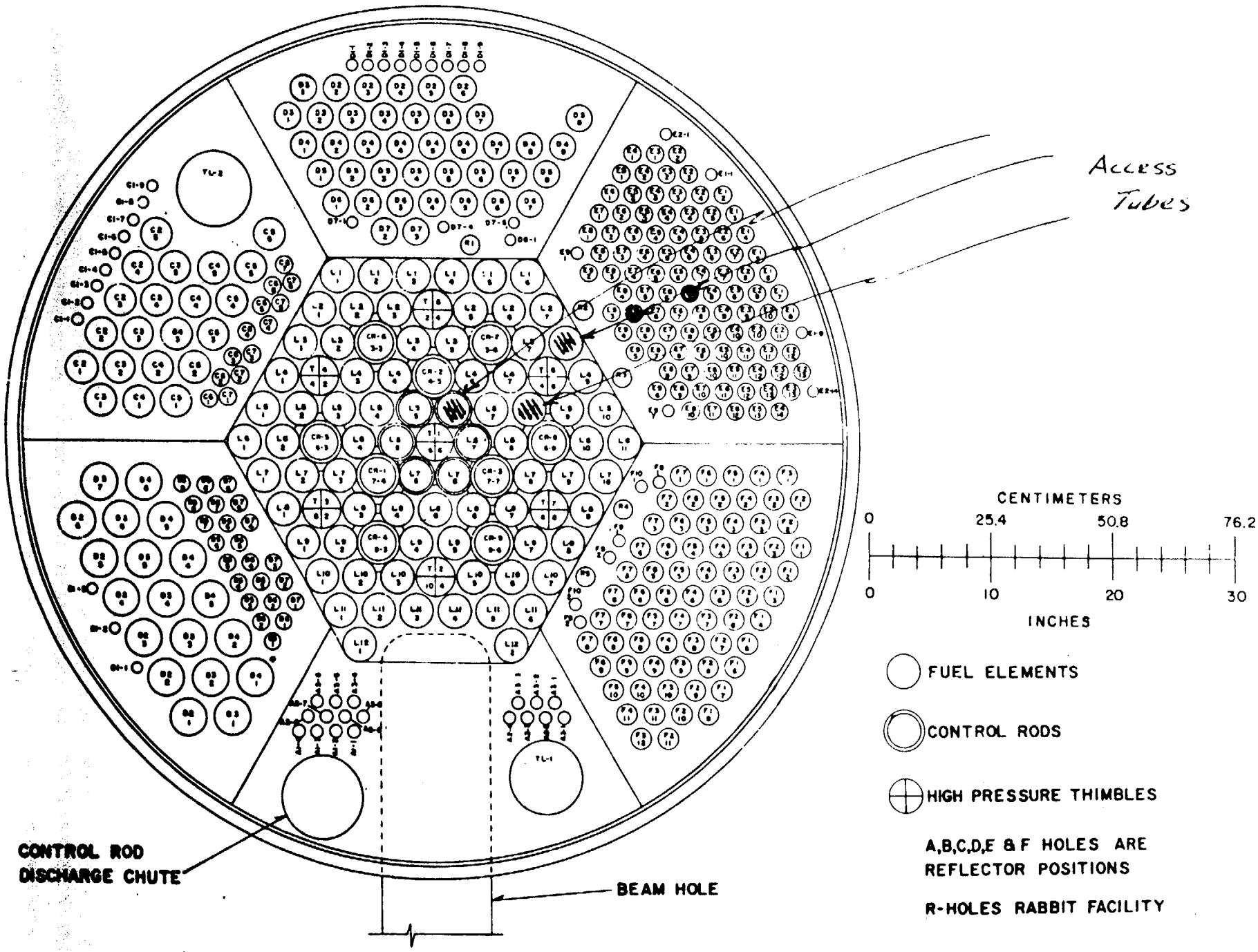

Access Tubes
CENTIMETERS
0
25.4
50.8
76.2
0
10
20
30
INCHES
FUEL ELEMENTS
CONTROL RODS
HIGH PRESSURE THIMBLES
A,B,C,D,E & F HOLES ARE REFLECTOR POSITIONS
R-HOLES RABBIT FACILITY
CONTROL ROD DISCHARGE CHUTE
BEAM HOLE

EXHIBIT G

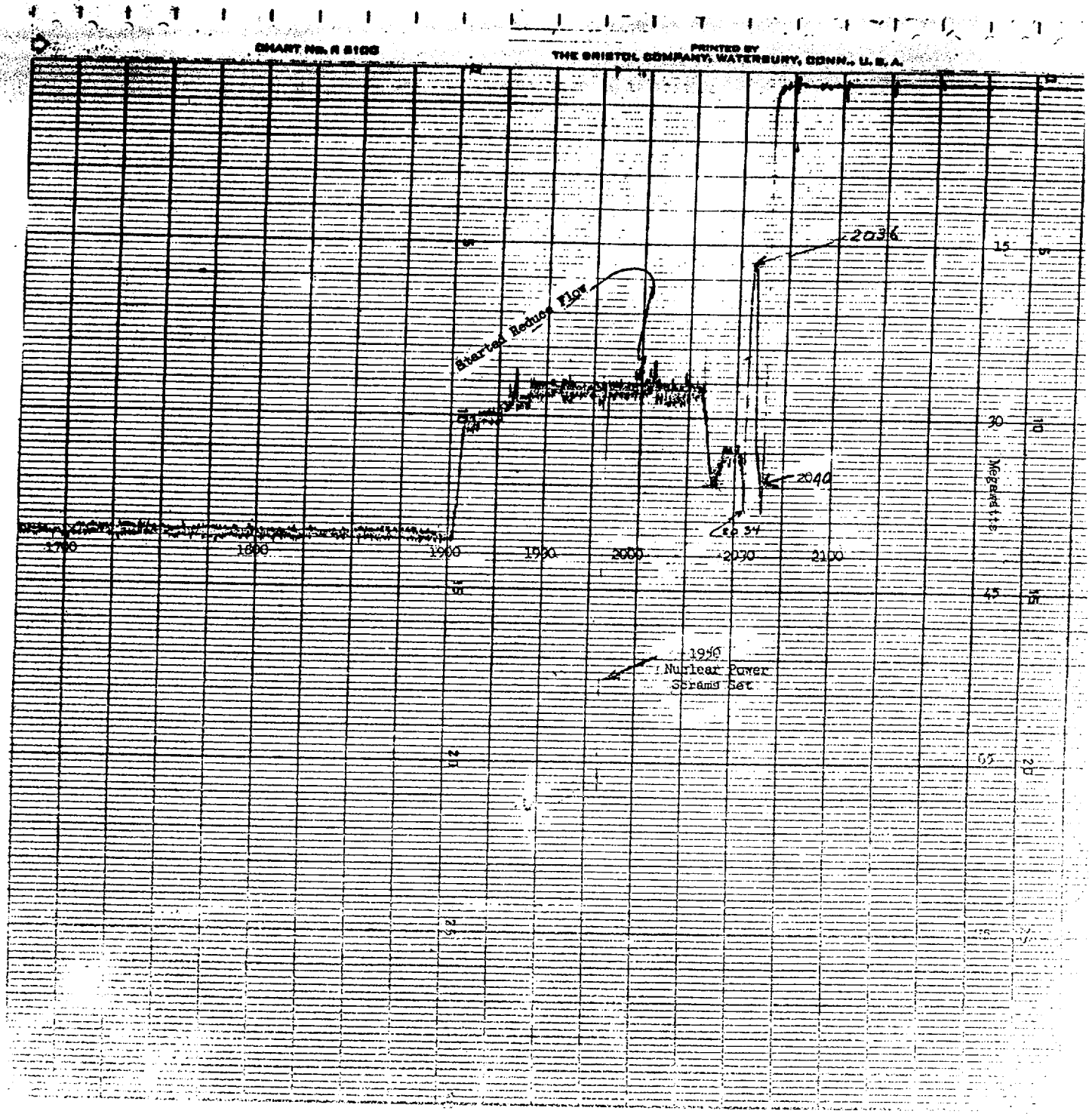


CHART No. A 5100
PRINTED BY
THE BRISTOL COMPANY, WATERBURY, CONN., U. S. A.
Started Reduce Flow
2036
2040
Eo 34
1940
Nuclear Power
Scram Set
1700
1800
1900
1000
2000
2030
2100
15
30
45
Megawatts

EXHIBIT H

WESTINGHOUSE

WTR — Medical Department

April [illegible], 195[illegible]

TO: WESTINGHOUSE TESTING REACTOR

All Personnel

Examinations of the group of personnel who received the highest [illegible] exposures during April 3 and 4 revealed the following:

1. All blood examinations were normal.

2. All urine specimens analyzed to date show no abnormal [illegible]

3. Thyroid scanning revealed no detectable levels of radioiodine

4. All nasal swabs indicated no [illegible] than [illegible] radioactivity.

The highest estimated dose received by anyone in [illegible] approximately [illegible] of the dose a person receives when [illegible] x-ray.

No person in the plant has received a medical [illegible] either externally or internally.

Thank you for your [illegible]

[illegible]
[illegible]

/mb

EXHIBIT

EXHIBIT

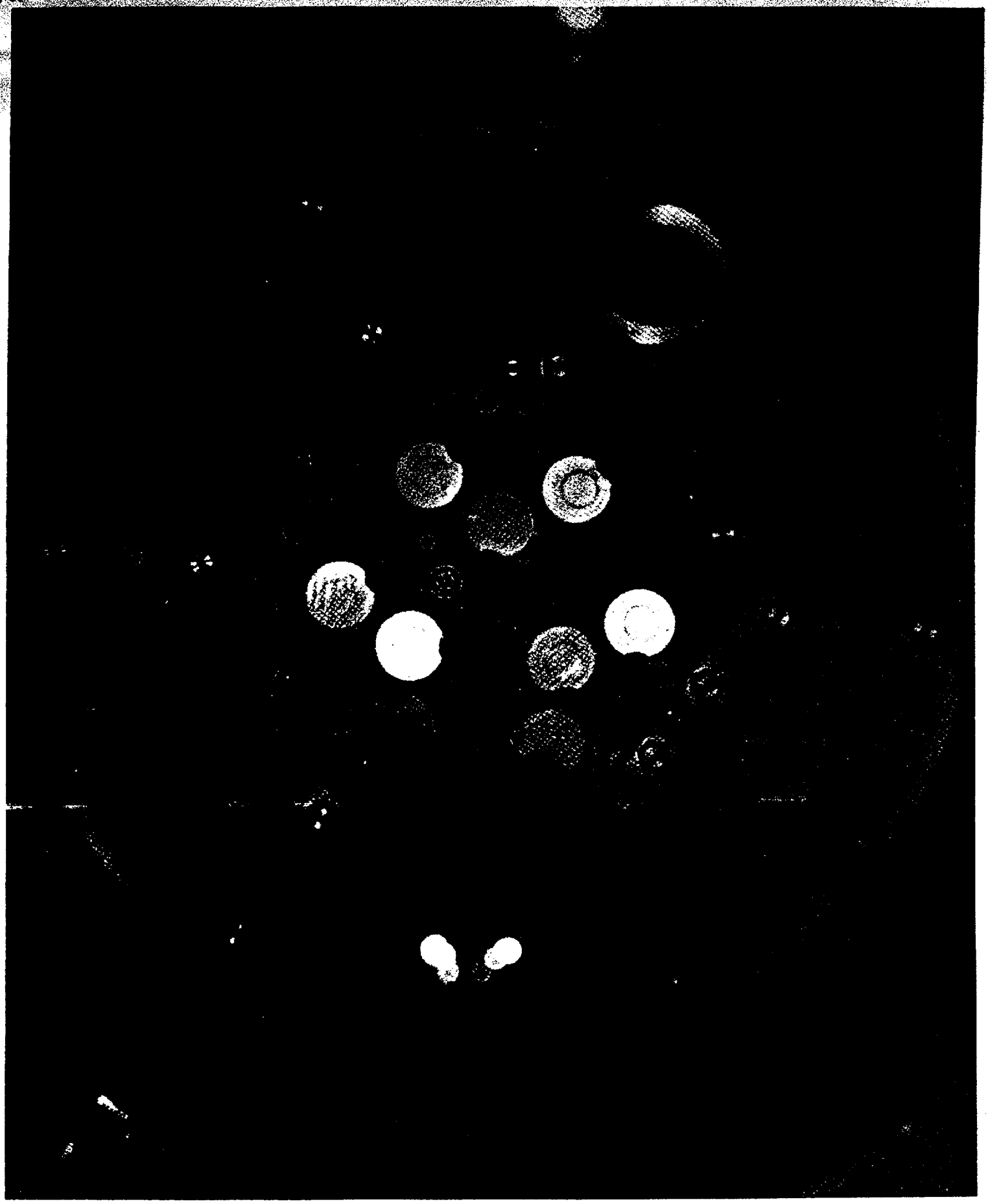


EXHIBIT J

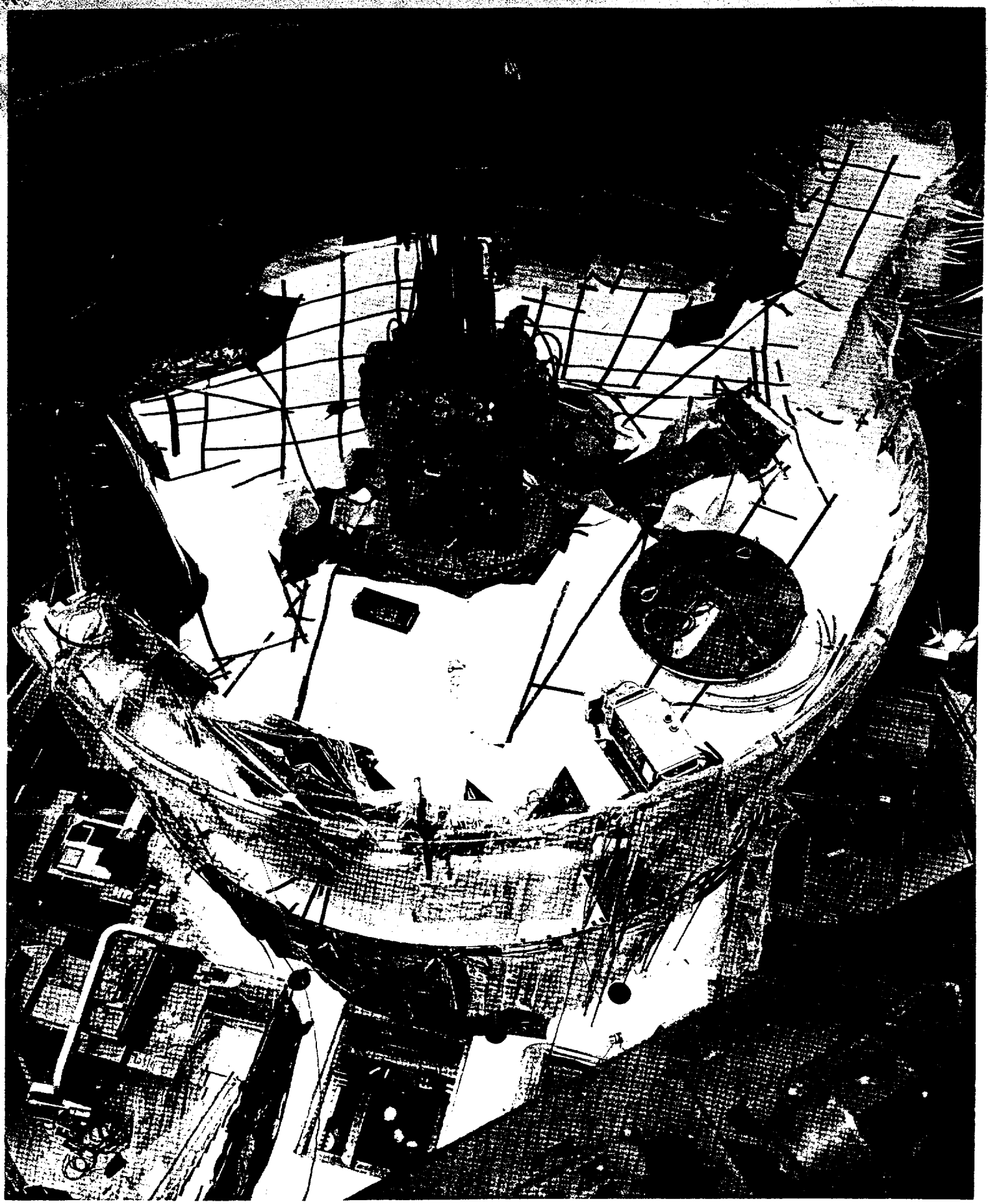


EXHIBIT K

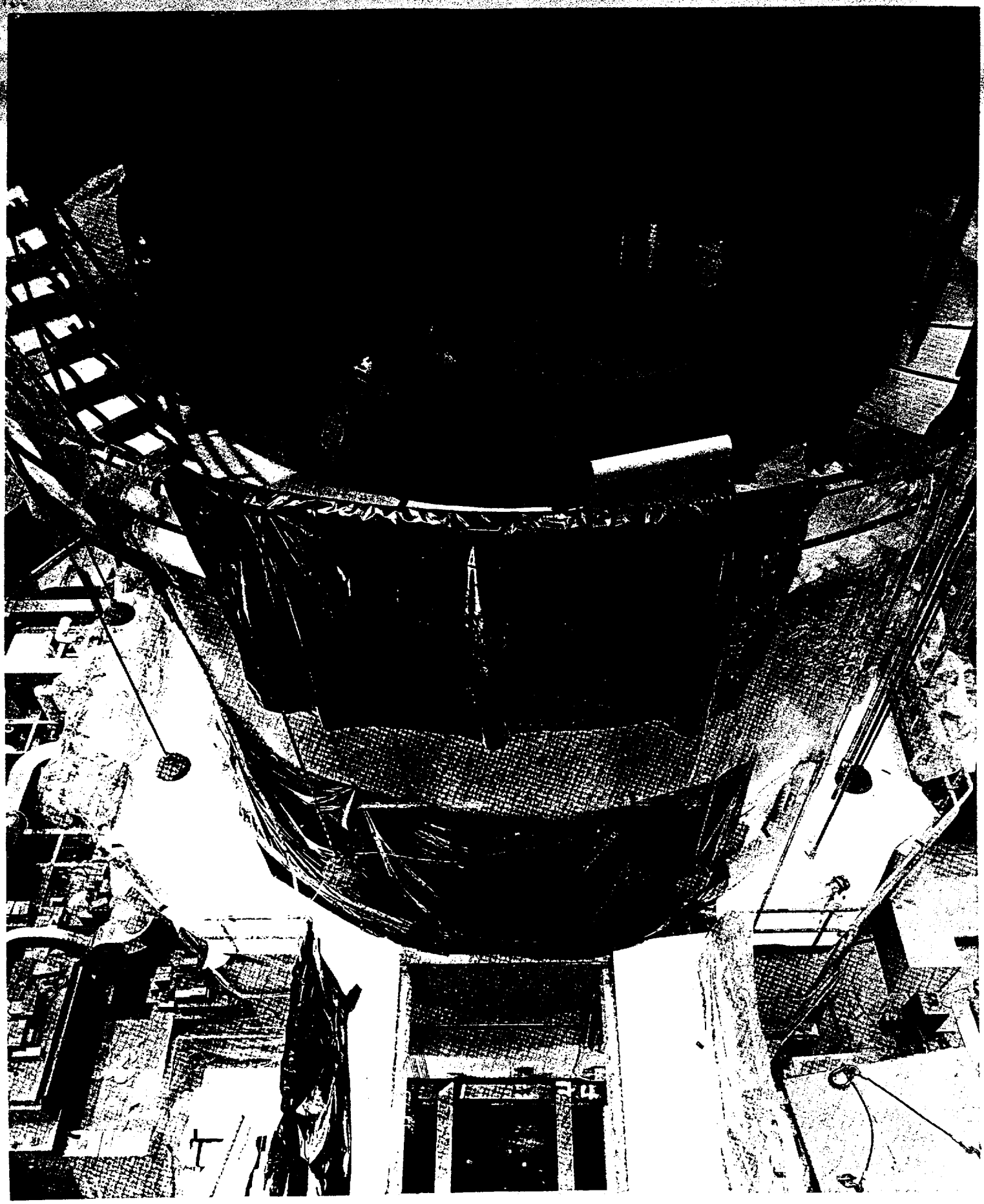
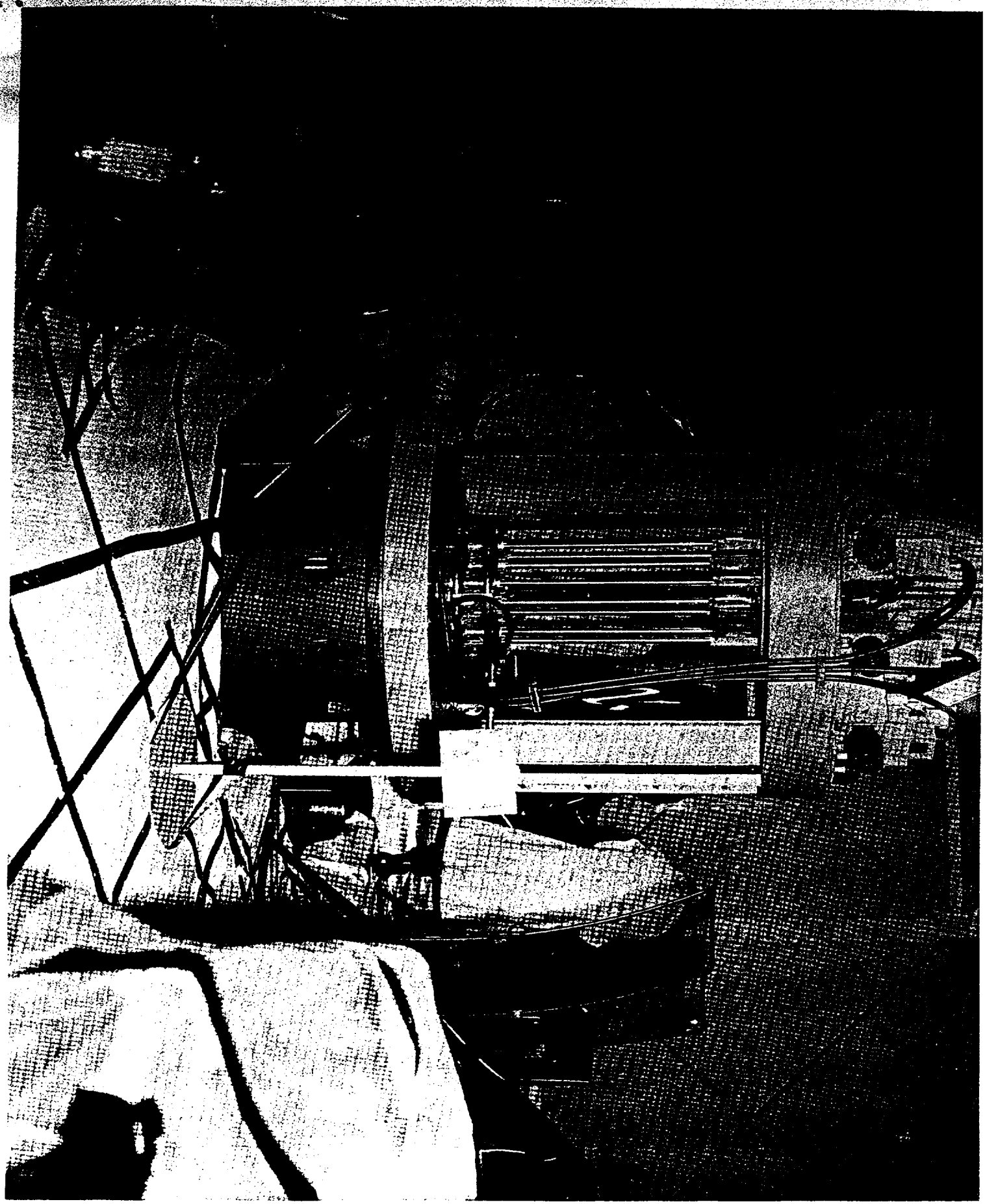


EXHIBIT L

EXHIBIT M



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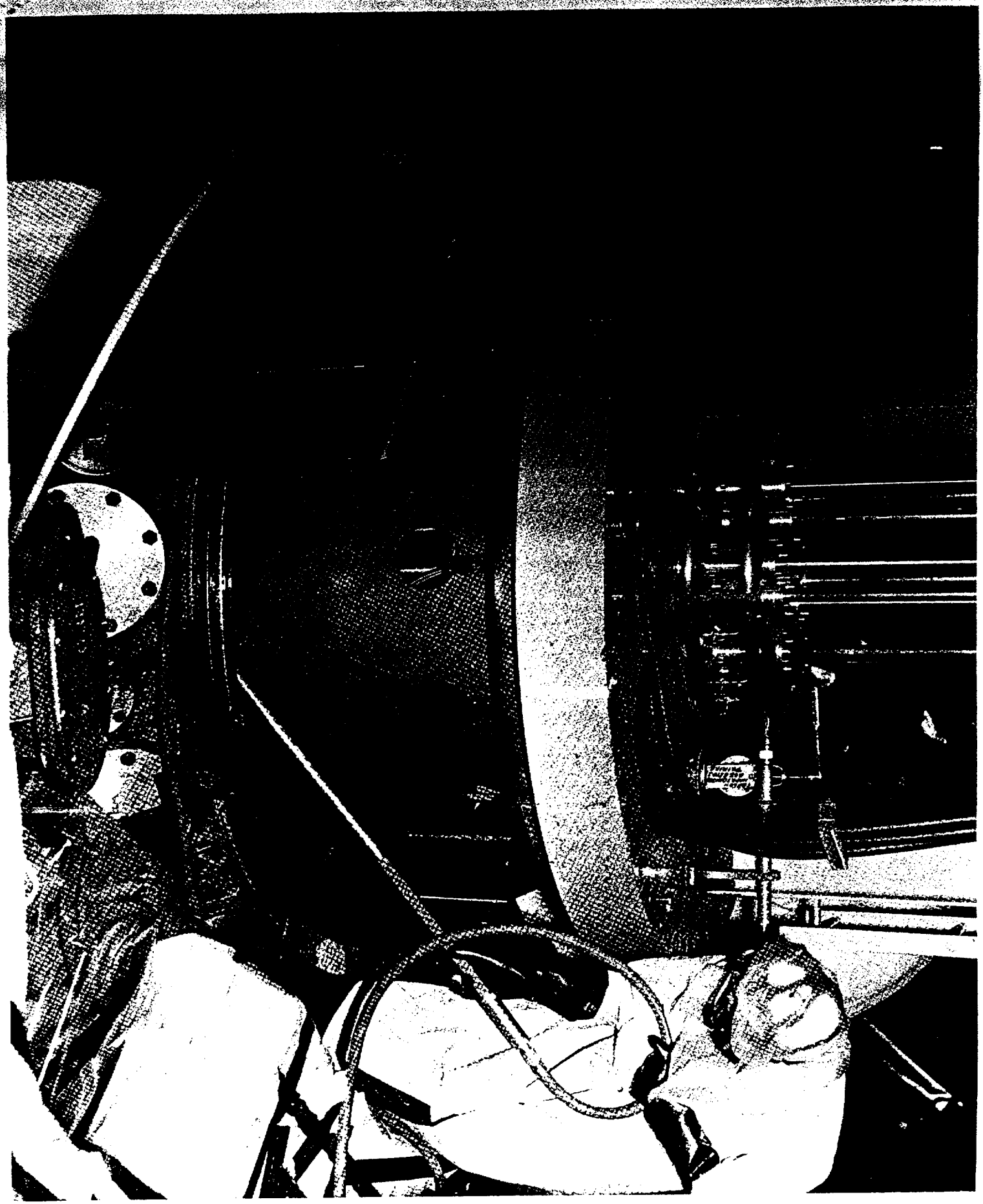

EXHIBIT O

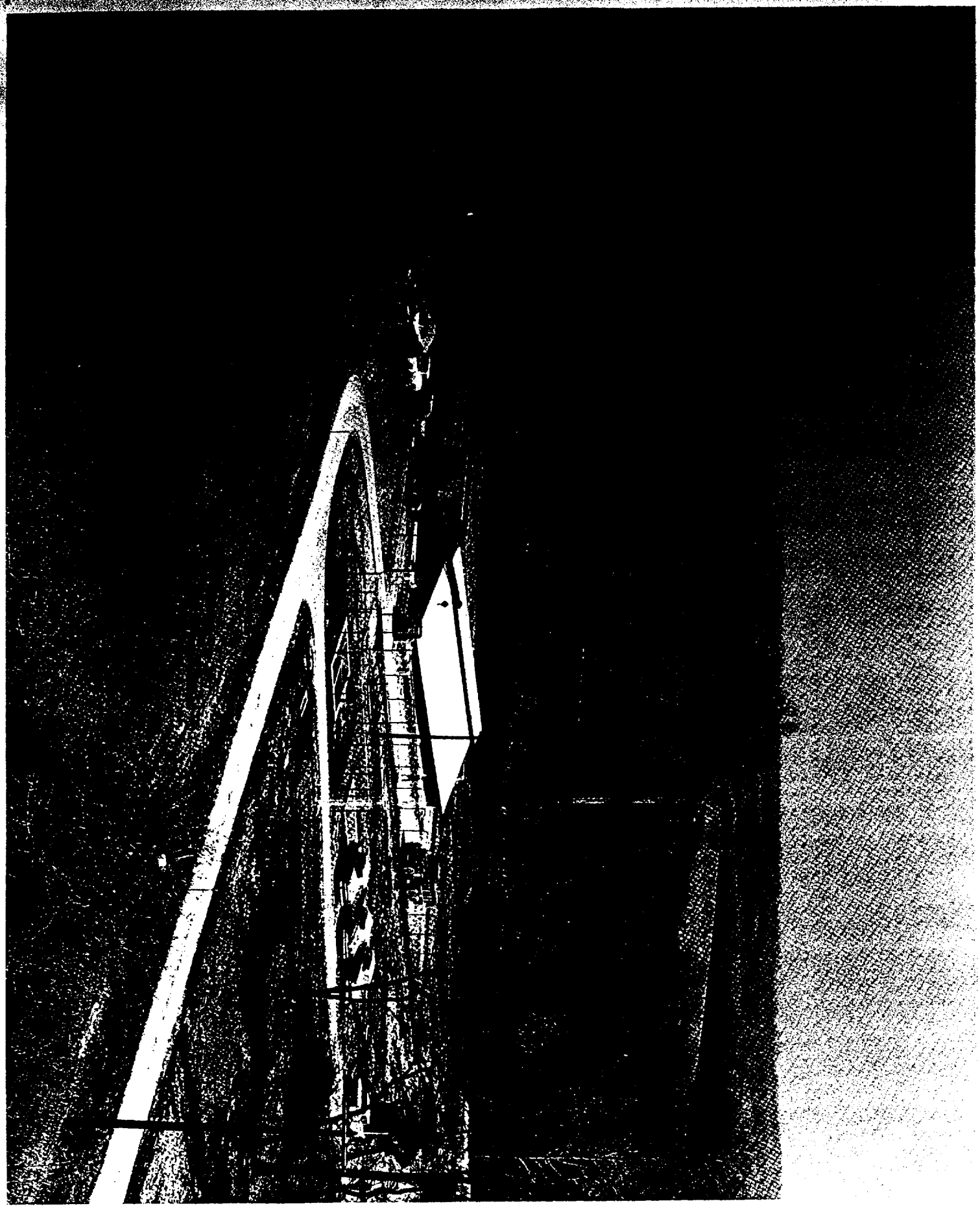
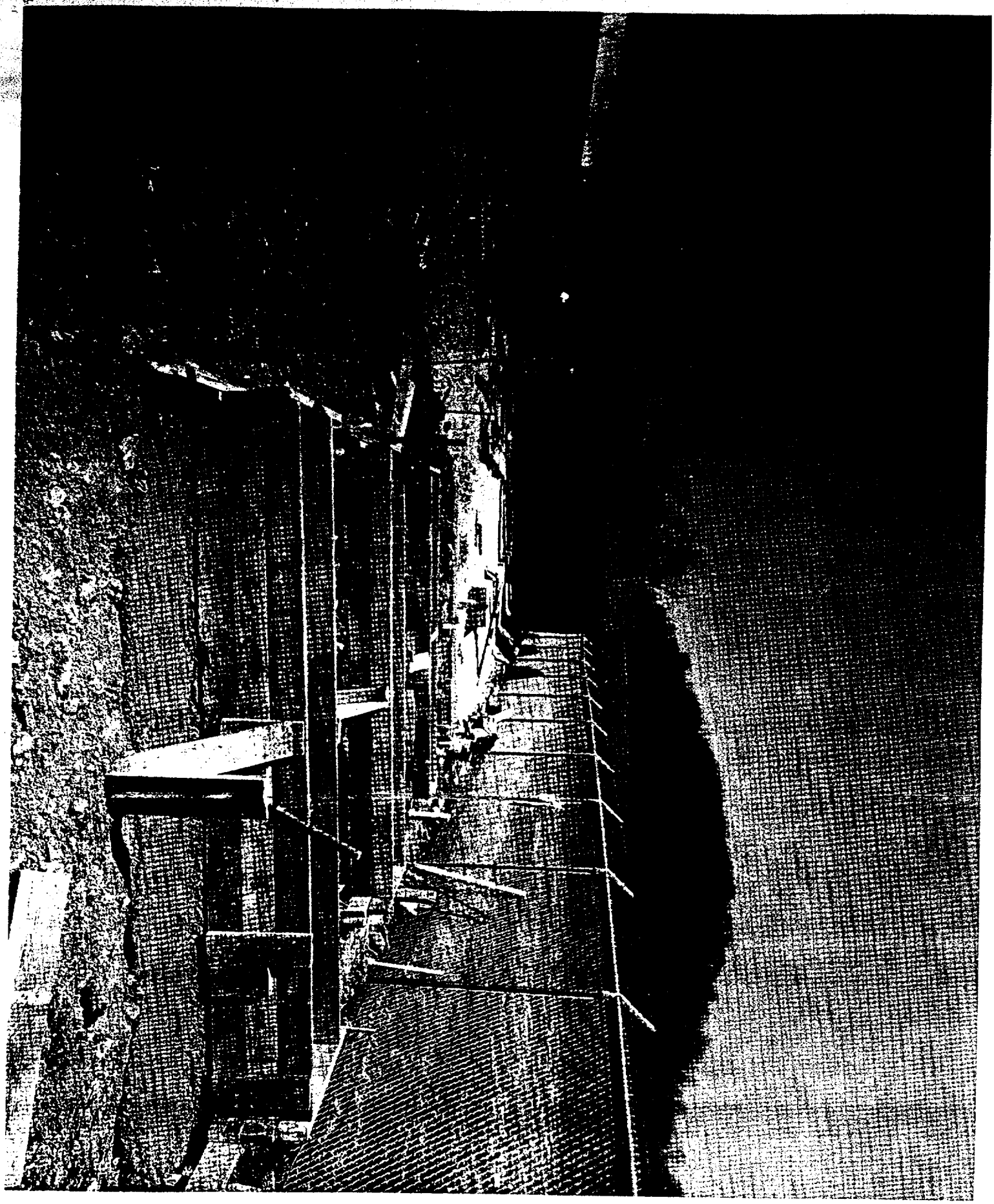
EXHIBIT P