U. S. ATOMIC ENERGY COMMISSION
DIVISION OF INSPECTION
REPORT CF-169

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Title: INVESTIGATION OF RADIATION INCIDENT AT THE WESTINGHOUSE TESTING REACTOR, LICENSE NO. TR-2, WALTZ MILL, PENNSYLVANIA

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 NY 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	-	Inspection Division New York Operations Office
Merson Booth	-	Division of Licensing and 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 Testing Reactor
Dr. M. A. Schultz, Engineering Manager, WTR
Dr. A. J. Pressesky, Manager, Scientific Support Section
Mr. R. J. Catlin, Manager, Health Physics Section

Distribution: General Manager
H. L. Price, DLR
Dr. C. K. Beck, DLR
L. E. Johnson, DLR
General Counsel (Mr. Eason)

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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 NY Inspection Division, in the preliminary investigation.

OPERATIONS PRIOR TO THE INCIDENT

1. 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 installed in the shield outside of the pressure vessel during the escalation in power from 20 megawatts to 60 megawatts. A series of reduced flow experiments had been made in February 1960, 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 (boiling). 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 experiments with the access tubes removed from the reactor in order to determine the relation between coolant flow and the initiation of boiling. This is the type of experiment which was being run on the night of the incident.

3. The minutes of the Westinghouse Testing Reactor Safeguards Committee meeting 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, dated February 19, 1960, is included as Exhibit B. 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.

4. For the particular experiment being performed on the evening of the incident, test specification No. 5-2 had been prepared. A copy is included as Exhibit C. Since in this experiment the flow was to be cut back to 5000 gpm, and the maximum power level was 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 supervisor and the operator and was available at the console. Specification 5-1 also was in force but a copy was not said to be available at the console.

5. Examination of Westinghouse's log book indicated that there had been 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. 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. 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.

Test specification 5-1 had placed an operating restriction on the first fuel ring bulk water outlet temperature at 220° F. The thermocouple readings of L-5-6 indicate that at no time, even during the incident, was this exceeded.

7. A final item which possibly 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 or bits of welding rod 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 particles of foreign material larger than about one quarter inch from the reactor.

It was stated that WTR personnel did not inspect the head tank during or after the welding operation.

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

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* See Exhibit ? for fuel element and thimble positions.

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 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 E. 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. 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 dropped within a few seconds to approximately 17 megawatts. The #9 rod, which was about two thirds withdrawn, was then withdrawn to about 85% by the automatic control, and the operator switched to #8. The #8 rod also was withdrawn about 85% by the automatic control, 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 then began to indicate increasing power, as a result of the control rod withdrawals, and Bianchi said that the period indicator on the console indicated an approximate 60 second period.

Bianchi recalls that as the power came up, a radiation monitor sounded. He said that he had been puzzled by having to use 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 return 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 the

radiation monitor on the reactor top. He very soon after heard another alarm go off 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 recorder in the control room at about 8:45 p.m.

Channel No.	Description	Approximate Reading in Counts/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 8:45 p.m. 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

Area	Reading in mr/hr
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 cannister-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 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 Suebert 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 10:00 p.m. to conduct direct reading surveys in outlying areas. 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 incident, 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 miles/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 60,000 gallons of water.

During the preliminary investigation, the inspectors contacted Mr. David Galm, Senior Scientist, who had been given the responsibility of analyzing, storing, and eventually disposing of the contaminated process water, the total of which amounts to about 250,000 gallons. Galm stated that he received a phone call at his home at about 11:30 p.m. on April 3, 1960. He stated that he arrived at the Suebert 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.

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 2.4×10^7 dpm/ml.

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} µc/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 Kanne Chamber. At the time of the incident, the recorder of the Chamber was on the 10^{-9} amps scale. Immediately after the fission product release, the pen went off scale and 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 remained 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.

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.

Willhoit and Collins presented the inspectors with copies of film badge and pocket chamber results for the period involving the incident. The 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 "
	185 "	150 "	265 "
	240 "	181 "	206 "
	150 "	125 "	106 "

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 " ".)

INFORMATION GATHERED DURING COMMITTEE MEETINGS

At the investigation committee meeting with the WTR staff, further information relative to the indicent 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. For approximately $2\frac{1}{2}$ minutes, the Brush recorder indicated, at first, very little perturbation, 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. Mr. Hemmerle 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 -.3%, 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 or 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.

3. Both Bianci and Pollono said that they had not been given any special instruction prior to this experiment with respect to sudden reactivity 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. 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 $1\frac{1}{2}$ 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 <u>not</u> have brought the reactor back to power.

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. Protective paper and polyethylene sheets were placed over all the equipment inside the containment shell. Discharge operations were initiated, and when element No. L 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 indicated melting had occurred over a length of several inches. 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 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 there 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.

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 not have been blister-annealed, and a call was made to Mr. Weber of Clevite during the committee meeting. Mr. Weber reportedly 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. However, it was said that no records are maintained that would verify that each plate is annealed.

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.

There are approximately 100 new fuel elements manufactured by Clevite in the WTR storage vault. Before installation of any of these elements into the reactor, the locking pins and the end spiders will be removed and all of the fuel cylinders of all elements will be examined.

In the future, Westinghouse will have a resident inspector at the fabricator's plant.

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.

Dr. Schultz also said that he intends having metallurgists 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.

4. The present plans for cleanup after this incident are being closely examined by WTR's insurers. 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 holdup 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.

SUPPLEMENTARY INFORMATION

Subsequent to the investigating committee's meeting, visits to the WTR site 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 and is now in the hot cell. Elements from locations L-7-5, L-5-5, and L-7-6, from the center fuel ring, and the element from location L-6-4, adjacent to the ruptured element location, have been placed in the same hot cell. It is reported that all channels in all elements appear clear and normal. Element from location L-7-6, which was the original instrumented element and had been in the reactor through a few cycles, is reported to have a slightly reddish-brown color. WTR people 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. It is planned that 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.

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.

6. The WTR staff is considering moving the location of the fission product monitor in an effort to improve its response.

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 a satisfactory solution.

Attachments:
Exhibits A thru F