70-820

UNC RECOVERY SYSTEMS

COMPLIANCE INVESTIGATION REPORT
VOLUME 1 - REPORT DETAILS

Rec'd w/ ltr dtd 8/14/64

AA-1

[redacted]

# COMPLIANCE INVESTIGATION REPORT

Division of Compliance
Region I

Subject: UNITED NUCLEAR CORPORATION
Scrap Recovery Facility
Wood River Junction, Rhode Island
License No.: SNM-777

Type "A" case - Criticality Incident

[redacted]

Period of Investigation: July 25, 1964 to August 7, 1964

Investigation Team: Walter R. Lorenz, Radiation Specialist
Willie G. Browne, Inspection Specialist (Criticality)
Alvin F. Ryan, Investigation Specialist
Ernest P. Resner, Radiation Specialist
Fred N. Brandkamp, Radiation Specialist
Peter J. Knapp, Radiation Specialist
James F. Bresson, Radiation Specialist
Hilbert W. Crocker, Inspection Specialist (Criticality)

4 4027

Volume I - Report Details

[redacted]

Aug. 14, 1964

TABLE OF CONTENTS

## REASON FOR INVESTIGATION

Initial telephone notification that there had been a criticality accident at a United Nuclear Corporation plant at about 6 p.m. was reportedly made by Mr. R. C. Johnson of the United Nuclear Corporation to the Division of Operational Safety, AEC,HQ at about 6:30 p.m., Friday, July 24, 1964. CO:HQ was alerted and Jack R. Roeder, Inspection Specialist for Staff Operations reached Richard S. Cleveland, Radiation Specialist (Review), CO:I, about 8:20 p.m. The Radiological Emergency Assistance Team of NYO and Willis G. Browne, Inspection Specialist (Criticality) of CO:I were alerted, location of accident at the Wood River Junction plant in Rhode Island was determined, and the plant was contacted regarding current situation. Robert W. Kirkman, Director, CO:I, was contacted about 10 p.m. and W. G. Browne and Ernest P. Resner, Radiation Specialist, CO:I were dispatched to be able to confirm adequacy of control of present situation and to start investigation early Saturday morning. Contact with staff of Rhode Island Hospital in Providence, Rhode Island on care of the one casualty confirmed he was resting comfortably and was being closely attended, but that health physics assistance would be appreciated. Ernest P. Resner was diverted to the hospital, and Ernest P. Resner and W. G. Browne, respectively arrived at hospital and plant at about 4 a.m. Saturday.

## THE UNITED NUCLEAR CORPORATION

### A. History and Organization

The United Nuclear Corporation was formed in June of 1961 by combining the Nuclear Divisions of the Mallinckrodt Chemical Company, Olin Mathieson Industry and Nuclear Development Associates. Within a year the Sabre-Pinon Corporation purchased most of the stock holdings and reorganized the company into three operating divisions. Sabre-Pinon became the mining and milling division of the United Nuclear Corporation, Nuclear Development became the development division and the other two facilities became the fuels division. Each division is headed by a Corporate Vice President.

### B. Corporate Responsibilities for the Wood River Junction Plant

John A. Lindberg is Vice President of the fuels division and is responsible for the chemical operations at Hematite, Missouri, and the fuel fabrication operations in New Haven, Connecticut. Robert Johnson, as Acting Manager of the chemical operations at Hematite and as Industrial Engineering Manager at New Haven, has responsibility for the fuels recovery facility at Wood River Junction, Rhode Island. Mr. Richard A. Holthaus is Plant Superintendent of the fuels recovery facility.

Mr. Louis J. Swallow, Manager of Operations Control at Hematite, Missouri and Mr. John Geil, Supervisor of Health Physics at the New Haven Operations are available to Mr. Holthaus on a consultant basis for problems involving nuclear safety or health physics. In addition, Mr. Geil is responsible for the interpretation of health physics data collected at Wood River Junction and Mr. Swallow is responsible for auditing the nuclear safety practices at Wood River Junction.

## The Wood River Junction Plant

### A. Plant Facilities

On May 8, 1963, ground was broken at the Wood River Junction site, for the construction of a non-irradiated nuclear fuels scrap recovery plant. The plant site is an 1100 acre tract of land that is located about one mile south and east of the town of Wood River Junction, Rhode Island.

The plant facilities consist of a single building 75 feet wide by 175 long, a 36' x 72' settling pond and an exclusion area surrounding the plant. A cyclone fence, about 100' x 150', encloses the settling pond, and similar fencing of approximately 200' x 225', is used for the exclusion area around the plant.

The area immediately north of the plant and within the exclusion area fence, is almost covered with asphalt paving and is used for the receipt and storage of process chemicals and drums of uranium solutions. To date, the only uranium receipts have been 55 gallon drums of pickle liquor from the New Haven, Connecticut plant and they have been stored in this paved area. The area east of the plant and within the exclusion area, is used for the storage of empty pickle liquor drums. The area south of the plant and within the exclusion area has not been used for anything and is used as a lawn area.

The fuels recovery building is divided into 21 "Bays" that are each 25' square. The general office area, the locker rooms, shipping and receiving, storage, maintenance, the analytical laboratory and the utility area, occupy bays 1 through 9. The process area occupies bays 10 through 21.

B. Processing Facilities

1. Material Processed

The fuels recovery plant was designed to process non-irradiated nuclear fuel scrap materials for the recovery of uranium enriched in the U-235 isotope. On March 16, 1964 the first material was processed in the plant and it was pickle liquor containing uranium with 93% U-235, that had been generated by the New Haven, Connecticut plant. To date, no $UO_2$ product has been shipped from the plant, because it has not been within specifications.

The pickle liquor is shipped from the New Haven plant in 55 gallon drums that have a polyethylene liner. The drums are received at the Wood River Junction plant in 75 drum lots and are stored outside the building on the paved area north of the plant. Each 75 drum lot is assigned a number for identification purposes, which is called the job number. To date, seven lots have been processed and at the time of the incident, part of job number 8 had been processed in the plant.

2. Transfer of Solution from Drums to Process Tanks

The 55 gallon drum received from New Haven will normally contain about 1 g/l of U-235 but may not exceed 5 g/l or a total of 800 grams of U-235 per drum. The pickle liquor solution, as received at Wood River Junction has been poisoned with 1 gram of cadmium nitrate per gram of U-235 present. Each drum of material is air sparged for about 15 minutes and then sampled to check against the shipper's determination of U-235 content. After analysis the contents of one drum, or less than 350 grams of U-235, is unloaded into the pickle liquor

adjustment tank (1-D-12), which has a capacity of about 90 gallons. Aluminum nitrate or aluminum hydroxide is then added to complex existing fluoride ion and to later act as a salting agent for the extraction column. A 5 or 10 ml samples is taken from 1-D-12 and the acid normality is checked by the operator by titrating it with one normal sodium hydroxide to a methyl red end point. Ammonium hydroxide (28%) is then added to bring the acidity between 2½ and 3½ N, with 3 N being the desired value. After ammonium hydroxide addition, a sample is analyzed by the operator to confirm the acid normality. The approximately 3 N acid solution, containing aluminum nitrate as a salting agent, is called "adjusted liquor". It goes through a stainless steel filter to the "adjusted liquor" holding tank (1-D-41). This has a capacity of about 15,000 gallons and is poisoned with pyrex glass rings.

3. Extraction Column Operation

The "adjusted liquor" is fed to the extraction column by means of a metering pump. A flexible connection on the metering pump allows solution to be drawn from either the 1-D-41 storage tank or the 1-D-9 A through F storage tanks, but not both systems at the same time. The feed enters the top of the pulsed extraction column (1-C-6) at a normal flow rate of about 35 gallons/hour. Scrub column solution is also introduced at the top of the extraction column. Organic solvent consisting of 30% TBP and stoddard solvent at a normal flow rate of about 7 gallons/hour is introduced at the bottom of the extraction column. Raffinate, normally containing less than one ppm of uranium leaves the bottom of the column and is transferred to the 1-D-21 A and B tanks (each tank is about 1200 gallons capacity and is filled with pyrex glass rings) for sampling, waste treatment and disposal. The organic solvent containing extracted uranium flows from the top of the 1-C-6 column to the bottom of the pulsed scrub column (1-C-7).

Nitric acid solution of between 0.5 and 3.0 normality is introduced at the top of the scrub column at a rate of 1 to 2 gallons/hour. The scrub solution is removed from the bottom of the column and returned to the top of the extraction column. The scrubbed organic solvent containing uranium is then pumped from the top of the 1-C-7 column to the bottom of the pulsed strip column (1-C-8).

Water that is less than 0.05 normal in nitric acid is added to the top of the strip column. The organic solvent, stripped

of its uranium, flows from the top of the 1-C-8 column to the organic wash column (1-C-9). One molar sodium carbonate solution and an air driven agitator in the column are used to wash any impurities out of the organic. The washed solvent is then transferred to the organic storage tank (1-D-5) for storage and subsequent reuse in the solvent extraction column.

The strip solution flowing from the bottom of the strip column (1-C-8) contains uranium nitrate at concentrations of 15 to 30 g/l. This solution flows to the bottom of the trichloroethane (TCE) scrub column (1-C-10) which contains a fixed charge of some 1 to 1½ gallons of TCE. As the product solution bubbles through the TCE, any entrained organic material is removed and the clean product solution is pumped from the top of the 1-C-10 column to the storage tanks (1-D-10 A and 1-D-10 B). Originally, it was anticipated that very small quantities of organic would be entrained in the product solution leaving the strip column and the necessity of changing the TCE solvent would probably occur only twice a year. Unfortunately, column up-sets, which resulted in emulsification, transferred large quantities of solvent into the scrub column. This accumulation of solvent in the TCE decreases the specific gravity of the mixture to the point where TCE and solvent could be carried out of the column. Dirt and crud also accumulate at the TCE interface and can be carried over into the product. When either of these two things happen, the TCE is normally drained from the column and replaced with new TCE.

4. Concentration of the Uranium Product Solution

The product solution stored in tanks 1-D-10A and 1-D-10B is called "OK liquor" and the concentrations normally range from 15 to 30 g/l of uranium. The OK liquor is fed by gravity to a continuous evaporator at a rate of 0.1 to 0.2 g/min. The OK liquor is concentrated to a specific gravity of 1.2, which corresponds to about 100 grams per liter of uranium. A specific gravity instrument connected to an alarm warns the operator when the 1.2 specific gravity is reached. When he hears the alarm, he turns on a pump for transferring the concentrated solution to the storage tank (1-D-10C). When the specific gravity in the evaporator drops to 1.14, the operator shuts off the pump. Condensate from the evaporator goes to the filtrate tanks (1-D-24A and 1-D-24B). These tanks have a capacity of about 500 gallons each and are filled with pyrex glass rings. The material sent to the 1-D-10C tank is called "concentrated OK liquor".

5. Precipitation and Filtration of Ammonium Di Uranate

The concentrated liquor is delivered by gravity feed from the 1-D-10C tank to the precipitator tanks 1-D-19A, B, C, and 1-D-20A, B, C, and D. Each precipitator batch contains about 2½ gallons of concentrated OK liquor and the precipitation of Ammonium Di Urante (ADU) is accomplished by bubbling in a mixture of air (2 cfm) and ammonia gas (8 cfm) until a pH of about 8 or 9 is reached. The operator determines when the precipitation is complete, by observing the change of color in the solution from green to yellow and by testing the pH with indicator paper. When the precipitation is complete, the ADU slurry is drained from the precipitator into a buchner funnel. The precipitate collects on the stainless steel filter of the funnel and vacuum pulls the filtrate into the 4 liter flask under the funnel. The ADU filtrate is then transferred to 5" diameter 11 liter bottles where the filtrate is sampled. After analysis indicates it is less than 5 ppm it can be transferred into one of the filtrate tanks (1-D-24 A or 1-D-24B). These tanks each have about 500 gallons capacity and are filled with pyrex glass rings. ADU filtrate which is above 5 ppm may be refiltered and resampled but if this does not bring the uranium content below 5 ppm, it can be returned to the precipitator, acidified, combined with more concentrated OK liquor and the batch reprecipitated.

The ADU cake in the buchner funnel is washed with dilute ammonium hydroxide solution to remove any ammonium nitrate present as solids. The buchner funnel containing the ADU cake is then transferred to the drying oven (1-H-1 or 1-H-2) where the cake is dried for about 4 hours at 300 to 400° F. The buchner funnel containing the dried cake is then placed in a glove box hood where a spatula is used for cutting the cake out of the buchner funnel. The cake is crumbled up so it will pass through the neck of gallon bottle which is under the hood funnel. When the gallon bottle is full, the bottle is weighed, tagged and serially numbered (4000 series). Information on the ADU placed in storage is given to the foreman who enters it on a daily production sheet. A running inventory of the ADU in storage is maintained in the office of the plant superintendent.

6. Conversion of the Ammonium DiUranate to $UO_2$

When ADU is to be converted to $UO_2$, the one gallon bottles are taken to the reactor loading hood. Three bottles are selected which contain a total of 13 kgs or less of ADU. The contents of the bottles are loaded into the reactor tube and the top reactor flange is bolted in place A dolly is used for removing

the reactor from the loading hood and transferring it to a spot where an electrically operated chain hoist can lift the reactor into the electrical furnace. A nitrogen line is connected to the top of the reactor, $N_2$ purging is started and the furnace temperature is brought up to 700° F. When the temperature reaches 700° F, steam is admitted through a second connection on the top of the reactor while the nitrogen line is being turned off and disconnected. The furnace temperature is then brought up to 1100° F and an ammonia line is connected to the former nitrogen purge connection. As the furnace temperature is raised from 1100 to 1500 or 1600° F, both ammonia and steam are fed to the reactor. The furnace temperature is then held at 1500 or 1600° F for about 18 hours. It is then cooled down, shutting off first the ammonia then the steam, and then the nitrogen purge. $N_2$ is added when the reactor has dropped to about 1000 to 1200° F. With the nitrogen line still connected, the reactor is then pulled from the electrical furnace, using the monorail hoist, and placed in the reactor cooler. Air cooling is used for about an hour before turning on the water sprays to rapidly cool the reactor down. After spray cooling for about 2 hours, the reactor has been cooled to room temperature and the nitrogen purge line is disconnected.

The cooled reactor is transferred to an unloading cradle in the unloading hood. The electrical chain hoist is used to lift the reactor tube and cradle to about 30° above the horizontal where the unit is bolted to the glove box wall. Using the hood gloves, the reactor tube flange is unbolted and $UO_2$ powder is drained and scraped from the reactor into a hood hopper. The hopper discharges to a screw feed that transports the powder into the hammer mill. The hammer mill, operating at about 3400 rpm, reduces the powder particle size so that it will pass through a herring bone screen. Powder from the screen falls into a hopper that fills the one gallon $UO_2$ bottles (4100 series). The one gallon bottles of $UO_2$ are weighed, tagged and delivered to storage. Data on the amount of $UO_2$ placed in storage is given to the foreman. The current inventory of $UO_2$ in storage is recorded on the daily production sheet in the plant superintendent's office.

$UO_2$ samples are taken from 3 or 4 bottles at a time and sent to New Brunswick for analysis. Current problems with high iron and high titanium content have not allowed any product to be shipped off site, as yet; but if $UO_2$ production meets specifications in the future, the powder will be sent to the blender hood. Lots of up to 10 kg.

of uranium can be put in the blender and the blended $UO_2$ powder is then loaded into the polyethylene shipping bags that are sealed in the "two pound coffee can" shipping containers.

C. Miscellaneous Process Operations

1. Stainless Steel Dissolver

The stainless steel dissolver has been used for the batch dissolution of off standard $UO_2$ and the preparation of extraction column feed from uranium solutions that are to be reworked through the extraction and precipitation operations. For $UO_2$ dissolution, 50 liters of solution, 3 normal in nitric acid and containing 6 kg of aluminum nitrate and 1½ kg of $UO_2$ are heated to 200° F in the stainless steel dissolver. The solution is held at 200° F for two hours and then sampled to check the acid normality and the completion of uranium solution. After cooling the solution to 120° F, the dissolver is pressurized to 15 lbs/inch with air and the dissolved solution is transferred through a 12 screen plate filter press to the assay tank (1-D-34 A, B or C). Air pressure on the assay tank is then used for transferring the solution to tanks 1-D-9A, B, C, D, E, and F. Uranium solutions are normally added to the dissolver, acidity and aluminum nitrate additions are made as required, and the solution transferred through the assay tank to the storage tanks 1-D-9A, B, C, D, E, and F.

2. Burning of Solid Wastes

Solid wastes can be calcined by placing the material in one of two covered, Hastelloy trays that fit into an electrically heated oven. The oven temperature slowly is raised to 500° F to remove any moisture or liquids in the waste and then brought to 1000° F and held for one hour. To completely remove all carbon, the ash is calcined at 1500° F for 1 to 2 hours. The trays containing ash are removed from the oven, air cooled, and emptied into one gallon polyethylene containers. Uranium is leached from the ashes by placing the ashes in a 4 liter stainless steel beaker, adding concentrated nitric acid and then boiling the acid for 1 to 2 hours. Solids are removed from the leaching acid by filtering the solution through a buchner funnel, rinsing the cake with nitric acid and then rinsing it with water. The solids are dried, sampled, and if OK'd can be stored in a 55 gallon drum. The filtrate is placed in an 11 liter bottle and sampled. These ashes are

the only materials that have been processed through the leaching hoods to date.

3. Trichloroethane Washing

Although it was not originally anticipated that TCE would need to be washed, extraction column up-sets resulted in solvent emulsification and the transfer of relatively large amounts of solvent to the TCE column. This required the frequent replacement of TCE in the 1-C-10 column. The first washing procedure which was started in May involves the use of a 4 liter separatory funnel in which equal portions of sodium carbonate and TCE were placed, shaken vigorously, separated, and then placed in 11 liter bottles for sampling and storage. About the middle of June, the use of an 11 liter bottle for the washing procedure was adopted because twice as much TCE could be washed at each washing. The washing procedure was essentially the same as the separatory funnel technique, since it used half carbonate solution and half TCE. A total of about 9 or 10 liters of solution was added to the bottle and two men shook the bottle to provide the agitation needed for good contact between the sodium carbonate solution and the TCE. To increase the washing efficiency, the procedure was eventually changed to use 1/3 TCE, 2/3 carbonate solution, and a total of about 8 liters solution in the 11 liter bottle. After washing the TCE in the 11 liter bottle, a separatory funnel was used for the actual separation of TCE from the carbonate solution. It was discovered that a one man agitation operations could be performed by balancing a capped 11 liter bottle on the stairway handrail and tilting the bottle up and down. A still more efficient washing procedure was proposed by Mr. Simas on July 17, 1964.

Experience with the TCE washing disclosed that fresh TCE was easier to wash than TCE that had been removed from the column and allowed to sit around for 3 or 4 days. The fresh TCE would usually only require 2 washings to reduce it to an acceptable throw-away limit, but the TCE that had sat around requires 3 or more washings. This encouraged the washing of TCE as soon after its removal from the column as possible. If the uranium did not wash out of

the TCE very well, it was also discovered that boiling down the TCE in the 1-L-3 hood and then washing the boiled down TCE with carbonate solution was effective in removing the uranium. The washing procedure attempted to reduce uranium content of the TCE to less than 10 ppm before discarding the TCE. The TCE to be discarded, was normally dumped along the fence line to kill weeds or poured onto the ground and allowed to soak into the soil.

The sodium carbonate solution that resulted from the TCE washing or the sodium carbonate solution removed from the solvent washing column, is normally placed in an 11 liter bottle for sampling, neutralizing it with nitric acid, and transferring it into the 1-D-12 tank system. Sodium carbonate solution from the organic wash column was usually changed about once a day when the columns were running, but sometimes it was changed as frequently as once per shift. Lately, to keep from up-setting the columns during the product rework program, the sampled and acidified sodium carbonate solution from the 1-C-9 column has been stored in a 55 gallon drum. There are now four or more drums on hand.

4. <u>The Return of Product Solutions to the Extraction Column System</u>

Acid solutions that contain product quality uranium can be returned to the extraction column system by merely pouring the solution into the overflow lines while the pumps were running. OK liquor could be added to the 1-C-10 column funnel on the second floor of the tower room, since the transfer pump was always running and the solution would be immediately transferred to the 1-D-10A or 1-D-10B storage tank. If the product solution is not absolutely clean, as when the TCE is removed because of interface dirt and crud, the solution can be returned to the extraction column by pouring it intothe 1" glass pipe which collects the overflow from the scrub column and pumps it back to the top of the extraction column. This same technique for returning solution to the extraction column could be used for the raffinate collected in gallon bottles when extraction column floods allowed organic to be discharged in the raffinate. This apparently occurred on 7/14/64 according to the Operators' Log Book A.

## Events Preceding the Incident

### A. Operating Problems Since Start-up

Pickle liquor solution was introduced to the scrap recovery plant in Wood River Junction on March 16, 1964. However, process equipment difficulties including leaking gaskets, pulser column bellows, glass to gasket seals, and leaking pump seals delayed the start of an ADU precipitation until the week of April 27, 1964. Equipment difficulties had been largely eliminated and plant operation was on a sustained basis by the week of May 11, 1964.

The only material processed through the plant between March 16 and the 24th of July, 1964 came from pickle liquor that contained uranium enriched to 93% in the isotope U-235. Iron and titanium contamination of the final $UO_2$ product had not allowed the off-site shipment of any uranium oxide product. An attempt was being made, during the week of July 20th, to rework and purify the uranium oxide that did not meet product specifications. As a result, the extraction column system was being operated under as nearly stable conditions as possible and the stainless steel dissolver was the primary source of feed for the columns.

### B. Plant Design Philosophy

The design of the plant for nuclear safety had been based on limited safe batches, limited safe geometry, or limited safe volumes. All uranium solutions of greater than 5 gr/l concentrations were to be contained in geometrically safe containers and during normal processing operations, product solutions would not be allowed to escape from the process equipment. Even those solutions which would normally contain low concentrations of uranium but would have high volumes were to be stored in tanks that were filled with pyrex glass rings (boron poisoned). Solutions removed from the process equipment were to be stored in one gallon polyethylene bottles or in 5" diameter by 4' tall 11 liter polyethylene bottles until after they had been samples and analyzed for uranium content. Instructions had been given to operators that solutions should not be used until the material was analyzed.

### C. TCE Washing in the Sodium Carbonate Tank (1-D-11)

The original plans for using TCE to remove organic materialf from the extraction system product stream did not envision the removal and replacement of TCE more than once every 6 months. In May, shortly after starting to operate at rates near design capacity, it was necessary to replace the first batch of TCE.

In an attempt to remove the uranium from the TCE sodium carbonate washing techniques were used. Subsequent column upsets required a more frequent TCE replacement, and there was a need for developing more efficient washing procedures, to remove the uranium from TCE. Since the first part of June, about 55 gallons of TCE had been needed for the TCE column.

On the day shift, of July 17, 1964, Joe Simas suggested to his shift supervisor, Cliff Smith, that the TCE washing could be done more efficiently if the sodium carbonate tank (1-D-11) with its lightning agitator could be used for TCE washing. Since there was approximately 30 gallons of TCE that needed to be washed, Mr. Smith decided to investigate the suggestion and went with Mr. Simas to check the analysis of the TCE bottle which Mr. Simas wanted to use. Mr. Smith discovered that the uranium content of the TCE in the 11 liter bottle was 750 ppm or about 0.75 grams/liter (U-235 concentrations of five grams per liter are safe for any volume of solution). The procedure as proposed, involved the use of the open top sodium carbonate make-up tank (1-D-11) which is located on the third floor of the Tower room and is a tank 18" in diameter and 2' deep. Mr. Smith gave Mr. Simas permission to use the tank for TCE washing.

Mr. Simas added two 11 liter bottles of water to the 1-D-11 tank and 4 pounds of sodium carbonate. The solution was agitated until all of the sodium carbonate dissolved. One 11 liter bottle of TCE, with an uranium analysis of 750 ppm, was added and the tank contents agitated for 45 minutes. The solution of TCE and sodium carbonate was then drained into the empty 1-C-9 column, which is a 3" diameter glass column that is 8' long. After allowing the solution to settle, the TCE and sodium carbonate solution separated into two phases and the TCE was drained out of the bottom of the 1-C-9 column into a one gallon bottle and then transferred to an 11 liter bottle for sampling and analysis. The sodium carbonate solution containing the uranium washed from the TCE was also drained into one gallon bottles and transferred to 11 liter bottles for sampling and analysis. This washing procedure reduced the TCE uranium content from 750 ppm to 192 ppm. This was the first time this procedure had been used in the plant and it took the whole shift to do the washing. Mr. Simas recorded his procedure for TCE washing in the Operators Log Book A.

The operator relieving Mr. Simas on the 4 to 12 shift on July 17, 1964 was Robert Peabody, and Mr. Simas explained to Mr. Peabody, the TCE washing procedure which he had just used. He told Mr. Peabody that the procedure was written in the operator's log, but also went over the details of the washing operation and explained the advantages of the new system.

Early in the shift, Mr. Peabody's supervisor, Bill Pearson, came up to the third floor of the tower room to talk with Mr. Peabody and discovered that Mr. Peabody was agitating TCE in the sodium carbonate tank. Mr. Pearson claims that he was angry when he found this procedure being used, and asked how long this procedure had been going on. Mr. Peabody explained that it had been performed on the day shift and explained the advantages of the washing procedure to Mr. Pearson. Mr. Pearson then asked him what the uranium analysis of the TCE was, and he was told that the TCE contained 200 ppm of uranium. Mr. Pearson checked the operator's log book and found the entry explaining that the washing had been done on the day shift, July 17, 1964. He then allowed Peabody to continue the washing and entered a note in the supervisor's log at the end of the shift (item 4) "Wash umpteen bottles of TCE", etc., indicating that he was aware of the TCE washing that had been done on his shift.

When Mr. Simas reported in on Monday, July 20, 1964, he checked the storage area and the analysis as shown on the TCE-bottle tags and concluded that Peabody had washed six 11 liter bottles of TCE on July 17. The uranium analysis of these bottles ranged from less than 20 to 60 or 70 ppm of uranium.

D. Accidental Criticality Alarm and Evacuation

On July 22, 1964 on the 4 p.m. to midnight shift, Robert Peabody, was washing down the pulse column room. Water apparently splashed onto the criticality alarm and set the alarm off at about 6:15 p.m. The building was promptly evacuated, and all personnel assembled at the emergency shack about 500' southwest of the plant. Because the alarm only sounded for a few seconds and then stopped, Smith concluded that no criticality had occurred and after a preliminary investigation allowed the men to return to the building. All people had returned to the building by 6:35 p.m. As a result of the evacuation, several suggestions were made for improving the emergency evacuation procedure and these were recorded in the supervisor's log. On July 23 and 24, Mr. Barton, the Health Physicist Technician, took action to correct some of the deficiencies in the evacuation procedure.

E. Evaporator and Precipitator Difficulties

On the 12 to 8 a.m. shift on July 23, Mr. Pearson, the shift supervisor, discovered that the evaporator was not operating. He assumed that the steam trap was not functioning properly, so he and Mr. Nowakowski spent most of the shift trying to repair the steam trap.

When the shift supervisor, Dale Chapman and the maintenance man LeRoy Bitgood, came in for the 8 a.m. to 4 p.m. shift on 7/23/64, the problem was described and the actions taken on the 12 to 8 shift were discussed. Mr. Chapman decided that the evaporator feed leg should be drained of solution and the flange between the feed leg and the evaporator should be taken apart to see if the line was plugged.

An 11 liter bottle was wired to the stairway railing in the ADU precipitator area and solution was sucked from the feed leg into a 1 gallon bottle and the contents transferred into the 11 liter bottle. Approximately half a bottle of OK liquor was removed from the feed leg. Apparently this bottle was then capped and later moved up to the dissolver area.

A stainless steel pan that overflows at approximately 1" depth, was placed under the flange that was to be taken apart. When the flange was broken it was discovered that the line was plugged solid with crystalline uranyl nitrate. An attempt was made to dig the crystals out with a screwdriver and collect them in a stainless steel beaker. Mr. Holthaus, the plant superintendent, arrived at the scene and suggested that live steam could be used for melting and dissolving the uranyl nitrate. A steam hose was then connected to the steam jacket supply line of the precipitator and a piece of tygon tubing was fitted to the end of the steam hose. Steam was then used to melt and dissolve the uranyl nitrate. The portion of the line between the flange and the evaporator was cleaned first. The liquid draining from the line was collected in a 1 liter stainless steel beaker and the contents transferred to an empty 11 liter bottle. When the 11 liter bottle was full it was noted that the material had again crystalized out. This 11 liter bottle was placed in a safe cart. A second bottle was filled with the uranyl nitrate and solution from the evaporator. This bottle was apparently all liquid and it was also placed in a safe cart.

Because the last bottle filled contained concentrated liquor, and partly in jest, the safe cart was placed on the north side of the processing area near the sodium carbonate storage area with four yellow posts placed around it to rope it off from the other bottles.

On the 4 p.m to 12 shift an attempt was made to dissolve the crystalline material in the 11 liter bottle and put it in the stainless steel dissolver.

When Mr. Pearson came in on the 12 to 8 a.m. shift on July 24 he was told of the material in the dissolver, so he had it sampled and analyzed. The analysis showed that it had a concentration of 450 g/l. He concluded that the 16 liters of solution that was in the dissolver contained too much uranium to be diluted as feed for the extraction column, so he instructed the dissolver operator to load the material back into an 11 liter bottle. The operator and supervisor, finding a half full bottle of material near the dissolver, assumed it was the same material that had been added to the dissolver so they transferred the dissolver material back into the 11 liter bottle. When the dissolver was empty, the 11 liter was just full. A total of only 5 to 6 liters had been drained from the dissolver so it was assumed that the 16 liters inventory logged as being in the stainless steel dissolver was in error. It had also been assumed that the 11 liter bottle half full of liquid was some of the leached acid solution that had been obtained from the bottle of crystals. However, it was probably the 11 liter bottle of OK liquor drained from the feed leg on the 8 a.m. to 4 p.m. shift, July 23.

Three liters of the solution in the bottle was returned to the stainless steel dissolver and aluminum nitrate and nitric acid was added to the dissolver to prepare the solution as feed for the extraction column. On the 8 a.m. to 4 p.m. shift on July 24, the remainder of the 11 liter bottle's contents was processed through the stainless steel dissolver in three additional batches. All four of these batches are recorded in the Operators' Log Book A. Of the three 11 liter bottles generated by the evaporator clean out, one half of a bottle of crystal is in bottle X and one other bottle remained.

On the 8 a.m. to 4 p.m. shift on July 17, it was noted that black crud was floating on the surface of the liquid in one of the precipitators. Since this could result in poor quality ADU precipitate, it was decided to add acid to the liquor in the precipitator and filter the solution through a buchner funnel. Two 11 liter bottles were filled with the concentrated liquor from this filtration operation. These 11 liter bottles were placed in safe carts and stored in the evaporator-precipitator area. In the inventory of 11 liter bottles that was

taken after the incident, these two 11 liter bottles were found: one was labeled "OK liquor that has been filtered" and the other was labeled "Conc. liquor from precipitator that has been filtered" signed LR.

The Incident

A. Smith-Peabody Contact

When Mr. Smith reported on the 4 p.m. to midnight shift on July 24, 1964, Mr. Chapman informed him that the columns were working all right and that the evaporator had not been working. He mentioned that the 4 to 12 shift would have to start the evaporator up because the storage tanks 1-D-10A and B were almost full of OK liquor. They discussed the problem of the black foreign material in one of the precipitators and Mr. Smith decided that TCE would be used for washing down the precipitators, if the precipitators finished on his shift.

When Mr. Smith talked with Mr. Peabody, he told him about washing the precipitators with TCE and that it would be necessary to shut down the columns because the 1-D-10A and B storage tanks were almost full. Mr. Peabody then walked back into the pulse column area.

Mr. Spencer who was working in the evaporator-precipitator area next to the tower room does not recall seeing Mr. Peabody going to the tower area with an 11 liter bottle. Mr. Mastriani who was working on the stainless steel dissolver in the area west of the tower room recalls having seen Peabody taking a safe cart with an 11 liter bottle on it toward his work area in the tower room, about a half hour before the alarm sounded. Mr. Mastriani thinks that he saw a tag on the 11 liter bottle.

According to Mr. Peabody's testimony, he went to the storage area looking for an empty 11 liter bottle, but could not find any. In the past, he has taken bottles containing TCE, and an analysis below 1000 ppm, and washed the TCE in the carbonate wash tank to get empty bottles. He went to the storage area and found six full bottles of TCE. As he recalls, three were marked TCE "sampled" but did not have an assay on them. Two bottles were marked "TCE with 680 ppm" and 1 TCE bottle was just marked "TCE" but had no assay on it. Mr. Peabody says he took this latter bottle and carried it up to the third floor of the tower room to put it in the carbonate wash tank. As he recalls, the valve on the bottom of the tank was open, but the valve on the second floor was closed. The tank was half full of sodium carbonate solution

and the agitator was running. He was holding the bottle across his body and supporting it on his left arm as he poured the bottle contents into the tank. When he had poured all but an estimated one liter into the tank, criticality occurred.

Mr. Peabody believes that he saw a blue-white light and some of the tank contents were ejected from the tank. He claims that he was forced back and fell to the floor. He was dazed, but not unconscious. He heard the criticality siren start blowing so he got up and ran down the three flights of steps to the first floor, then out of the building. As he went through the escape gate in the fence south of the plant, he started taking off his clothing and had removed all of his clothing by the time he reached the emergency shack which is located 500' southwest of the plant.

At the time that the criticality alarm sounded, Mr. Mastriani was working on the stainless steel dissolver platform, Mr. Spencer was working near a precipitator tank, Mr. Smith was south of the stairs to the stainless steel dissolver at the platform near the "safeway aisle", and Mr. Coon, the guard, was at his station in the northwest corner of the building. Mr. Spencer evacuated the building through the south door of the plant and through the south gate in the exclusion area fence. Mr. Smith and Mr. Mastriani evacuated the building through the locker room and the guard station door at the northwest corner of the plant. Mr. Coon left his post and attempted to open the yard gate before going to the emergency shack. All men including Peabody assembled at the emergency shack.

## Post Incident Events

### A. Observations Concerning Peabody's Injuries

Mr. Coon unlocked the emergency shack and took two blankets out of the shack one of which he threw on the ground and the other he put around Mr. Peabody. Mr. Smith used the telephone for notifying the men listed in the emergency procedure. The plant access roads were roped off. Film badges were collected and each man was given a building plan map on which he indicated his evacuation route. Mr. Peabody was nauseated and began to vomit. His face under his eyes began to swell slightly and his eyes became very red. He began to bleed from the mouth, nose and rectum. One of his hands was also a reddish color. Before the ambulance arrived he suffered severe cramps.

B. Removing Peabody in the Ambulance

When the ambulance arrived about 7:00 p.m., Mr. Peabody was put on the stretcher and placed in the ambulance. Mr. Spencer also rode in the ambulance with him. The ambulance started for Westerly Hospital, but was rerouted to the Rhode Island Hospital in Providence, Rhode Island. During the ambulance trip, in addition to vomitting, Peabody began to have severe headaches and the cramps extended from his legs to his abdomen and then to his chest. Mr. Peabody and Mr. Spencer were met by Drs. Forsythe and Karas who decontaminated them and isolated Mr. Peabody in the old X-ray room of the hospital.

C. The Arrival of Mr. Holthaus and Draining of the Carbonate Tank

Mr. Holthaus, Superintendent of the Plant, arrived at the plant, shortly after 6:30 p.m. and went to the emergency shack to determine what additional actions would be necessary for bringing the situation under control. Mr. Holthaus took a beta-gamma instrument to the plant and made a survey to determine where radiation readings were in excess of 100 mr/hr. From the survey, it was apparent that the radiation was coming from the tower area. He prepared a map of these survey results.

State Civil Defense Authorities people arrived at the scene about 7:30 p.m. with two radiation instruments that could read up to 500 r/hr. Mr. Holthaus borrowed one of the high range instruments and re-entered the building accompanied by Mr. Smith. They went into the tower area and up to the third floor where they found yellowish green solution all over the floor. Mr. Holthaus entered the room and walked over to the sodium carbonate tank. An 11 liter bottle was up side down in the tank with the bottom of the bottle facing west. Mr. Holthaus took the bottle out of the tank and threw it on the floor and then turned off the agitator.

The valve on the bottom of the tank was open so Holthaus and Smith left the room and went down to the second floor, intending to drain the tank contents into safe geometry containers. They had intended to drain the tank into gallon bottles at the second floor level but there were no containers to drain it into, so they went down to the first floor and got a number of one gallon bottles. Mr. Smith drained the contents of the 1-D-9 tank into the one gallon bottles. Mr. Holthaus then went up to the second floor, to open the valve and drain the sodium carbonate tank into the funnel of the 1-C-9 column.

When Mr. Holthaus opened the valve at the second floor level, no material drained out of the line, so he went back to the third

floor restarted, the agitator in the sodium carbonate tank and then returned to the second floor. He turned on the column stirrer and then drained slurry from the sodium carbonate tank into the column. When the column was full, he ran back to the first floor and assisted Smith in draining the uranium slurry from the column and into one gallon bottles. At this point they ran out of empty gallon bottles, and left the column area to pick up additional bottles from the storage rack. They returned to the column room with about 6 empty gallon bottles and drained additional slurry into the gallon bottles. Smith took the full bottles out to the process area for storage in a single row at about 4' spacing. Mr. Holthaus went back to the second floor and drained additional material into the funnel for the 1-C-9 column from the sodium carbonate tank. Smith was still removing slurry from the column. The hose flopped out of the funnel and slopped some material on the second floor. Mr. Holthaus shut off the valve, ran back up to the third floor, looked in the tank and finding the tank empty, shut off the agitator. He then went back to the second floor, and opened the valve on the sodium carbonate line to let the last of the material drain from the hose into the funnel. At this point, he told Mr. Smith to shut the valve at the bottom of the 1-C-9 column and they both left the tower area.

Although Mr. Holthaus and Mr. Smith were away from the civil defense car for about 45 minutes, Mr. Holthaus estimated that 15 minutes was spent in approaching the tower area and that five minutes was actually spent in the tower area, for a total of 20 minutes in the process area.

## Preliminary Surveys and Controls Adopted

### A. Arrival of the REAT Team and Surveys of the Environment

The NYOO REAT personnel, F. T. Richardson, Robert Sanna, and Karen O'Brien, arrived at the plant site about 6 a.m. on 7/24/64. After being informed about the nature of the incident, they made a survey of the area outside of the plant. The wind had been blowing steadily from the northeast at about 10 mph, since the incident (from the plant toward the emergency shack), so most of the preliminary surveys were taken downwind from the plant. Alpha radiation, primarily from uranium on exposed surfaces, using a PAC-3G direct reading alpha meter, showed 50 to 150 cpm outside and 100 to 200 cpm inside the plant office. area. There were a few isolated exceptions but all readings were less than 500 cpm. A gamma survey of the office area showed 0.1 mr/hr, which was the same as the background readings outside the plant. It was concluded that the incident materials were all contained in the building and, since no hazard existed in the area outside of the plant, the REAT group decided to leave the plant.

To expedite the processing of film badges, it was decided that Mr. Richardson would take the badges back to the New York Operations Office, with him. The Landauer Badge Company would then pick them up in New York and start processing them immediately. John Geil, Health Physicist from the United Nuclear Plant at New Haven, Connecticut surveyed all the film packs and decontaminated the film badge holders before giving the film packs to Mr. Richardson.

Later in the day, air samples were taken at special off-site points. Analysis of the samples indicated that uranium levels were essentially background. Samples taken along the Narragansett Trail. plant road and a point southwest of the plant, off the plant property had a maximum of 4.2 dpm for alpha and 26.6 dpm for beta-gamma (essentially background levels). All of these samples confirmed the fact that contamination released by the incident had not spread outside of the process building.

B. Plant Entries and Radiation Surveys Inside the Plant

About 8 p.m. on 7/24 radiation levels in the plant locker room were about 12 mr/hr, so the men contaminated during the incident and in the subsequent draining of the column 1-C-9 were allowed to shower and decontaminate themselves at the plant.

At approximately 8:45 p.m., Elmer Barton, the Wood River Junction plant Health Physicist, arrived at the emergency shack and, while using a Nuclear Chicago 2650 geiger survey meter with a range of up to 100 mr/hr, he and Mr. Holthaus went to the plant office area. Readings obtained between the emergency shack and the plant office area on two instruments were a constant 12 mr/hr. When Barton and Holthaus went into the shipping and receiving area, the readings increased to 25 mr/hr and in the process area behind the wall, west of the dissolver, the reading was 50 mr/hr. Mr. Barton started three air samplers in the area. When they went to the south end of the wall to check the gallon containers drained from the 1-C-9 column, the meter reading went off scale and they returned to the change room. At this time, Mr. Barton noticed Bob Johnson at the guard's desk talking on the telephone.

Mr. Holthaus told Barton that he would like to stop the monitors from sounding, so Barton got a meter with a range of up to 500 r/hr from Mr. Amato and, with constant monitoring, readjusted the monitor alarms near the foreman's office in the analytical laboratory and attempted to readjust the monitor in the precipitation area. The monitor in the precipitation area would not stop alarming, so Mr. Barton opened the meter box in an attempt to bypass the alarm

circuit, but he was not successful. At this point the monitor carried by Mr. Barton indicated a field of 10 r/hr. Total elapsed time to this point was not more than 3½ minutes. Mr Barton then went into the first floor of the column room and obtained a reading of 50 r/hr. He was in this areaabout 15 to 20 seconds. He then returned to the change room where he assisted in the decontamination of the men who had just finished showering.

When Mr. John Geil, Don Karn, and Marshall Cutler arrived a little later, Karn and Cutler went into the building to make surveys and to bring the air sampler heads out of the process area. (The samplers Barton had started.)

Mr. William Pearson arrived at the emergency shack about 12:15 a.m. July 25, and started decontamination efforts on the ambulance. About 4 a.m., just after W. G. Browne of Compliance, Region I arrived, decontamination of the ambulance was completed. Shortly after this, Mr. Pearson went into the plant with John Geil, using a beta-gamma survey meter with a range of up to 100 mr/hr. When they rounded the south end of the wall near the dissolver, the meter pegged. Mr. Barton had previously told Mr. Pearson that solution was overflowing from the evaporator so,after confirming the overflow, Mr. Pearson ran down to the evaporator area and turned off the valve which controls the flow of uranium solution from the storage tank to the evaporator.

About 8:30 or 9 a.m. Mr. Pearson returned to the process area to make a beta-gamma survey using an instrument with a range of up to 100 mr/hr. He did not enter any areas which exceeded 100 mr/hr, and the total time spent in the survey was about 15 minutes. He made a map of these survey results.

Decontamination of the office area and the locker rooms was started about 7:30 a.m. on July 25, since radiation levels were less than .1 mr/hr in the area. At this time it was agreed by Mr. Johnson and Mr. Lindberg that no further entries would be made to the process area, and that until specific plans had been agreed upon, no further activity would be allowed in the process area.

## Entry to the Process Area and Data Gathered

### A. Observations of Plant Status During First Planned Entry

In was agreed that an entry to the plant area would be made on July 2[illegible], 1964. Pictures were to be taken of the area and of the bottles stored in the area, but nothing was to be disturbed. United Nuclear people, using two polaroid cameras and one 35 millimeter camera with flash attachment, took a series of photographs, copies of which were to be made available to the AEC at a later date.

When the first entry was made, it was observed by W. G. Browne that one safe cart containing an 11 liter bottle was located just about 4' east and 3' south of the leaching hood 1-J-5B. The bottle was approximately half full of dark material which was probably uranium nitrate crystal. Solution had leaked from the bottle and formed a pool of greenish liquid on the floor. The tag on the 11 liter bottle said "Bottle X - Concentrated Liquor From the Evaporator". This notification was written on the back or yellow side of the tag. The tag was held on the bottle by a rubber band.

Five one gallon bottles were stored in a single row on the floor in the area bout 13' south of the wall by 1-J-5B. The first bottle was about 13' east from the end of the third product storage area wall. The second bottle was 21' east of the first bottle, the third bottle was 4½' east of the second bottle, the fourth was 6-3/4' from the third bottle and the last bottle was 5¼' from the fourth bottle.

Bottle No. 1 was about 7/8 full. Bottles 2 and 3 were 2/3 full, bottle 4 was 1/2 full, and bottle 5 was 1/4 full. The first 4 bottles contained about 2 to 3" of solids in the bottom of the bottle. Radiation readings about 3' from the first four bottles were 350 mr/hr. About 7½' east of bottle number 5 an 11 liter bottle was stored on the floor, not in a safe cart. About 4' east of the 11 liter bottle were four safe carts containing one 11 liter bottle in each cart. The first 11 liter bottle had a tag on it which said "Mop up from around 1-D-12 Pump." The other 4 bottles in the carts were tagged, "Concentrated Liquor from Precipitator - Has Been Filtered" signed LR, Bottle 11010 "ADU Filtrate," Bottle 11005, "Wash from Evaporator," signed LR, Bottle 11011, "OK Liquor that has been Filtered."

Immediately inside the doorway in the south west corner of the first floor tower room a tag was found on the floor underneath the stairs. This tag had an entry on the back of the tag which said bottle Y "ADU filtrate". A line was drawn under the statement ADU filtrate and "concentrated liquor from evaporator" was written below the line and signed LR. There were also two rubber gloves lying on the floor east of the tag partially under the stairwell. Neither of the gloves had any detectable beta-gamma radiation either on the inside or the outside of the glove. Against the south wall of the stairwell and opposite the door into the first floor of the tower room was an empty safe cart.

Standing at the door of the first floor of the tower room and looking north, 8 one gallon bottles could be seen located around the west, south and east side of the room with one bottle near the base of pump 1-P-32. Three empty gallon jugs were lying on their side and were about 3' west of pump 1-P-32. A tag was lying on the floor about 2' west of pump 1-P-32 and written on the yellow side was the statement "These two bottles are material taken from 1-D-5, probably a mixture of solvent and carbonate". (The latter notation was discovered after the tag had been picked up for examination several days later). On the orange or front side was written "Evaporator sample". A third tag was lying on the floor under the open well that goes from the first floor to the third floor in the north east corner of the room. The entry on the yellow side of this tag was "OK liquor from evaporator". The floor area immediately north of the third tag was covered with solution and yellow precipitate estimated to have been more than 1 gallon. The 1-C-9 column was half full of yellow precipitate and solution was within an inch or so of the overflow line that goes to 1-D-5. This column is 3" in diameter and about 8' tall.

On the second floor of the column room south of the two funnels and about 9' from the west wall there was a spill of solution and yellow precipitate on the floor. A hose running from a half inch line on the north wall, of the column room terminated in the funnel nearest to the north wall. On the third floor of the column room standing in the doorway and looking north, an 11 liter bottle was lying on the floor, just south of the platform for the sodium carbonate make up tank (1-D-11). Solution and precipitate covered a large area of the floor south west of the sodium carbonate tank, dried

yellow precipitate was observed on the fluorescent light fixture which is overhead and located halfway between the door from the stairwell and sodium carbonate tank. Yellow precipitate could be seen on the north wall of the well, at the third floor level. Solution had also been splashed on I beams that are located on the east side of the wall at both the third and 2nd floor levels.

The 11 liter bottle lying on the floor did not have a tag or rubber band on the bottle. Dirt on the bottle obscured the permanent identification, which was later discovered to be 11014. The 18" diameter sodium carbonate tank is 2' deep and has an open top. A lightning agitator 1-A-3 was attached to the northeast quadrant of the tank rim. It was observed that the tank was empty with only traces of yellow precipitate near the tank outlet. The valve on the bottom was open. A screwdriver was in a vertical position in the angle iron tank support that was on the south west quadrant of the tank. Nine inches north east of the tank was a hose clamp. On the floor, about 10' west-southwest of the tank was a putty knife. 174" southwest of the tank was some aluminum pipe insulation covering and a stainless steel hose clamp. All of these items were subsequently taken as samples for determining the number of fissions that occurred during the criticality.

C. Inventory of 11 Liter Bottles

On July 31, 1964 an inventory was taken of all the 11 liter bottles at the Wood River Junction Plant. A total of 36 bottles had been purchased. Three are missing and presumed to have been burned. Three new bottles are in the receiving area and have never been used. One bottle is located in the analytical laboratory. In the product storage area, the 3rd row from the foreman's office, there are two bottles, bottle #11003 with a tag reading "$HNO_3$ used to leach calciner ash" and one bottle labeled "TCE from wash column". In the fourth row from the foreman's office were the following eight bottles:

Bottle G - TCE at 680 ppm
Bottle 11006 - TCE from OK liquor wash column - 680 ppm
Bottle 11008 - TCE wash from evaporator
Bottle 11015 - ADU filtrate (signed GJS)
Bottle N - TCE at 680 ppm
Bottle 11002 - no tag
Bottle 11012 - no tag
Bottle F - washed TCE (signed RM)

In the fifth row from the foreman's office was one bottle, bottle #11001 - ADU dissolved in $HNO_3$ (signed Peabody).

The following ten bottles were stored about 14' east of the foreman's office and under storage tank 1-D-9A, seven were in safe carts and the other three were not. The bottles in the cart are:

Bottle X - (Identification sticker #12) - concentrated liquor from evaporator.
Bottle 11011 - (Identification sticker #10) OK liquor that has been filtered.
Bottle 11005 - (Identification sticker #9) wash from evaporator (signed LR.) The orange face of this tag says TCE wash from evaporator.
No Bottle # (Identification sticker #7) - tag says "Concentrated liquor from precipitator that has been filtered" (signed LR).
Bottle 11004 tag on top of bottle for sample #1029 says boiled TCE washed three times in carbonate. (Sample bottle was found lying on the floor).
Bottle 11013 - no tag, no identification.
No Bottle #, tag on bottle - wash from stainless steel dissolver filters - washed in $HNO_3$ and water. A second tag lying on the cart with sample #1125 written on the face - washing from stainless steel filters, washed in $HNO_3$ and water. Sample bottle #1125 was sitting on the edge of the cart.

The following three bottles were not in carts:

No Bottle # (Identification #6) mop up from around 1-D-12 pump.
Bottle 11010 - (Identification #8) ADU filtrate.
Bottle 11007 - stoddard solvent from precipitator (signed GJS).

One bottle was found on the first floor of the column room 2/3 full of liquid but with no bottle number or identification tag. Bottle 11014 was on the third floor of the column room and was not included in the 7/31 inventory but was later identified on 8/6/64. There were six bottles with no identification number and no tag, which were used as a drip catcher or to collect vent overflows from process equipment. One bottle was near the 1-D-13 tank. Three bottles were in the dissolver area, one bottle was on the 1-D-24A vent and one bottle was on the 1-D-24B vent.

Next Page 27

27

8-12-64

# INVESTIGATION OF CRITICALITY INCIDENT AT UNITED NUCLEAR CORP., WOOD RIVER JUNCTION, RHODE ISLAND, JULY 24, 1964 - INVESTIGATION DATA COLLECTED JULY 31 - AUGUST 6, 1964

by

H. W. Crocker

## Introduction

The operator's log, supervisor's log, operation sample log, laboratory log, and personnel testimony were reviewed in an attempt to locate and define the material used in the incident. This report summarizes the data collected by H. W. Crocker between 7/31/64 and 8/6/64, as part of the AEC investigation.

A review of the 1,1,1, trichloroethane (TCE) washing history shows that no written procedure was available for the standard TCE wash that was done in the 11 liter bottle. After July 17, 1964, at least two shifts were washing TCE in the unsafe geometry vessel 1-D-11. It is evident that at least 81-110 liters of TCE were treated in 1-D-11. It appears that all samples run by the shift supervisors are not logged in the sample book and therefore the TCE washes are not fully documented. They have dumped at least 7-11 liter bottles of washed TCE (3-36 ppm U) along the fenceline to kill weeds.

A review of records and testimony indicates that at least three and possibly four bottles of concentrator uranium solution and solids were generated in the evaporator plug incident. One bottle was reprocessed in the dissolver, one bottle of solids is still available (#12 - X) possibly another 11 liter bottle of solution is still intact. Analyses on the bottles are not complete, so this situation cannot be resolved at this time.

During the decontamination cleanup work it was discovered that plant personnel were transferring solutions (low ppm U by analyses) containing unknown solids from 1-gallon bottles into a 55-gallon barrel (Polyethylene lined) for storage. This operation was halted until a procedure was issued to provide separation and safe storage of the unknown solids.

A procedure for safe storage of decontaminated tile was prepared by UNC personnel.

(continued)

Mr. R. C. Johnson, Acting Plant Manager, discovered that uranium solids were not being stored according to license conditions. The materials in the storage area were separated by only 16-inch center to center instead of the required 32-inch center to center spacing. Calculations revealed the material to be safe. An application for license amendment has been submitted to DML. The bottles have been repositioned to comply with the 32-inch spacing limit until approval for the 16-inch spacing is obtained.

A review of the log data indicates: (1) that the personnel need more experience in pulse column operation; (2) management does not provide close supervision of the operations; and (3) part of the supervisory force possess only minimum qualifications and experience.

General Processing Operations

The operator's log and shift supervisor's log were reviewed in some detail. The following significant points were noted:

1. The primary problems at the plant appear to be in the pulse column operation.

2. The numerous changes in pulse frequency, pulse stroke and associated log entries without supporting explanation indicate the operators and supervisors may be somewhat deficient in pulse column operation knowledge.

3. There are no indications that the supervisor's log is reviewed by the plant manager.

Evaporator Incident

It appears that the bottle of solution used by Mr. Peabody originated from the evaporator plugging incident on Thursday, July 23, 1964.

The evaporator plugged on the 12-8 shift Thursday morning. On the day shift the evaporator was cleaned out and the cleaning operation was actually finished about 5:00 p.m. on Thursday. Significant points of the cleanout follow:

1. Approximately 5-6 liters of solution were sucked from the evaporator feed leg and put into an 11 liter plastic bottle. This bottle was not labeled. Mr. Roode filled this bottle. (See Attachment 7 for confirmation.)

(continued)

2. The bottom flange of the evaporator was removed and the crystallized uranium nitrate was recovered by a combination of chipping and live steam dissolution. (See Attachments 6, 7, and 8 for confirmation.)

3. During this plug cleanout, Mr. Roode filled another 11 liter bottle with solution and labeled it "Concentrated liquor from evaporator." Mr. Roode moved this bottle to the north in-process storage area, and placed three yellow stands around it. (See Attachments 7, 8 and 9 for confirmation.)

4. Mr. Kenyon filled one 11 liter bottle with half solution and half crystals. Mr. Kenyon labeled the bottle "Concentrated liquor from evaporator." (See Attachments 7 and 8 for confirmation.)

5. The cleanout of the evaporator was completed by Mr. Spencer at about 5:00 p.m., 7/23/64. Mr. Holthaus and Mr. Chapman stayed over from the day shift until the job was completed. (See Attachments 6, 7, and 8 for confirmation.)

6. There is a question as to whether Mr. Spencer put the final cleanout material in one of the Roode bottles, in the Kenyon bottle, or into another empty bottle. During his shift on 7/23/64, Mr. Spencer made a note in the operator's log which stated that the jugs on the floor in the precipitator area contain material from the evaporator cleanout. Mr. Spencer moved to Iowa on July 31, 1964. Another interview with Mr. Spencer might fully establish the disposition of the final evaporator cleanup material. (See Attachments 6, 7, and 8 for confirmation.)

7. It appears that Mr. Mastriani loaded part of the evaporator liquor into the stainless steel dissolver later on the 4-12 shift on 7/23/64. (See Attachments 9, 11, and 12 for confirmation.)

8. On 7/24/64, the 12-8 shift found unknown solution in the stainless steel dissolver, so Mr. Pearson transferred the solution into an 11 liter plastic bottle that was already half full (possibly Mr. Roode's first bottle). The material was analyzed and found to be 450 g/l in uranium. This shift then started reprocessing the material in 3 liter batches through the stainless steel dissolver. The first batch was almost finished at 8:00 a.m. (See Attachment 12 and previous testimony by Mr. Pearson for confirmation.)

(continued)

9. Day shift on 7/24/64 completed processing the 11 liters of evaporator concentrate in three additional batches. (See Attachments 9 and 12 for confirmation.)

10. It appears that some of the material put into the dissolver on 4-12 shift, 7/23/64, came from bottle #12 - X, which is now half full of crystals and is labeled "OK liquor from evaporator." This appears to be the bottle Mr. Kenyon filled on day shift of 7/23/64. (See Attachment 1 for confirmation.)

11. On 4-12 shift, 7/23/64, Mr. Spencer finished cleaning out the evaporator. Mr. Smith stated he believes Spencer only removed about four liters of material (solution mixed with solids) from the evaporator into a glass flask. He (Smith) does not know what Spencer did with the material, but believes it was transferred into the stainless steel dissolver later in the shift. When 4-12 shift started, there was an 11 liter bottle wired to the platform near the evaporator, but it has not been established that it was labeled. (See Attachment 11 for confirmation.)

12. Smith remembers seeing two bottles in carts on the safe track just south of the stainless steel dissolver on 4-12 (7/23/64) but does not know what they contained. (See Attachment 11 for confirmation.)

13. On 7/24/64, Smith talked to Chapman about foreign "black material" in the precipitator at 4:00 p.m., and the desirability of washing down the precipitator with TCE which was in two 11 liter bottles. Chapman stated he had an 11 liter bottle of solids (half full) from the evaporator which should go into the stainless steel dissolver. The bottle was in a cart just south of the stainless steel dissolver. (See Attachment 11 for confirmation.)

14. (4-12, 7/24/64) Smith told Peabody they would have to wash the precipitator with TCE. (See Attachment 11 for confirmation.)

(continued)

Washing Residual Uranium From Trichloroethane

An attempt was made to determine the methods used by the licensee in processing spent TCE.

Testimony by plant personnel indicate that no written procedure was available for TCE treatment, but that the following method was recognized as standard:

1. Put ~ 3 liters TCE in an 11 liter bottle.

2. Add ~ 6 liters of $Na_2CO_3$ solution (~12%).

3. Shake bottle to provide good aqueous - organic contact to strip the residual uranium from the TCE.

4. As necessary, pour into a 4 liter separatory funnel and drain the separated phases into 11 liter polyethylene bottles.

5. When separation is complete, sample the TCE, if analysis is < 100 ppm U, obtain permission to dispose of the material by a combination boil-off and calcination in the calciner. If analysis is > 100 ppm U rewash the material with fresh carbonate.

6. Sample the $Na_2CO_3$ in the 11 liter bottle, when analysis is received the material may be acidified and reprocessed under the supervisor's direction.

According to the Operator Sample Log (Attachment 3) about 140 liters of TCE were treated by this method between May 15, 1964 and July 16, 1964.

On July 17, 1964, J. Simas, an operator, told his supervisor, Mr. C. Smith, that the TCE wash procedure could be accomplished more efficiently if a complete 11 liter bottle was treated in the $Na_2CO_3$ tank (1-D-11) which had an agitator. Mr. Smith approved the method, providing wash of solutions containing < 750 ppm U. It appears that two supervisors, Mr. W. Pearson and C. Smith, gave approval to use this procedure which is as follows:

1. Add 22 liters $H_2O$ to tank 1-D-11. Add two scoops (four lbs.) of $Na_2CO_3$ and agitate.

2. Add 11 liters of TCE and agitate 45 minutes.

3. Shut off agitator, settle 5-10 minutes.

(continued)

4. Drain as required into empty tank 1-D-10 (the wash column). Allow phases to separate.

5. Drain the organic and aqueous into separate bottles. When full, sample and dispose or rework bottles according to the uranium content limits.

This procedure had not been approved by upper management. Tank 1-D-10 is a safe geometry vessel. Tank 1-D-11 is of unsafe geometry and is not authorized for SNM use.

A review of the Operator Sample Log and personal testimony (original testimony J. Simas) shows that approximately 200 liters of TCE has been treated between July 6, 1964 and July 24, 1964. Approximately 81-110 liters or more of TCE was processed in the 1-D-11 tank.

Most of the stripped TCE was disposed by boil-off and calcination but approximately seven 11 liter bottles were dumped along the fenceline to kill weeds. The uranium content of the TCE dumped along the fence varied from 3-36 ppm. Fenceline disposal is not authorized by license conditions.

Storage of Decontamination Solutions

At approximately 1:00 p.m. on August 1, 1964, W. Lorenz and myself were touring the plant processing area. While Mr. Lorenz was inspecting around the precipitator area, I walked over to observe an operation where an employee was handling a 1-gallon solution. There were a large number of containers (maybe 50) spaced at 24 inches edge to edge on the floor. These had been sampled, analyzed and were ready for storage. I asked the operator what he was doing with the bottles. He stated that he was pouring them into a 55-gallon storage barrel and that they were waste solutions. They were all $< 130$ ppm in uranium content. I noticed sludge in the bottom of many of the bottles, which was not being filtered out, and I told him to halt the operation temporarily. A supervisor, William Pearson came in the area and I told him that the sludge should be filtered off and only the filtrate (which had been sampled) poured into the barrel. I explained that there was no valid analysis on the sludge and to put this into the barrel with the liquid is a hazardous practice. He said that he had wondered about it, but had filled one barrel (22 bottles, each $\sim 3$ liters and $< 130$ ppm U).

(continued)

I requested that Mr. Pearson discontinue the operation until I contacted management. He agreed. I mentioned this situation to Lorenz as we went to the locker room. We met Mr. R. C. Johnson (Acting Plant Manager) and explained the situation to him. He recognized the hazard and discontinued the operation until a safe procedure was formulated for handling and storing the decontamination solution. Mr. S. F. Skowronek, UNC, prepared a procedure which included filtration of the material prior to storage of the filtrate in the barrels, and provided for safe storage of the solids residue until ready for dissolution and sampling. A copy of Mr. Skowronek's procedure is attached (Attachment 13). The one barrel that was filled should have then been filtered as done in the treatment of the 1-gallon bottles.

I recognize that the sludge associated with the decontamination incident will not contain much uranium except from the material cleaned in the tower areas and that the safety hazard is not great. However, to be sure of a safe system it is required that the filtration be done.

I felt that Mr. Pearson did not fully realize the importance of separating the solids when I first mentioned this to him. I felt that he had been told to transfer the solution from the 1-gallon bottles to the storage drums, accepted this instruction and proceeded without evaluating the hazard potential. Mr. Pearson was very cooperative in terminating the operation until the situation could be evaluated and proper handling methods issued.

Contaminated Tile Storage

Mr. Skowronek has prepared an acceptable procedure for storage of the contaminated tile that UNC plans to remove from the floors. This procedure is contained in Attachment 14.

Storage Area Noncompliance

At approximately 2:00 p.m. on August 4, 1964, Mr. R. C. Johnson told me that they have discovered a violation of their license in the inside storage area. The 1-gallon bottles are to be stored at 32-inch center to center distances on the storage shelves according to their license. However, the storage positions are actually only spaced at 16 inches center to center. The horizontal shelf rows are separated by 20 inches in the vertical dimension. The error in the license submission appears to be that Mr. Swallow (Criticality representative) used the distance between bolt mount centers for

(continued)

the shelves (32 inches) instead of the center to center distance between the SNM containers. Mr. Raber and Mr. Skowronek calculated a safe solid angle of 2.4 steradians for the existing storage array, which is still under the 3 steradians required for the system. I made a rough check calculation which confirmed theirs. Mr. Johnson stated that Mr. Swallow will apply for a license amendment immediately to cover this situation. I mentioned this matter to R. Chitwood of Headquarters when he called shortly after the talk with Mr. Johnson. On August 5, 1964, they began removal of alternate bottles from the storage row and placed them in another isolated storage row to provide the required 32 inches center to center spacing for compliance with the license until the amendment proposal is approved.

ATTACHMENT I

DATA COPIED FROM UNC OPERATOR'S LOG BOOK

The following data were copied from the UNC Operator's Log by H. W. Crocker between 9:08 and 10:00 a.m., on August 2, 1964. This Log Book is stored in the Supervisor's office.

| | | |
|---|---|---|
| 6/5/64 | (4-12) | I'm getting sick of doing all the wash - how about some one else doing it. --- Peabody |
| 6/8/64 | (4-12) | Changed Tri Chlor. --- Peabody |
| 6/9/64 | | Hand extracted TCE and sampled. --- Simas |
| 6/10/64 | (8-4) | Changed TCE and $Na_2Co_3$. --- |
| 6/12/64 | (12-8) | Changed $Na_2Co_3$. TCE removed and washed. --- |
| 6/16/64 | | Changed TCE and $Na_2Co_3$. --- Peabody |
| 6/30/64 | (12-8) | Changed TCE. --- |
| 7/1/64 | (12-8) | Changed TCE at 0400 and 0600 boiling off TCE emulsion in tray. |
| 7/1/64 | (8-4) | Finish boiling down TCE-TBP in tray dissolver. --- VON |
| 7/3/64 | | In process of separating TCE and TBP in columns. --- VON |
| 7/6/64 | (8-4) | Changed TCE @ 1530. --- Simas |
| 7/13/64 | (12-8) | Washed out 1-D-10's and evap. with TCE - washed out 1-D-19's. --- |
| 7/13/64 | (8-4) | TCE has been recycled through 1-D-10A-B. --- GJS |
| 7/13/64 | (4-12) | Finish draining evap. - has $H_2O$ and TCE. --- Mike |
| 7/14/64 | (4-12) | There is a mess of jugs, in extractor room. They are all labeled except two. The labeled ones came from 1-C-6 during the many floods we had today. They will have to be reworked when columns are in operation. --- Simas |

(continued)

| | | |
|---|---|---|
| 7/17/64 | (8-4) | Used 1-D-11 to wash TCE. Put in 1-11 L bottle TCE (full), 6 gal. $H_2O$ (2-11 L bottles), 2 full scoops (4#) soda. Allow to agitate 45 minutes and drain from $Na_2Co_3$ cock on second floor. Put only 3½ gal. into 1-C-10 and allow 20-30 min. to separate. Drain off and spl. --- Simas |
| 7/17/64 | (8-4) | It would seem to me that 4.5 ft. of concentrate is too much for the 1-D-19's, when precipitated, it all settled to the bottom and gave a lot of trouble getting out. No pump - no air- trouble. Better luck than I have had. --- GJSpencer |
| 7/20/64 | (12-8) | The four gallon jugs on tray $\bar{C}$ separator have had high ppm material in them and should be washed if used elsewhere. Started filling 1-D-21A @ 0630. Before that slop went into 11 L bottles as marked. System A - OK as presently set. Suggest continued use of same settings. --- Simas |
| 7/23/64 | (4-12) | The jugs in the precipitation area contain concentrate from the evaporator troubles. -- GJSpencer |
| | | SS diss. 16 L of conc. liq. from evap. is in SS diss. --- R. Mastriane |

ATTACHMENT II

DATA COPIED FROM UNC SUPERVISOR's LOG BOOK

The following data were copied from the UNC Supervisor's Log Book by H. W. Crocker between 10:00 - 11:00 a.m., on August 2, 1964. This Log Book is stored in the Supervisor's office.

| | | |
|---|---|---|
| 6/16/64 | (12-8) | More switching around of shifts requested but I have insisted that "qualified" personnel be on all shifts -- since we now have only three operators trained on the extractors, these three must be on different shifts. Once additional operators are trained, this situation will change. Should get Murphy and Aiello trained. --- Chapman |
| 6/16/64 | (4-12) | Changed TCE. |
| 6/19/64 | (12-8) | Boiled down some more TCE. |
| 6/24/64 | | Raschig rings were checked in 1-D-41.<br>N 7¼" )<br>E 7½" ) depth from top manhole.<br>S 7¼" )<br>W 6 3/4") |
| 6/29/64 | (12-8) | Took samples for inventory, 1-D-5, 1-D-12; 1 gal. bottles A; 11 L bottles 11011, 11005, 11002, 11010, 11001, 11007, 11003 and 11004 were previously sampled. 1 gal. bottle A was previously sampled. |
| 6/29/64 | (4-12) | Wrote in operator's log that goggles are required at all times by everyone in the P.L. adjusting room and pulse column room. --- Chapman |
| 6/30/64 | (8-4) | We are within 280 gms of U on total inventory. What's in bottle 11012? Bill knows for sure but I believe solution from work of Mg sulfate insulation. By my calculation over 800 gms to go on inventory.--- Chapman<br><br>Murphy splashed pickle liq. in left eye while sweeping foam. |
| 6/30/64 | (4-12) | Refigured inventory vs input and I came up with over 800 gms to go yet -- primarily cause ADU on 1st 11 pyro runs was only 66% U and not 68% U. |

(continued)

| | | |
|---|---|---|
| 7/6/64 | (12-8) | Bart: Gamma Alarm #836 is not working - pp't area. Changed TCE 0030. |
| 7/9/64 | (4-12) | No extraction to be done this week. --- Chapman |
| 7/10/64 | (8-4) | Installed a spl point at south end of SS dissolver. |
| 7/10/64 | (4-12) | Flushed 1-D-10's with TCE (1 gal /tk) intend to repeat. --- Chapman |
| 7/13/64 | (12-8) | Jury rigged an air bubbler to be inserted in the top of the scrub or strip acid tanks for mixing. Also set up transparent line for trans. from assay tank to feed tank. --- Chapman |
| 7/13/64 | (8-4) | 10 gal TCE added to evap. for recycle to 1-D-10's. |
| 7/13/64 | (4-12) | Finished flush with TCE. |
| 7/14/64 | (12-8) | Speaking of the dissolver, Murphy left the valve for the nitric acid addition line open and when pressure briefly applied to dissolver, $HNO_3$ was forced back, and overflowed the air gap. Two errors we should watch for in future. Drained TCE from evap. and 1-D-10's. --- Chapman |
| 7/14/64 | (4-12) | Washed TCE bottles. 11013, 11014 need rewash. |
| 7/16/64 | (12-8) | Would love to get a "kerosene" wash column installed prior to evaporator as a second chance for organic removal. |
| 7/16/64 | (4-12) | Found material in SS dissolver condensate tank and material spill on the roof around the spout. The tank was emptied and put back into the dissolver. When recirc. air was put on @ 35" carried over again. |
| 7/17/64 | (4-12) | Washed umpteen bottles of TCE. |
| 7/20/64 | (12-8) | Drained TCE. |

(continued)

7/22/64 (4-12) H. W. Crocker summary of false alarm evacuation at 1815 on 7/22/64:
At 1815 the Gamma alarm went off. Everyone evacuated to emergency shack, read the emerg. manual, took beta-gamma instrument, approached bldg - all readings low, into bldg - again all readings low. Only the alarm in pulse column room went off. Holthaus was called and informed, people returned to bldg 1835. Peabody had been hosing down pulse columns and evidently this water shorted out the alarm. The following items were indicated to be lacking at emergency shack:

(1) up-to-date phone numbers in emergency manual
(2) new telephone book
(3) bug bombs
(4) beta-gamma meter operation manual
(5) saw horse for NE road

The siren only lasted for 3 quick steps. The supervisor rechecked readings with the beta-gamma instrument at guard's desk, they confirmed the original low readings taken upon re-entry to the building.

NOTE:

(1) Only entry in supervisor's log by Holthaus dated 7/24/64 concerns a PRV on the evaporator and is addressed to all foremen.

(2) No evidence in supervisor's log (initials, etc.) to positively indicate that Mr. Holthaus reviews the log.

ATTACHMENT 3

DATA COPIED FROM OPERATION SAMPLE LOG RECORD NO. 1

The following data were copied from the sample log by H. W. Crocker on 8/3/64. This log is stored in the supervisor's office. The analytical results for specific samples are recorded in the last column and were copied from the analytical log book in the laboratory. Uranium content is in parts per million.

| Log No. | Sample By | Descriptions | Container | Disposal | Uranium Analysis (ppm) |
|---|---|---|---|---|---|
| 1-1-32 | CES | TCE from 1-c-10 | 11004 | Calcined | 7.7 |
| 1-2-13 | WRP | TCE | | Dumped at fence | 24 |
| 1-7-29 | CES | TCE | A-11 L | Refiltered | 34 |
| 1-8-10 | JS | TCE carbonate washed | A-11 L | Calcined | 0.7 |
| -22 | JS | TCE carbonate washed | 11007 | Calcined | 4.4 |
| -27 | WRP | TCE carbonate washed | 11014 | See 1-9-5 | 120 |
| 1-9-5 | JS | Rewash of 1-8-27 TCE | 110114 | See 1-9-11 | |
| -11 | WRP | Rewash TCE 1-9-5 | 11014 | Boiled & calcined | 104 |
| -25 | WRP | TCE from 1-c-10 | 11013 | 1-c-10 | 760 |
| -26 | JS | TCE & TBP | 11013 | Reworked | 40 |
| -28 | JS | TCE & TBP | 11011 | Reworked | 760 |
| -33 | GS | TCE | 11010 | Reworked | 360 |
| -39 | JRM | Washed Organic | #1 | | 6.8 |
| 1-12-9 | CEK | TCE from 1-c-10 | 11002 | Along fence | 6 |
| -24 | JS | Washed TCE | 11015 & 11018 | Along fence | 24 |
| -25 | WRP | Washed TCE | 11010 | Calcined | 8.2 |

## OPERATION SAMPLE LOG RECORD NO. 1

7/10/64

| Log No. | Sample By | Description | Container | Disposal | Uranium Analysis (ppm) |
|---|---|---|---|---|---|
| 1-13-1 | JS | Raff. slop below guage | 1-D-21A | 1-D-41 | 84 |
| -2 | JA | ADU Filtrate | 11002 | Refiltered | 175 |
| -3 | JA | ADU Filtrate | 11015 | 1-D-24B | <5 |
| -4 | CEK | Scrub solution from tank after bubbling | | | 0.06 N $HNO_3$ |
| -5 | JS | TCE left from 2d Friday | 11010 | Boiled & Calcined | 5 |
| -6 | JS | Scrub solution sample for titrate | 1-D-3 | | 0.06 N $HNO_3$ |
| -7 | GJS | ADU filtrate | | | 112 |
| -8 | JS | TCE from column | 11012 | Boiled & Calcined | |
| -9 | VON | ADU filtrate | 11014 | 1-D-24B | |
| -10 | VON | ADU filtrate | 11012 | 1-D-24B | |
| -11 | JA | ADU filtrate | 11006 | 1-D-24B | |
| -12 | JA | TCE rinse from evap. | 11008 | | |
| -13 | LR | TCE wash from evap. | 11012 | Washed in carbonate | 440 |
| -14 | LR | TCE wash from evap. | 11002 | Washed in carbonate | 540 |
| -15 | LR | TCE wash from evap. | 11010 | Washed in carbonate | 460 |
| -16 | LR | TCE wash from evap. | 11005 | Washed in carbonate | |
| -17 | LR | TCE wash from evap. | 11006 | Washed in carbonate | 600 |
| -18 | LR | TCE rinse from 1-D-10's | #E | Washed in carbonate - resampled | 100 |
| -19 | LR | TCE rinse from 1-D-10's | 11013 | Washed in carbonate - resampled | 600 |
| -20 | GJS | ADU filtrate | 11014 | 1-D-24B | <5 |
| -21 | JS | Carbonate sparged 3.25 N | SSB #4 | | 240 |
| -22 | GJS | TCE rinse from 1-D-10's carbonate washed | E | Calcined | 1.2 |
| -23 | GJS | TCE rinse from 1-D-10's carbonate washed | 11013 | Calcined | 3 |
| -24 | WRP | 1-D-24B sample 1.4 ppm | See tag on tank | | 1.4 |

| Log No. | Sample By | Description | Container | Disposal | Uranium Analysis (ppm) |
|---|---|---|---|---|---|
| 1-13-25 | VON | TCE of carbonate washed | 11013 | Rewashed | 280 |
| -26 | VON | TCE of carbonate washed | 11014 | Washed in carbonate | 194 |
| -27 | VON | Carbonate sample SS barrel #4 | SS #4 | | 660 |
| -38 | CEK | Carbonate sample SS barrel #4 | Bottle C | | |
| -39 | GJS | TCE washed in carbonate | 11006 | Rework | 360 |
| -40 | GJS | TCE washed in carbonate | F | Fenced | 6 |
| -41 | JS | Raff. slop 4" | 1-D-21A | Rework | 500 |
| -42 | GJS | TCE washed in carbonate | 11014 | Fenced | 2.8 |
| -43 | VON | Solvent washed in strip sol. | 11013 | Fenced | 48 |
| -44 | VON | Strip sol. washed through solvent | 11010 | Rework | 100 |
| -45 | JS | Raff. from column | 1-c-6 | | 60 |
| -46 | VON | Wash from $UO_2$ spill on roof | 2 of #69 | | 800 |
| -47 | JA | ADU filtrate | G | 1-D-24B | < 5 |
| 7/17/64 | | | | | |
| -48 | JS | TCE washed | 11007 | Rewashed | 720 |
| -49 | JS | TCE not washed JS #1 | | Rewashed | 760 |
| -50 | JS | TCE not washed | 11003 | Rewashed | 660 |
| 1-14-1 | JS | TCE not washed | 11014 | Reworked | 540 |
| -2 | RM | Wash from SS diss. filters | | | 700 |
| -3 | RM | Washed TCE | F | Reworked | 196 |
| -4 | JS | Washed TCE | 11012 | Reworked | 104 |
| -5 | JS | Carbonate C acid | Pickle liquor | | 740 |
| -6 | WRP | TCE washed | 11014 | Discarded by fenceline | 22 |
| -7 | WRP | TCE washed | | Discarded by fenceline | 20 |
| 7/20/64 | | | | | |
| -8 | VON | ADU filtrate | #V | 1-D-24B | 32 |
| -9 | VON | Washed TCE | 11016 | Fenced | 12 |
| -10 | VON | Washed TCE | 11007 | Fenced | 36 |

ATTACHMENT 3 (continued)



| Log No. | Sample By | Description | Container | Disposal | Uranium Analysis (ppm) |
|---|---|---|---|---|---|
| 1-14-11 | VON | Washed TCE | 11002 | | 21 |
| -12 | JS | High raff. | 1-c-6 | | 840 |
| -13 | CEK | Filtrate tank | 1-D-24A | Lagoon | 1.2 |
| -14 | CEK | Raff. (A) marked on card | A | SS diss. | 160 |
| -15 | CEK | Raff. (B) marked on card | B | SS diss. | 172 |
| -16 | CEK | Sample of OK liquor | | | 38,508<br>Fe 46 ppm/g U |
| -17 | CEK | ADU filtrate | N | 1-D-24's | |
| -18 | GJS | Stoddard sol. from pptator | N | Reworked | 800 |
| 7/21/64 | | | | | |
| -19 | GJS | Stoddard sol. from pptator | 11007 | Reworked | 144 |
| -20 | JS | Raff. sample | 1-c-6 | Reworked | 5.6 |
| -21 | VON | ADU filtrate | #V | 1-D-24B | 2.4 |
| -22 | JS | Washed TCE on 3-11 1 rework | F<br>11012<br>11002 | | 680 |
| -23 | JS | Raff. sample | 1-c-6 | | 40 |
| -24 | LR | ADU filtrate | 11010 | 1-D-24's | <5 |
| -25 | LR | Ovfl. from calc. scrubber | 2 gal. jugs | Waste treat tank | 8.2 |
| -26 | CEK | Raff. from Ext. column | | | 46 |
| -27 | LR | ADU filtrate | V | 1-D-24's | <5 |
| -28 | Pea. | Raff. from column | Sample only | | 1.8 |
| -29 | Pea. | Filtrate tank - 22 inches | 1-D-24B | 1-D-14B | 1.3 |
| 7/22/64 | | | | | |
| -30 | GJS | ADU filtrate | G | 1-D-24A | 10 |
| -31 | JS | Raff. sample | 1-c-6 | 1-c-6 | 62 |
| -32 | JS | Raff. slop | 1-D-21A | 1-D-41 | 4 |
| -33 | JS | Raff. sample | 1-c-6 | | 28 |
| -34 | CEK | Solvent going to wash column | Sample only | | 22 |
| -35 | CEK | ADU filtrate | V | 1-D-24A | 5 |

ATTACHMENT 3 (continued)



| Log No. | Sample By | Description | Container | Disposal | Uranium Analysis (ppm) |
|---|---|---|---|---|---|
| 1-14-36 | GJS | ADU filtrate | X | 1-D-24A | <5 |
| -37 | GJS | ADU Cleanup in $HNO_3$ | Z | | 700 |
| -38 | JS | Washed TCE | 1 gal. jug | Reused | 64 |
| -39 | JS | Raff. sample | 1-C-6 | 1-C-6 | 5 |
| -40 | JS | $Na_2CO_3$ barrel | | Stored outside | 740 |
| 7/23/64 | | | | | |
| 1-15-1 | | Raff. sample @ 0300 | 1-C-6 | | 28 |
| -2 | | SS diss. | 11011 | 450 g/ℓ | See log book |
| -3 | JS | Raff. sample 0730 | 1-C-6 | | 4.8 |
| -4 | | 1-D-24A filtrate 31½" tank | 1-D-24A | | 2 |

ATTACHMENT 4

## LOCATION OF 11 LITER BOTTLES IN THE IN-PROCESS STORAGE AREAS AFTER THE CRITICALITY INCIDENT

This data was obtained from Mr. L. Allison of UNC on August 5, 1964.

On the July 27, 1964 entry, the following data were obtained, and L. Allison (UNC) has the photographs for confirmation:

1. An empty cart for the 11 L bottle was found near first floor stairs of tower.

2. The empty 11 L bottle used by Peabody (and later removed from $Na_2CO_3$ tk) was found on floor next to $Na_2CO_3$ tk in third floor tower room.

3. Four 11 L bottles were in the north section in process storage area.

   a. bottle 11004, tag spl #1029 Oil-TCE washed three times in carbonate. NOTE: spl log shows this to be 680 ppm.

   b. bottle 11007 (not in cart) Stoddard solvent from pptator - GAS. NOTE: log 1-14-19 shows this to be 144 ppm.

   c. bottle 11013, no tag.

   d. bottle No.#, tag spl #1125 washes from SS diss. filters, washed in $HNO_3$ and $H_2O$. NOTE: spl log shows to be 700 ppm (1-14-2).

4. Five 11 L bottles were in the area by the stairs at the ADU precipitators.

   a. bottle #6, (not in cart), mop up from around 1-D-12 pump.

   b. bottle #7, conc. liquor from pptator that has been filtered. L.R.

   c. bottle #8 (not in cart), 11010 - ADU filtrate.
   wash from evaporator.

   d. bottle #9, 11005, wash from evaporator; TCE/NOTE: this bottle contains aq & org. spl 1-13-16.

   e. bottle #10, 11011, OK liquor that has been filtered.

5. One 11 L bottle, #12 - X (1-14-36) ADU filtrate OK liquor from evaporator, was located just south of the stairs to the upper dissolver level. This bottle is a leaker. ~ ½ full of crystals.

ATTACHMENT 5

INVENTORY OF 11 LITER BOTTLES IN THE RECOVERY PLANT ON JULY 31, 1964

This inventory was taken by W. G. Browne, A. Ryan, and H. W. Crocker on July 31, 1964.

11 Liter Bottles in Permanent Storage Area

1. No #, TCE from wash column.
2. #11003, $HNO_3$ to leach calcined ash.
3. #G, TCE @ 680 ppm. Previous entry on this tag was - 1-14 ADU filtrate.
4. #11006, TCE from OK liquor wash column, @ 680 ppm.
5. #11008, TCE wash from evaporator, sample #1-13-12.
6. #11015, ADU filtrate (EUS)
7. #N, TCE @ 680 ppm. NOTE: sample in log (#1-14-18) shows #N to be 800 ppm uranium.
8. #11002, no identification. NOTE: sample in log (#1-14-22) shows #11002, #11012, and #F to have 680 ppm uranium.
9. #11012, no identification.
10. #F, washed TCE (RM)
11. #11001, ADU dissolved in $HNO_3$ (WRP). NOTE: sample in log (#1-10-20) shows this to be 400 ppm uranium.

11 Liter Bottle in North Wall In-Process Storage Area

1. #12 - X, OK liquor from evaporator. NOTE: this bottle has about 5 liters of crystals in it.
2. #11011 - #10, OK liquor that has been filtered. NOTE: this bottle contains about 5 liters of solution.
3. #6, Mop up from around 1-D-12 pump. NOTE: this bottle contains about 4 liters of solution.

4. #11010 - #8, ADU filtrate. NOTE: this bottle is full of solution.

5. #11005 - #9, wash from evap. (LR) Tag is also labeled TCE wash from evap. NOTE: this bottle contains both organic and aqueous phases and is full.

6. #7, Concentrated liquor from precipitator that has been filtered. NOTE: this bottle is full of solution.

7. #11007, Stoddard solvent from precipitator (GAS). NOTE: this bottle is full of solution, sample 1-14-19 shows this to be 144 ppm uranium.

8. #11004, Oil - TCE washed three times in carbonate, sample #1029. NOTE: this bottle contains about 9 liters of solution, the sample taken on 7/6/64 shows the material to be 680 ppm uranium.

9. #11013, no identification. NOTE: this bottle was empty.

10. No #, washes from SS dissolver filter, washed in $HNO_3$ and $H_2O$, sample #1125. NOTE: this bottle is full of solution and by log 1-14-2 (#1125) contains 700 ppm uranium.

11. There were 5 - 11 liter plastic bottles used as receivers from the vessel vent-overflow headers. All of these were empty.

ATTACHMENT 6

D. CHAPMAN INFORMATION 11:00 - 11:10 a.m., 8/5/64

Mr. Chapman gave the following information to H. W. Crocker at 11:00 - 11:10 a.m. on 8/5/64:

Dale Chapman stated that he thought a total of three 11-liter bottles were filled during the evaporator cleanout on July 23, 1964. He said that Roode put the initial solution that was sucked out of the evaporator into an 11-liter bottle. Chapman doesn't know if the bottle was full. Later, on unplugging the evaporator, Roode and Kenyon filled two more 11-liter bottles. Chapman stated that he and Holthaus stayed over until around 5:00 p.m. to oversee the evaporator cleanout completion. Chapman said that Spencer finished the actual cleanout and he thought the last solution was put in one of the bottles Roode or Kenyon filled.

ATTACHMENT 7

L. ROODE STATEMENT 4:00 p.m., 8/5/64

Mr. Roode made the following statements in an interview with L. Allison (UNC) and H. W. Crocker at 4:00 p.m. on 8/5/64:

Leo Roode stated that he siphoned off one bottle of solution from the feed leg of the evaporator. He believes he filled at least ½ of the 11-liter bottle and maybe it was more than this. Mr. Roode stated he did not label the bottle -- it could have been charged into the dissolver. When cleaning the dissolver bottom, we filled two bottles (Kenyon & Roode). Roode labeled one of them "concentrated liquor from evaporator". Kenyon, he thinks, labeled his also. When they left at 4:00 p.m. Spencer took over to finish cleaning the evaporator. Roode states that his bottle from the evaporator bottom cleanout was all solution.

ATTACHMENT 8

MR. KENYON'S INTERVIEW, 4:15-6:40 p.m., 8/4/64

The following notes were taken by H. W. Crocker during Mr. Ryan's interview with Mr. Kenyon.

Mr. Kenyon was working days on 7/23 and 7/24. Dale Chapman was his supervisor.

Messrs. Roode and Kenyon cleaned out the evaporator. They sucked the liquid out of the evaporator feed leg and Mr. Roode took the liquid for storage. Mr. Kenyon doesn't know where Roode took the liquid for storage nor how much liquid was in the feed leg. They took off the bottom evaporator flange and found it to be plugged. Mr. Chapman and Mr. Holthaus were present during the evaporator cleanout.

Kenyon stated that he and Roode flushed the evaporator with steam to unplug the crystals. The material was put into 2 - 11 liter polyethylene bottles. Roode labeled one of the bottles "Concentrated liquor from the evaporator", and he believes Roode labeled the other one. He stated both bottles were placed in portable storage racks. There was still material left in the evaporator when Kenyon and Roode went home. Roode stated that his 11 liter bottle contained about half and half crystals and solution. He believes that Roode's bottle also contained some crystals. He stated that Roode put posts around the bottle he took from the evaporator. Kenyon stated that he was told by Mr. Allison (at 1:00 p.m., 8/4/64) that Spencer finished the evaporator cleanup on 7/23/64.

Mr. Kenyon said that when he arrived for day shift on 7/24/64 that the evaporator had been reassembled. Kenyon worked at the pulse columns on 7/24/64. He stated that Mr. Aiello was on the stainless steel dissolver and Mr. Roode was on the precipitators on 7/24/64. Mr. Kenyon said he did not see any bottle labels on the floor on 7/24/64.

ATTACHMENT 9

MR. AIELLO'S INTERVIEW, 4:45 p.m., 8/5/64

The following notes were recorded by H. W. Crocker during Mr. Ryan's interview with Mr. Aiello:

Mr. Aiello said he has not operated the columns, nor washed TCE, and does not know the method for washing TCE. He stated that Charlie Kenyon and Leroy Roode cleaned out the evaporator. Mr. Holthaus and Chapman were also there during the cleanout on 7/23/64. Mr. Aiello worked on the SS dissolver during that shift. He was processing $UO_2$.

Mr. Aiello was on day shift (8 - 4) on 7/24/64. He worked on the SS dissolver. He processed 3 batches of solution from evaporator cleanout, and got the solution from an 11 liter bottle. He used a gallon bottle (marked at 3 L) for the transfer from the 11 L bottle to the dissolver. Murphy processed 1 batch on 12 - 8 (7/24/64). And Aiello finished his batch. The concentrator batches Mr. Aiello processed from the 11 L bottle were all solution. He said he started another batch in the dissolver near the end of the shift, this was $UO_2$. Another bottle from the evaporator was nearby that was ½ full of crystals and had no solution. "I (Aiello) checked with Chapman and he said to leave this alone and run a batch of $UO_2$, and this is what I did. The bottle I processed was in a dolly in the "safe way", the ½ bottle of crystals was also there (just south of the SS dissolver). I believe the 11 L bottle I processed was removed by Leroy Roode after it was emptied." On Thursday day shift, Roode put one 11 L bottle in the north in-process storage area and placed 3 yellow stands around it (no rope was used). He said Roode told him it was highly concentrated material.

ATTACHMENT 10

W. PEARSON INFORMATION 5:00 p.m., 7/31/64

At approximately 5:00 p.m. on 7/31/64, Mr. W. Pearson, a supervisor, gave the following information to H. W. Crocker:

Mr. Pearson stated that trichloroethane is used in place of trichloroethylene in the process because it is less toxic. He also stated that trichloroethane (TCE) is charged in a batch to column 1-C-10 and that the aqueous product liquor bubbles up through the TCE continuously to remove traces of organic solvent from the product.

ATTACHMENT 11

MR. C. SMITH INTERVIEW, 11:00 a.m., 8/6/64

The following notes were recorded by H. W. Crocker during Mr. Ryan's interview with Mr. C. Smith on 8/6/64.

Mr. Smith stated he came in on evening shift on 7/23/64. He had Mr. Spencer finish cleaning out the evaporator. Spencer removed less than four liters of material from the evaporator. Mr. Smith does not know where the material was put, but believes Mr. Mastrioni loaded it into the stainless steel dissolver later in the shift. Mr. Smith noted that one 11 liter bottle was wired to the evaporator platform when he arrived on shift. He stated that he did not know if it was labeled. He also recalls seeing two 11 liter bottles in carts in the "safe track" to the south of the evaporator. Mr. Smith does not know what was in the bottles or if they were labeled.

On 7/24/64 when Mr. Smith arrived at work, he and Mr. Chapman discussed the ADU precipitation problems which included a planned TCE flush of the precipitator. The TCE was stored in two 11 liter bottles. Mr. Smith told Mr. Peabody that they planned to wash the precipitator with TCE, and that they might have to shut down the columns because the 1-D-10A and 1-D-10B tanks were filling up.

Mr. Smith stated that he authorized Mr. Simas to wash TCE in the 1-D-11 tank. Mr. Smith assumed that he had authority to approve the use of the procedure.

ATTACHMENT 12

DISSOLVER

Operating Report

Apparently should be dated 7/23 or 7/24 Murphy's operations were done end of 12-8 shift Fri a.m.

Job Symbol Rawark

Enrichment 93%

Diss, however, actually loaded by Mastriani 7/23 Note by WL Allison 8/3/64

Date 7/22/64

Batch Number 37

I. Weight Check

| Scrap Container No. | Material Description | Supplier's Net Wt. ( ) | Our Weights ( ) Gross | Tare | Net | Initials Oper. | Supr. |
|---|---|---|---|---|---|---|---|
| | CONC. LIQ FROM EVAPORATOR | | | | | RM | |
| | | | | | | | |
| | | | | | | | |

II. Dissolver Charge

| Material Charged | Weight or Volume Chgd. | Time Charged Start | Finish | Oper. Initials | Comments |
|---|---|---|---|---|---|
| Conc. liq. | 32 L | 0735 | 0740 | JTm | 1.45 Kgs of U |
| $H_2O$ | 41 L | 0740 | 0755 | JTm | |
| $HNO_3$ | 6 L | 0755 | 0700 | JTm | |
| | | | | | |

III. Dissolution and Adjustment (" = time)

Operator

Circulation Started at 0755" — JTm

Steam Added to Heating-Cooling Coil at 0700" — JTm

Dissolver Solution Temperature 158 °F at 0736" — JTm

— °F at ____" ____

— °F at ____" ____

Water to Heating-Cooling Coil at 0734" — JTm

5.0 of Aluminum Nitrate added at 0735" — JTm

Dissolver Solution Initial Excess Acid -- ____N ____

Ammonia Addition

____ cfh from ____" to ____"

Excess Acid = ____ N ____

____ cfh from ____" to ____"

Excess Acid = ____ N = Final Excess Acid ____

Cooling Finished at 0800" Solution Temperature = 110 °F — JTm

Filtration Started at 0815" and finished at 0915". — JA

IV. Comments

Level on $HNO_3$ 1-D-27 Tank is 26L

65,850 Kgs to 1-D-9-A-B+C

DISSOLVER

ATTACHMENT 12

Operating Report

Job Symbol Rework

Date 7-24-64

Enrichment 93%

Batch Number 38

I. Weight Check

| Scrap Container No. | Material Description | Supplier's Net Wt. ( ) | Our Weights ( ) Gross | Tare | Net | Initials Oper. | Supr. |
|---|---|---|---|---|---|---|---|
| Conc. Liq. | | Recom | Evaporator | | | CA | |
| | | | | | | | |
| | | | | | | | |

II. Dissolver Charge

| Material Charged | Weight or Volume Chgd. | Time Charged Start | Finish | Oper. Initials | Comments |
|---|---|---|---|---|---|
| Conc. Liq. | 3 L | 0950 | 0955 | | |
| H2O | 41 L | 0955 | 1000 | | |
| HNO3 | 6 L | 1005 | 1010 | | |
| | | | | | |

III. Dissolution and Adjustment (" = time)

Operator

Circulation Started at 1000 " — CA

Steam Added to Heating-Cooling Coil at 1000 " — CA

Dissolver Solution Temperature 190 °F at 1040 " — CA

_____ °F at _____ " —

_____ °F at _____ " —

Water to Heating-Cooling Coil at 1045 " — CA

5 KG of Aluminum Nitrate added at 1055 " — CA

Dissolver Solution Initial Excess Acid = _____ N —

Ammonia Addition

_____ cfh from _____ " to _____ "

Excess Acid = _____ N —

_____ cfh from _____ " to _____ "

Excess Acid = _____ N = Final Excess Acid —

Cooling Finished at 1105 " Solution Temperature = 140 °F — CA

Filtration Started at 1110 " and Finished at 1125 " — CA

IV. Comments

58.670 KG to 1-D-9 A+B+C

DISSOLVER

ATTACHMENT 12

Operating Report

Job Symbol Lenore

Enrichment 93%.

Date 7-24-64

Batch Number 39

I. Weight Check

| Scrap Container No. | Material Description | Supplier's Net Wt. ( ) | Our Weights ( ) Gross | Tare | Net | Initials Oper. | Supr. |
|---|---|---|---|---|---|---|---|
| Conc. | Liq. from Evaporator | | | | | DA | |
| | | | | | | | |
| | | | | | | | |

II. Dissolver Charge

| Material Charged | Weight or Volume Chgd. | Time Charged Start | Finish | Oper. Initials | Comments |
|---|---|---|---|---|---|
| Conc. Liq | 3 L | 1130 | 1135 | DA | |
| H2O | 41 L | 1135 | 1145 | DA | |
| "HNO3 | 16 L | 1145 | 1150 | DA | |
| | | | | | |

III. Dissolution and Adjustment (" = time)

Operator

Circulation Started at 1145" DA

Steam Added to Heating-Cooling Coil at 1145" DA

Dissolver Solution Temperature 175 °F at 1240" DA

_____ °F at _____"

_____ °F at _____"

Water to Heating-Cooling Coil at 1245". DA

5 KG of Aluminum Nitrate added at 1255" DA

Dissolver Solution Initial Excess Acid = _____ N

Ammonia Addition

_____ cfh from _____" to _____"

Excess Acid = _____ N

_____ cfh from _____" to _____"

Excess Acid = _____ N = Final Excess Acid

Cooling Finished at 1305" Solution Temperature = 125 °F DA

Filtration Started at 1310" and Finished at 1335" DA

IV. Comments 59.330 TO 1-D-9 A+B+C

ATTACHMENT 12

DISSOLVER

Operating Report

Job Symbol Pewee

Date 7-24-64

Enrichment 93%

Batch Number 20

I. Weight Check

| Scrap Container No. | Material Description | Supplier's Net Wt. ( ) | Our Weights ( ) Gross | Tare | Net | Initials Oper. | Supr. |
|---|---|---|---|---|---|---|---|
| Conc. Liq. from | Evap. | | | | | DA | |
| | | | | | | ✓ | |
| | | | | | | | |

II. Dissolver Charge

| Material Charged | Weight or Volume Chgd. | Time Charged Start | Finish | Oper. Initials | Comments |
|---|---|---|---|---|---|
| Conc. Liq. | 3 L | 1340 | 1345 | DA | |
| H2O | 41 L | 1345 | 1355 | DA | |
| Urea | 1.L | 1355 | | DA | |
| | | | | ✓ | |

III. Dissolution and Adjustment (" = time)

Operator

Circulation Started at 1355" — DA

Steam Added to Heating-Cooling Coil at 1355" — DA

Dissolver Solution Temperature 155 °F at 1425" — DA

_____ °F at _____" —

_____ °F at _____" —

Water to Heating-Cooling Coil at 1430". — DA

5 KG of Aluminum Nitrate added at 1430" — DA

Dissolver Solution Initial Excess Acid = _____N —

Ammonia Addition

_____ cfh from _____" to _____" —

Excess Acid = _____ N —

_____ cfh from _____" to _____" —

Excess Acid = _____ N = Final Excess Acid —

Cooling Finished at 1435" Solution Temperature = 140 °F — DA

Filtration Started at 1440" and Finished at 1500" — DA

IV. Comments

60.330 To 1-D-9-A+B+C

ATTACHMENT 13

| | | |
|---|---|---|
| R. A. Holthaus | Wood River | 3 August 1964 |
| S. F. Skowronek | Wood River | USAEC file |

Consolidation, Analysis and Handling of Solutions Generated in The Decontamination Effort

The Procedure which shall be used to consolidate solutions, generated during the decontamination, which are presently stored in one gallon bottles at two foot edge to edge spacing on the floor is as follows:

1) Solutions will be acidified and vacuum filtered into a 4 liter flask. Only one gallon bottle in use at one time. (safe volume)
2) Solution will be transferred into 11 liter, 5" diameter bottle. When this liquid level is almost to the top, the 11 liter bottle will be hand agitated and sampled. Bottle and sample will be labelled.
3) Uranium concentration and grams of U per 11 liter bottle will be determined.
4) If the concentration of U is $\leq$ 3 grams per liter, solutions will be transferred into a polyethylene lined 55 gallon drum. No more than 350 grams $U^{235}$ will be allowed per drum.
5) When drum contains 350 grams or less, it will be closed, monitored for radiation and placed in outside storage. Each drum will have a radiation decal and will be identified as to U content, and radiation at the surface.
6) Filters and entrapped solids generated in this operation will be considered hot waste and will be stored in a one gallon container. No more than 400 grams of material will be placed in a single container.
7) The responsibility for proper transfer and identification shall rest with the Shift Supervisor.

S. F. Skowronek

S. F. Skowronek

SFK/pt

ATTACHMENT 14

P. Clemons Wood River 4 August 1964

S. Skowronek Wood River

Packaging limits for the tile removed from floors.

A sample tile, which visually indicated the worst contamination found was analyzed for Uranium. It was found to contain 0.94 grams of total Uranium or 0,884 grams $U^{235}$ assuming full enrichment.

Using as maximum allowable $U^{235}$ content of 350 grams per drum, 395 tiles are allowed par drum. The weight of a single tile plus mastic as found is about 380 grams. Allowed net weight of removed tiles per drum is therefor set at 150 Kg or 330 pounds.

Drums containing up to 330 lbs. of removed tiles should be sealed and may be stored outside if they are protected from in leakage of water.

Since maximum $U^{235}$ density is less than 6 gms per Liter even at full tile packing, no surface to surface separation is required.

S. Skowronek

S. Skowronek

SS/pt

# ATTACHMENT #15

## VESSEL NOMENCLATURE FOR WOOD RIVER JCT. PLANT, (UNC).

| VESSEL | DIMENSIONS | CAPACITY GAL. | MAT'L. | TITLE |
|---|---|---|---|---|
| 1-D-1 | 8'-6"D x 12'-0"L | 5,000 | 304L | $NH_4OH$ STORAGE |
| -2 | 24"D x 30"L | 55 | " | $NH_4OH$ HEAD TK. |
| -3 | 48"D x 54"L | 400 | " | SCRUB TK. |
| -4 | SS BUCKET FOR | | | $Al(NO_3)_3 \cdot 9H_2O$ |
| -5 | 24"D x 45"L | 80* | 304L | SOLVENT FEED |
| -6A | | | | |
| -6B | 48"D x 54"L | 400 | " | STRIP ACID TK. |
| -7 | | | | OK LIQ SURGE TK. |
| -8 | | | | LIQ. WASH TK. |
| -9A | | | | |
| -9F | 5"D x 45'-0"L | 45 | 304L | HOLD TKS. |
| -10A | | | | |
| -10C | 5"D x 60'-0"L | 60 | " | OK LIQ. STOR. TKS |
| 11 | 18"D x 24"L | 20 | " | $Na_2CO_3$ WASH T.K. |
| 12 | 30"D x 30"L | 90 | " | RAW LIQUOR TK |
| 13 | 5"D x 10'-0"L | 10 | " | WASH TK. |
| 14A | | | | |
| 14B | 4'-6"D x 6'-6"L | 750 | " | WASTE TK. |
| 15 | | | | SOLVENT SURGE TK. |
| 16 | 5"D x 45'-0"L | 45 | " | OK LIQ. STOR. TK. |
| 17 | | | | SOLVENT WASH TK. |

* PACKED WITH RASCHIG RINGS.

# ATTACHMENT #15

| VESSEL | DIMENSIONS | CAPACITY GAL. | MAT'L | TITLE |
|---|---|---|---|---|
| 1-D-19 A-C | 4"D X 8'-0"L | 5 | 304L | PRECIPITATOR |
| -20 A-D | 5"D X 8'-0"L | 8 | " | " " |
| -21 A,B | 6'-6"D X 5'-0"L | 1200* | " | SLOP TK. |
| -24 A,B | 48"D X 5'-6"L | 500* | " | FILTRATE TK. |
| -27 | 12"D X 33"L | 12 | " | $HNO_3$ GAGE TK. |
| -28 | 4'-6"D X 4'-6"L | 500 | " | AMN MAKE-UP TK. |
| -29 | 8'-6"D X 12'-0"L | 5,000 | " | $HNO_3$ STOR. TK. |
| -30 | 10"D X 12"L | 4 | MONEL | HF GAGE TK. |
| -31 A,B | 2'D X 2'-6"L | 55 | 304L | RAFF. SURGE TK. |
| -34 A-C | 5"D X 10'-6"L | 10.5 | " | ASSAY TK. |
| -35 | 1'-6"D X 3'-0"L | 40 | PVC | HEAD TK. |
| -36 | 5"D X 8'-0"L | 8 | 304L | TRAY DISS. STOR. TK. |
| -41 | 6'-6"D X 7'-0"L | 1500* | " | EXTRACT. FD. TK. |
| -42 | 1'-6"D X 4'-0"L | 55 | " | REAC. SPRAY COOLER |
| -43 | 5"D X 8'-0"L | 8 | " | MISC. SOLN. HOLD TK. |
| 1-E-1 | 5"D | | " | CONDENSER |
| -2 | | | " | OK LIQ. EVAP. |
| -7 | 5"D | | " | DISS. VENT COND. |
| 1-F-2 | | | | ADU FILTER |
| -4 | 14"D X 3"L | | 316 | ADU PRESSURE FILTER. |

# ATTACHMENT #15

| VESSEL | DIMENSIONS | CAPACITY GAL. | MAT'L | TITLE |
|---|---|---|---|---|
| | | | | |
| 1-F-6 | 21"x21"x 1¾" | | KEL-F | DISS. TRAY FILTER |
| -15 | 5"D | | 316 | POLISHING FILTER |
| 1-H-1,38 | 12"x13"x 13" | | SS | CAKE DRY OVEN |
| -3, | 7"D x 48"L | | | VERT. TUBE FURNACE |
| -6 | 8"x8"x16" | | | MUFFLE COOLER |
| -7 | 10¾"D x 36"L | | | HEAD ENDS CALCINER |
| 1-J-1 | | | TEF. SS | TEFLON DISS. |
| -4 | | | 304L | UNLINED DISS. |
| 5 A,B | 26"x26"x1¾" | | KEL-F | TRAY DISS. |
| 6 | 26"x26"x1¾ | | 11 | SOL'N. FILTER |
| 1-C-1 | | | | MIXER SETTLER |
| -6 | | | | EXTRACTION COL. |
| -7 | | | | SCRUB COL. |
| -8 | | | | STRIP COL. |
| -9 | | | | SOL. RECOV. COL. |
| -10 | | | | WASH COL. |

NEXT PAGE 36

Evaluation of Health Physics Program at United Nuclear Corporation Facility, Wood River Junction, Rhode Island

A. Responsibilities for Health Physics Program

Elmer Barton stated that he is the only health physics representative at United Nuclear's Wood River Junction, Rhode Island plant. He stated that he reports directly to Richard Holthaus, the Scrap Plant Superintendent. He described his duties as follows: He is responsible for administration of the health physics program at the Wood River Junction facility. He operates in accordance with "The Health Physics Manual", dated December 1, 1963, prepared by L. J. Swallow, Operations Control Manager at United Nuclear Corporation's Hematite Plant, St. Louis, Missouri. He is also responsible for the administration of the plant safety program. In the area of nuclear safety and criticality his responsibility is limited to a visual check of the spacing of containers of U-235 and a review of the operator's activities, which he performs by reviewing the foreman's log, visual observation, and personal contact with the foremen.

He stated that with regard to health physics, his major problem is alpha contamination. He collects air samples, water samples, monitors areas for contamination, both by taking smears and performing instrument surveys. He collects urine samples periodically, changes film badges and sends the film to Landauer for analysis, conducts environmental surveys, provides and maintains instruments for personal contamination monitoring, prescribes protective clothing and sees that it is worn, and is responsible for seeing that building procedures with respect to health physics problems are followed. He monitors incoming and outgoing shipments. He gives advice on proper handling of radioactive material and decontamination procedures, both personnel and area.

He stated that he has been provided only with portable radiation detection instruments. For evaluation of water, air, and contamination samples, he said that he must send the samples to New Haven for analysis. He said that analysis is performed at his request by John Geil, health physicist at United Nuclear Corporation's Fuel Division Plant at New Haven.

Barton said that when he has recommendations or questions concerning building procedures, the process, or health physics equipment problems, he brings them directly to Holthaus. He also stated that he is consulted by Holthaus if a process change should occur. He said that if he and Holthaus disagreed, on a process change, and Holthaus persisted, he would not hesitate to take the matter further to Mr. Johnson or Mr. Lindberg.

Barton stated that he turns to John Geil for technical assistance and counting of samples. He again stressed the fact that he does not work for Geil.

Holthaus stated that ultimate health physics responsibility at the Wood River Junction plant lies with him as Scrap Plant Superintendent. He said that Barton was quite enthusiastic in performance of his duties. He said that ultimate responsibility for health physics lies with L. J. Swallow, who actually wrote the health physics procedures and prescribed the instruments. He would be consulted in the event of a serious disagreement on procedures according to Holthaus.

The inspector noted that in the licensee's application for a special nuclear material license dated November 27, 1963, section 205.2.3 specifies that the Supervisor, Nuclear Safety and Health Physics must have a B.S. in Engineering or Chemistry as well as training in an AEC contract or licensed facility, with specialized courses in nuclear safety and health physics. As Barton does not meet the educational requirements and Geil has no administrative responsibility for this plant, ultimate responsibility for health physics at this plant lies with Swallow.

John S. Geil stated that he provides health physics technical support on request only. He stated emphatically that he had no administrative responsibility for the Wood River Junction facility. He stated that he is a Health Physics and Safety Specialist at the United Nuclear Corporation Fuels Division at New Haven, Connecticut. He heads a section composed of five people. He stated that he performs counting services for Barton in evaluating air, water and contamination samples. He stated that he sends copies of the sample results to Barton by mail unless he finds one that exceeds limits at which time he calls Barton and gives him the information via telephone.

B. Training and Education of Health Physics Personnel

(Additional information concerning training was obtained in interviews conducted by A. F. Ryan, Investigation Specialist, in conjunction with his investigation of the incident.)

Barton stated that he attended Lynden Teacher's College, Lynden, Vermont for two years. In February 1958 he began work at the United Nuclear Corporation, New Haven plant which at that time was affiliated with Olin Mathieson. For the period 1958 - 1962 he was employed in the Accountability and Materials Control Section under the supervision of Charles Joseph, Superintendent, Materials Control. This section also included Health Physics. During the period he became familiar with various aspects of handling special nuclear material including shipping, monitoring, construction of various types of criticality vessels, particularly storage vessels and "bird-cages". He also worked in the metallurgical lab becoming involved in enriched uranium processes.

Barton stated that in June 1962, when United Nuclear took over the plant, the Accountability Section became separated into two groups, and Barton became a Health Physics Technician. His supervisor was John Geil, and he remained in the Health Physics Section until February 1964, when he was transferred to Wood River Junction, Rhode Island, as health physics representative.

Barton stated that during the period June 1962 - February 1964, he had participated in all phases of the health physics program. His training has been mainly the "on-the-job" type. According to Geil he demonstrated proficiency in all phases of the health physics program with two notable exceptions. Although he has operated both alpha and beta-gamma counting systems, and can make minor repairs, his responsibility has ended with the recording of the samples in terms of dpm. He has not as yet learned to make the calculations necessary for converting these results to more meaningful units, such as uc/ml or uc removable contamination.

Barton stated he had not been required to become familiar with the requirements of the Code of Federal Regulations, particularly parts 20 and 70, prior to his arrival at Wood River Junction, and was admittedly quite vague as to their content. However, he has had experience in a licensed facility involved in handling enriched uranium, and the Health Physics Manual has been written in accordance with Code of Federal Regulations requirements. Barton has combined elements of both the "Health Physics Manual" written by Swallow and the health physics procedures in effect at the New Haven plant to prepare his own work manual.

John Geil said that he has a B.S. in physics and was graduated from the AEC Fellowship Program in 1951. He participated in this program both at the University of Rochester and Brookhaven National Laboratory. From 1951 - 1955 he said he was a health physicist at the Army Chemical Center, Edgewood, Maryland. When he left he was the Chief,Health Physics Section. He stated he then held a position at the Glenn L. Martin Company (now Martin-Marietta) as Chief Health Physicist from April 1955 to October 1957, at which time he joined Olin Mathieson where he has remained ever since. He has set up the health physics program there, and indicated that it was quite similar to what has been set up at Wood River Junction, Rhode Island.

C. Routine Health Physics Program

1. Personnel Protection

a. Film Badges

Barton said that film badges are supplied by Landauer and are changed on a bi-weekly basis. Film badges are collected and changed by Barton. Films are evaluated for beta-gamma exposure only. The inspector noted that the badge holder was provided with an indium foil, used as an emergency monitor in the event of a criticality incident. (Foils from the badges involved in the incident were evaluated at HASL, and Idaho Falls, and the results appear elsewhere in the discussion of the incident).

Records of film badge results were examined for the period from March 5 through July 21, 1964. All exposures were noted as "Minimal". Landauer claims a minimal sensitivity of 10 mrem. He stated that there are no criticality or personal neutron dosimeters provided at the facility, nor have neutron film badges been provided.

b. Urinalysis

Urine samples are collected as part of a pre-employment physical. All personnel submit samples. Barton stated that from March through July, samples were analyzed for natural uranium. A fluorometric analysis was performed by Nuclear Science and Engineering Corporation according to Dr. A. Edelmann, Vice President of Nuclear Science and Engineering Corporation, and consultant to United Nuclear.

Barton said that all operators and technicians submit samples monthly during process. Supervisory and technical personnel and guards submit samples twice a year. All other personnel, such as secretaries and janitors, submit samples quarterly. Barton said that henceforth analyses are to be performed specifically for enriched uranium.

Dr. A. Edelmann stated that urine samples for people involved in the incident are currently being analyzed for both enriched uranium and gross fission products.

Records of the results of analyses of urine samples submitted for March through June were examined. It was noted that in March the highest analysis was .006 mg/l. In April the highest was .003 mg/l. For May the highest total was .003 mg/l, and for June all results were recorded as less than .001 mg/l. It was noted that different operators had submitted the highest sample each time. (Results of urinalyses conducted on people involved in the incident are located elsewhere in the part of the report covering the incident).

c. Medical Examinations

Barton said that each individual received a medical examination prior to beginning work. The examinations are performed annually thereafter and prior to termination. The examinations are also performed on workers as considered necessary, according to Holthaus. He said that this would be in case of accident or radiation exposure.

d. Personnel Monitoring and Contamination Control

Barton said that change room procedures are in effect at United Nuclear. All personnel are required to wear special protective clothing on the "Hot Side" of the change area. He said that normal protective clothing at this plant consists of coveralls and safety shoes or shoe covers. Rubber gloves, extra shoe covers, caps, respiratory protective equipment are prescribed on an "as needed" basis. Personnel are required to monitor themselves for contamination before they leave the process area. Hands are washed as a matter of routine at this time. Present in the change area for hand monitoring is an Eberline Model AHM-10 monitor. If this should become inoperable, an Eberline Model PAC-3G is supplied for monitoring purposes according to Barton.

He said that showers are available and are used if there is a reason to suspect personal contamination. Various cleaners, scrub brushes, and the standard potassium permanganate and sodium bisulfite solutions are available for decontamination. Barton said that there have been at least three occasions when personnel decontamination has been necessary, although levels of personal contamination have always been below 1000 cpm as detected by the monitoring equipment.

Procedure XI, paragraph 2(a) of the Health Physics Manual entitled "Contamination Control" states, "Full face air line masks may be used in certain limited applications that have been specifically designated. It is the responsibility of the line supervisor and the individual using the mask to see that it is maintained in proper working order." It was noted by the inspector and confirmed by Barton that no such equipment was available at the plant at the time of inspection.

The only respiratory protection equipment noted during the inspection was from 5 to 10 MSA full face masks equipped with both chemical and dust filters, and approximately the same number of MSA "Comfo" respirators equipped with "ultra" filters. It was noted that there was no self-contained breathing equipment available at the time of inspection except for 2 Scott Air Paks which, according to Barton, are normally kept in New Haven. Geil had brought them with him on the night of the incident.

Barton stated that during the first two months of operations, there had been a problem with two of the employees who were lax in checking their hands for contamination. As a result, on a few occasions these persons left the facility with contaminated hands. He did not specify how he had found this out. He stated that after both he and Holthaus had talked at length with these individuals, the situation improved and the monitoring was performed.

A general facility clean-up is performed at least weekly, according to Barton. In the event of spills or other contamination problems, clean-up is initiated upon his

request. He said that he recommends clean-up when he detects levels of contamination in excess of 2000 cpm on his PAC-3G alpha detector.

2. Equipment

a. Radiation Equipment

The inspector noted that the facility is equipped with an area alarm system, a Nuclear Measurements Corporation Model GA-2A. There are six detectors in the system with a range of .05 - 50 mr/hr. They are beta-gamma detectors. A diagram of their location and the location of three building evacuation alarms is included in this report as an exhibit. Evacuation alarm points are set at 20 mr/hr. Barton said that he checks the monitors weekly to determine that they are functioning properly. He alarms a different monitor each week by moving the alarm point to the indicator to determine that the connection between the alarm and the siren is operating properly. This check is normally performed on Monday mornings, according to Barton.

Although Section XLV A of the Health Physics Manual states that alarms will be activated with a gamma source, Barton says that he had not been provided with one, and can only make a visual check to determine proper functioning. Section XIV A further states that the detector units are calibrated and inspected every three months in accordance with the manufacturer's recommendations. Barton stated that they have not been calibrated with a gamma source since their installation in February 1964.

Normally present at the facility are two Nuclear Chicago Model 2650 beta-gamma survey meters with a range of from 0 - 100 mr/hr. Barton stated that one of these is kept at the guard location and the other is kept in the emergency shed. Each week the instruments in each location are interchanged. Also present are two Eberline Instrument Corporation PAC-3G alpha survey meters with a range of from 0 - 100,000 cpm. These are kept at the

health physics desk. Barton stated that he had been provided with no calibration sources. Section XIV B and XIV C of the Health Physics Manual states that all meters are calibrated every three months in accordance with the manufacturers recommendations. Barton said he is able only to utilize check sources provided with the instruments to determine that they are functioning properly.

Barton stated that he had not been provided with any counting equipment as of yet, so that contamination and air samples must be sent to New Haven for counting. He furnished a purchase order showing that a Nuclear Measurements Corporation Model PC-3B gas flow proportional counter with a 2" detector chamber has been ordered so that he can do his own counting in the future. However, it had not yet arrived at the time of inspection.

John Geil, who counts Barton's samples at New Haven, stated that his counting equipment consists of a Technical Measurements Corporation Model SG-2A scaler equipped with a NRD Model SC-5 alpha scintillation detector and pre-amplifier. He stated that with this set-up he obtains a counting efficiency of approximately 33%. Geil said that beta counting is performed with a Nuclear Chicago Model 181 scaler equipped with an end window GM tube. He stated that in general he uses an efficiency factor of 9 when using this set-up to count general air samples.

b. Other Equipment

Barton has been provided with six ¼ horse power millipore pumps for collecting air samples. He said that these had been calibrated at New Haven prior to his receiving them. Flow rate has been determined to be 20 l/minute. Air samples are taken for 50 minutes so that 1 cubic meter of air is obtained per sample.

Barton said that a velometer has been ordered so that hood inlet velocity can be measured. In addition, a Staplex Hi-Vol sampler has just been received so that high volume air samples can be obtained as needed.

3. Surveys

Barton stated that he had made up a weekly schedule for performing surveys. A sample of the schedule is included as as exhibit.

a. Air Sampling

Barton said that air samples are collected on Whatman 41 filter paper. One cubic meter of air is collected per sample. Areas normally sampled are as follows: outside air, in-plant clear areas, process areas, the roof area, and various exhaust stacks. All air samples are currently sent to New Haven for counting. Normally, results in excess of air concentration limits are reported to him by John Geil via telephone as soon as they are counted. Because of the time involved in sending the samples to New Haven, Geil said that he does not have to bother with a correction for natural activity.

i. Outside Air Samples

Barton said that one air sample down wind at approximately 75 yards from the plant is taken once a week, usually on Friday. The United Nuclear Corporation limits for air in public areas is $2 \times 10^{-12}$ uc/cc alpha. Records are maintained in units of $dpm/m^3$. The inspector noted that $2 \times 10^{-12}$ uc/cc equals 4.4 $dpm/m^3$. Records were examined and it was noted that all outside air samples have been evaluated as less than 4.4 $dpm/m^3$, the highest noted being 3.8 $dpm/m^3$.

ii. In-Plant Air Samples

Records were examined and it was noted that in-plant air samples are taken such that all areas are sampled at least once a week. Barton has prepared a schedule for sampling as well as a plant diagram showing the sample locations. These are included in this report as an exhibit. The inspector noted that United Nuclear's air concentration limits for various areas are listed in the "Health Physics Manual", Section

VIII, "Control Limits". They are compatible with and a bit more restrictive than limits as they appear in Appendix B, Tables I and II, 10 CFR 20 for U-235. Maximum allowable air concentration for in-plant clear areas is: 1 x $10^{-10}$ uc/cc alpha or 22 dpm/$m^3$. Maximum permissible limits for restricted areas are .5 x $10^{-10}$ uc/cc (110 dpm/$m^3$) in immediate work areas and .25 x $10^{-10}$ uc/cc (55 dpm/$m^3$) in general process areas. Again, records were examined and it was noted that results are maintained in dpm/$m^3$. The inspector noted that none of the air samples have exceeded the general limits as specified above.

iii. Roof Samples

Barton said that a weekly air sample is taken of the general roof area. The plant MPC for this area is 2 x $10^{-12}$ uc/cc. Records were examined and it was noted that none of these samples have exceeded the above limits.

iv. Stack Samples

The inspector noted that on three occasions, stack air effluent samples have been taken by Barton. These samples were taken from exhaust ducts leading from process vessels, hoods, and glove boxes. It was noted that the ducts which were sampled are equipped with absolute type air filters. Diagrams of the various stacks and corresponding process equipment they serve have been prepared by Barton and are included as exhibits in this report.

Barton stated that the exhaust ducts have been tapped after the absolute filters so that sampling equipment can be inserted. It was noted that the sample is taken at right angles to the air flow.

Records were examined and it was noted that on two occasions air effluent from the calciner or incinerator (Sample No. 22 in the diagram referenced above in this paragraph) showed evidence of air particulate release. On 5/29/64 a result of $1.19 \times 10^{-10}$ uc/cc (265 DPM/$m^3$ $\alpha$ ) was reported by Geil. A second sample on the same day of the same duct was evaluated as $2.17 \times 10^{-10}$ uc/cc (482 DPM $\alpha$ ). Another sample taken from the same area on 6/15/64 was also evaluated at 265 DPM/$m^3$ or $1.19 \times 10^{-10}$ uc/cc. Barton stated that the incinerator had not been functioning properly at that time. Further information concerning this problem is included in Section 7 of this report entitled, "Unusual Events."

Barton stated that he checks the manometer readings which register the differential pressure readings across the filters and the condition of the filters on a weekly basis. (A list of the process vessels equipped with absolute type filters is included as an exhibit.)

b. Contamination Surveys

Barton stated he takes a total of 100 contamination samples each week and sends them to New Haven for counting. Records were examined and it was noted that in general, samples taken from clean areas had been less than 250 dpm/100 $cm^2$, alpha. In general, samples taken from the process area have averaged from 500 to 1,000 dpm/100 $cm^2$. It was noted that in April 1964 a few minor spills resulted, such that contamination in the areas ranged to 20,000 dpm/100 $cm^2$. On June 17, 1964 another spill occurred such that samples taken in this area ranged from 20,000 to 40,000 dpm/100 $cm^2$. The latter spill will be discussed in Section 7 entitled, "Unusual Events." Barton has prepared a general diagram of smear locations which are included in this report as an exhibit. The inspector noted that except for spills, the licensee has been able to maintain operations within the contamination limits specified in the Health Physics Manual.

c. Instrument Surveys

Barton performs daily instrument surveys with a PAC-3G. He stated that when he finds areas in excess of 2000 cpm in the process area, he immediately notifies supervision to initiate clean-up. Records of these surveys are maintained in Barton's Health Physics Log Book.

4. Waste Disposal

Holthaus and Barton stated that all process effluents are carried via a waste pipe to the settling lagoon. Waste liquid is treated with sodium carbonate which, together with the uranium, settles to the bottom of the lagoon. The lagoon is completely lined with a polyethelene liner to facilitate sludge disposal. All liquids are sampled prior to disposal. Uranium content must be less than 5 ppm, and Barton said that normally waste effluent is around 1 ppm.

As the lagoon becomes full, water is pumped into the Pawcatuck River. A meter at this discharge point records the flow rate. It was noted that Barton maintains a record which includes the metering dates, grams of uranium released to the lagoon during the metering period, grams transferred to the river, and the concentration of the effluent. The pH of the discharge is also noted. (A sample of this report form is included with this report as an exhibit). This pH ranges from 8.5 to 10. A limit of $2 \times 10^{-5}$ uc/ml alpha has been set on lagoon discharges. This has been documented in the"Health Physics Manual". The inspector noted that the limit for release of U-235 either soluble or insoluble is $3 \times 10^{-5}$ uc/cc as listed in Appendix B, Table II, Column 2, 10 CFR 20.

A 100 ml sample is pulled from a 1 liter sample and sent to John Geil who evaporates it and counts it for alpha contamination. Records were examined and it was noted that in all cases, results have indicated a concentration of approximately $10^{-7}$ uc/ml in the discharge water. A complete table of such waste effluent is submitted as follows:

| Metering Period | U-235 Released To Laqoon | Gal. Transferred To River | Concentration To River |
|---|---|---|---|
| 4/3 - 4/9 | 15.245 gm | 874 gal. | $10^{-7}$ uc/cc |
| 4/10 - 4/16 | 10.966 gm | None | " |
| 4/17 - 4/23 | 5.859 gm | None | " |
| 4/24 - 4/30 | .327 gm | None | " |
| 5/1 - 5/7 | 2.175 gm | None | " |
| 5/8 - 5/14 | 15.016 gm | None | " |
| 5/15 - 5/22 | 19.459 gm | None | " |
| 5/23 - 5/29 | 16.508 gm | None | " |
| 5/30 - 6/5 | 36.644 gm | None | " |
| 6/5 - 6/12 | 65.04 gm | 1390 gal. | " |
| 6/12 - 6/19 | 25.922 gm | 1670 gal. | " |
| 6/19 - 6/26 | None | 8960 gal. | " |
| 6/26 - 7/3 | 7.22 gm | 9215 gal. | " |
| 7/4 - 7/10 | 45.43 gm | 7772 gal. | " |
| 7/10 - 7/17 | None | 7928 gal. | " |
| 7/17 - 7/24 | 11.63 gm | 432 gal. | " |

Barton said he takes monthly water samples of Pawcatuck River above and below the point of discharge. These records were examined and it was noted that in all cases samples have been evaluated at approximately $10^{-7}$ uc/cc which is about the limit of sensitivity for the sampling procedure used according to Geil.

The inspector noted that on six occasions washed TCE samples have been disposed of via a method referred to as "fenced" in the operator's log. Upon questioning, Barton stated that on these occasions, eleven liter bottles containing trichloroethane (TCE) waste have been carried outside and dumped along the facility fence to kill weeds. He stated that he had not been aware of this practice until one day while conducting a perimeter radiation survey he noticed an area in which vegatation had died. Upon questioning, one of the shift supervisors told him what had been done. He said that he had not yet been successful in stopping the practice. The following records of these disposals along with assays and determinations of amounts of uranium disposed of:

| Date | Operation Sample Log | Amount | U-235 Concentration | Gm U-235 |
|---|---|---|---|---|
| 7/10/64 | 1-13-40 | 11 liters | 6 ppm | .066 |
| 7/17/64 | 1-13-42 | 11 " | 2.8 ppm | .031 |
| | 1-13-43 | 11 " | 48 ppm | .528 |
| 7/17 - 7/20/64 | 1-14-6 | 11 " | 22 ppm | .242 |
| | 1-14-7 | 11 " | 20 ppm | .220 |
| 7/20/64 | 1-14-9 | 11 " | 12 ppm | .132 |
| | 1-14-10 | 11 " | 36 ppm | .426 |
| | | | | 1.645 gm |

Barton said that protective coveralls are washed in the plant. The effluent is piped from the washer to the lagoon effluent pipe. This water is not sampled after leaving the washer. Barton said that this discharge is evaluated in the monthly river water sample taken below the discharge point to the river. However, the inspector noted that any activity released through the wash water pipe could be long dispersed below the sampling point prior to sampling.

Holthaus said that sanitary sewerage is disposed of to a dual septic tank system. Each tank is equipped with a tile drain field. Barton and Holthaus stated emphatically that no radioactive waste of any kind is released to the sanitary sewerage system with the exception of waste from the sink located on the "Hot Side" of the change room.

Barton said that solid waste is incinerated so that any uranium might be reclaimed. Residue from the incinerator is collected in 55 gallon drums and stored outside the facility. These drums are surveyed by Barton for contamination and tagged both with the standard, "Caution - Radioactive Material" sign and symbol and with a green tag indicating that the drum has been surveyed and found to be free of contamination. Barton stated that only three drums of waste have been collected so far and that none has been transferred. He stated that they would probably be sent to the United Nuclear Corporation plant at New Haven for ultimate disposal.

5. Health Physics Training of In-Plant Personnel

(The following information was obtained during an investigation conducted by A. F. Ryan, Investigation Specialist, CO:I.

(More detailed information is available in statements received from John Geil, Elmer Barton and various operators and shift supervisors.) Geil stated that on two occasions he conducted formal training sessions. He remembered that the first was conducted on 2/26/64. At that time, a team from New Haven consisting of Mr. Briggs, Industrial Relations Officer; Dr. London, Training Officer; Mr. Stallak, Security Officer, and Mr. McGuinness, Personnel Manager, visited the Wood River Junction, Rhode Island plant on a training mission. Geil stated that all operators, shift supervisors, maintenance personnel and office staff were present at this lecture. Geil described his program as follows: He first showed a film, "A is for Atom" which lasted approximately 30 to 45 minutes. He then conducted a 45 minute lecture on general health physics procedures and responsibilities of the health physics representative. He stressed the fact that operations personnel also have a responsibility in following health physics practices. Following the health physics lecture, a 30 minute film entitled, "Criticality" was shown, after which Geil conducted a lecture on nuclear safety. In conjunction with this lecture, a booklet, "Principles of Nuclear Safety", was distributed to each person present. (A copy of "Principles of Nuclear Safety" is included with this report as an exhibit). Geil stated that he reviewed the booklet page by page with his audience and that they were instructed to read along with him. A question and answer period followed. Geil then presented a 30 minute lecture on industrial safety.

Geil stated that one day in April he returned to the plant to deliver a safety lecture, because it had been noticed that a few minor eye injuries had been reported. At this time, he presented the health physics and nuclear safety material to two new operators, Mastriani and Nowakowski. He stated that these two visits comprised his complete training efforts.

Barton stated that during "cold runs" prior to start up, he included demonstrations of building health physics procedures, including change room procedures and hand monitoring procedures. During this period, he also presented lectures covering emergency procedures and evacuation procedures, although, at that time, no practice evacuations were performed. Also during this period Barton said he spent about as much time as he could with individual operators going over health physics procedures and answering their questions.

On June 20, 1964 Barton said that all plant personnel were present on the first day to prepare the plant for an open house. He stated that the entire morning was spent in a sort of general safety meeting, at which time he again went through the nuclear safety booklet page by page. He stated that the operators seemed quite interested in the subject and that a lively discussion period ensued.

Barton said that he had not included parts of 10 CFR 20 in his lecture except to mention in passing that operations are to be conducted according to the Code of Federal Regulations, and that as a licensed facility, the plant is bound to comply with pertinent parts of the Code of Federal Regulations.

During start up, Barton stated that he constantly reviewed change room and monitoring procedures.

Barton stated that on July 20, the evacuation alarm sounded. He stated that Peabody had somehow managed to slop water on one of the area monitors causing it to short out. This activated the siren. He stated that all people in the facility evacuated, and that the evacuation seemed to run smoothly.

6. Posting and Labeling

The inspector noted that the health physics manual does not contain posting and labeling procedures or instructions. During this investigation, the inspector noted that doors leading to the process area were not posted with the standard, "Caution - Radioactive Material" signs and symbols. It was noted that the fence around the facility, which is the restricted area limit, is also not posted with the standard, "Caution - Radioactive Material" sign and symbol although incoming "pickle liquor" and waste drums are stored in this area. It was noted that there is a storage area at one corner of the process room. Portions of the storage area are separated by concrete block partitions. In this area are several containers of varying sizes containing various concentrations of enriched uranium. It was noted that there are several containers in each of the compartments. The general dose rate at the perimeter of this storage area is approximately 50 mr/hr. The inspector noted that this area was not posted as required with the standard "Caution - Radiation Area" sign and symbol. The inspector noted that

the containers themselves have the standard United Nuclear Corporation labeling tag attached to them by means of rubber bands. These tags contain the standard, "Caution - Radioactive Material" sign and symbol and information as to kind and quantity of material present and date of assay.

The inspector noted that there was a total of three 55 gallon waste drums in the outside storage area. These were labeled with the standard, "Caution - Radioactive Material" signs and symbols, and also with a green tag which showed that a health physics survey had been performed and that contamination limits and dose rate levels were low enough so that these drums could be shipped. Barton confirmed this procedure. The inspector further noted that no evaluation of amounts of material in these waste drums have been included on the tags.

7. Unusual Events

Holthaus stated that several problems had been encountered during start up of the operation. He stated that prior to start up, cold runs had been performed. A report of the cold run procedure was submitted on 3/5/64 by Holthaus to J. A. Lindberg. A copy of this communication and the cold run procedure is included as an exhibit of this report. It was noted that cold runs were not performed with acid solutions. Holthaus summarized the problems encountered during start up as follows:

a. Poor Pulse Column Design

The pulse columns are constructed such that glass sections are interposed between stainless steel sections. He thinks that the weight of the stainless steel caused too much stress on the glass connections. These connections cracked on two occasions. When this occurred, the stainless steel sections were replaced by lighter glass sections.

b. Poor Gasket Design

Holthaus stated that the original gaskets were Teflon which he thinks has poor sealing ability. He stated that the problem has been alleviated by replacing the Teflon gaskets with Tygon gaskets.

c. Pressure and Corrosive Action

The corrosive action of acid solutions and build up of pressure due to filter cake loading increased the stress on the system, resulting in leaks in the system.

d. Failure of Pump Seals

Holthaus assumes that this occurred because the pumps tend to run hot, due to the small volume of liquid transferred by high capacity pumps. In one instance, some ADU squirted out on the floor because the pump associated with this operation had not been provided with a pressure relief valve. (The spill is documented both in the health physics and operations log.)

Holthaus stated that the majority of the problems seem to have been corrected. He stated that the entire pulse column area has been provided with a .7" deep stainless steel drip pan. All pumps have been provided with drip pans.

As noted in Section 3 a. (iv) of the health physics section of this report entitled, "Stack Samples," on 6/18/64, Barton was notified by Geil of a high reading resulting from sampling of the calciner exhaust. Investigation showed that the calciner was not functioning properly. Barton stated that through Holthaus he had recommended that the calciner not be used. In spite of this, on 6/22/64, John Simas started to incinerate. A fire started. The absolute filter in the calciner air exhaust was completely destroyed. It has not yet been replaced. Barton stated that he was told the calciner had been used on one or two other occasions without the filter.

During this investigation, smear samples on the inside of all stack effluent ducts were performed by Fred Brandkamp, Radiation Specialist, CO:I. Included in this survey was the exhaust duct leading from the calciner. No evidence of contamination was detected on this sample. (Results of Brandkamp's survey are included in the section covering Environmental Monitoring.)

On 7/20/64, a spill on the roof was noted. Holthaus and Barton stated that this occurred because the stainless steel dissolver vessel, 1-J-4, was filled to overflowing. There is no liquid level gauge provided for this vessel. Material overflowed from the dissolver, filled the overflow tank and bubbled up through a vent to the roof. This area was surveyed by Fred Brandkamp and a record of his survey is included in this report as an exhibit. Although decontamination had been attempted, Brandkamp noted that contamination levels in the spill area exceeded 100,000 cpm as measured on a PAC-3G alpha survey meter belonging to HASL. It is further noted that the contamination limit listed in United Nuclear's Health Physics Manual for this area allows a total alpha contamination limit of 500 dpm/100 $cm^2$. Holthaus stated that it has been planned to take up part of the roof covering in this area and replace it.

The inspector noted that on the roof are several vents leading directly from those process vessels which utilize a vacuum transfer. It was noted that although these vessels are equipped with a demister and a cyclone, there is still a direct escape route from the process vessel to the roof. Samples of all these vents were taken by Brandkamp. Although they appear to be constructed of a plastic material and are quite smooth, evidence of contamination was detected on the vent leading from the dissolver and that leading from the reduction furnace. (See Brandkamp's report for levels of contamination.)

8. Emergency Procedures

A book entitled, "Emergency Control Plan" has been prepared and was submitted with the original license application dated 11/27/63. The inspector noted that it includes an emergency evacuation plan to be followed in case of either fire or nuclear disaster, addresses and telephone numbers of supervisory personnel, doctors, hospital and consultants. Plans for block-off of approaches to the facility and emergency surveys are included. In conjunction with this plan, Barton has prepared a list of equipment which is to be located in the emergency shed located approximately 150 yards from the facility. Barton stated that at the time of the incident, all equipment listed, with the exception of a first aid kit, was present in the shed.

The inspector noted that a specific area is not included in the emergency procedures. This involves re-entry procedures to be followed in the event of a criticality accident. The inspector could find no evidence that planning along these lines had been considered.

The inspector discussed equipment located in the emergency shed with Barton and Holthaus. He noted that no emergency personnel monitoring equipment is provided in the list. Furthermore, no emergency self-contained breathing apparatus is available anywhere in this plant.

At the time of inspection there were no film badges or dosimeters available for monitoring the people who made the first re-entry into the facility following the criticality. Although two dust respirators were reportedly present in this shed at the time of the accident, they were not utilized by Smith, Holthaus, or Barton during their re-entries according to them. Holthaus said he made his re-entry without benefit of protective clothing and respiratory equipment. He reported that he did wear a film badge during re-entry.

Barton stated that during his re-entry, he did not utilize a film badge, dosimeter, respiratory equipment or protective clothing of any kind. The inspector noted that the first re-entry in which personnel had been adequately clothed and monitored was that of Karn and Cutler. This occurred at approximately 10:20 p.m. on July 24, approximately four hours after the incident, and was described in detail by John Geil in his interview with A. F. Ryan.

9. Miscellaneous

Two license conditions are noted. Condition 13 states, "Within 90 days after start up of each area, the licensee shall submit to the Division of Licensing and Regulation:

(1) The results of the survey programs for airborne radioactivity in the plant and concentrations of radioactivity in the liquid waste effluent from the lagoon, and

(2) A proposed future survey program including the minimum sampling frequency."

Since licensed activities commenced on 3/16/64, this report was due 6/16/64. Barton stated that he has compiled data and sent it to Geil for analysis. Geil stated that he has the data and is working on the report. However, it had not been submitted at the time of the incident, at which time the plant had been in operation for four months.

License Condition 14 states, "This license does not authorize the licensee to make any changes in equipment or procedures involving special nuclear material other than maintenance or replacement with like equipment." Furthermore, United Nuclear Corporation's internal procedures Section 207.2.2 entitled, "Organization" states in part "When a new piece of equipment or modification of existing equipment is planned, the person responsible for the installation and operation contacts the Nuclear Safety Supervisor. At this time, the nuclear safety problems are discussed. The design then progresses taking into account the recommendations of the Nuclear Safety Supervisor. When the design and basic operating procedures have been finalized, the Nuclear Safety Supervisor prepares detailed operating procedures which include any special nuclear safety requirements such as batch size, equipment spacing, work area, handling procedures specified in the license application or feasibility report."

In addition, Section V of the Health Physics Manual lists as one of the responsibilities of the Operations Department; "Obtaining the approval of the Health Physics Department of all equipment and process designs, standard operating procedures and the modifications or additions thereto." This is necessary so that Item B "Specific Responsibilities" listed under Section IV "Health Physics Responsibilities" can be carried out. Paragraph B states in part, "The Health Physics Department is responsible to the Manager Chemical Operations for:

(3) Performing an advisory service to the Operations Department for new process equipment and procedures in the development stage.

(4) Reviewing and approving all planned modifications and/or additions to the plant equipment processes and standard operating procedures."

The inspector asked Barton and Holthaus whether they had been aware of the new procedure which one or two of the supervisors had originated and approved for washing TCE. They stated that they had not been aware of this. They were asked whether they considered this a modification of the process. The replied that they did, and Holthaus stated that he was aware of the various approvals to be obtained, both by United Nuclear Corporation officials and the Commission prior to changing either equipment or procedures. He said that the reason this was not done was because he was not aware that this procedure was being performed at all. Barton stated that had he been aware of the procedure, he would have notified Holthaus.

Summary of Decontamination Proceedings at the United Nuclear Corporation, Wood River Junction, Rhode Island

The following is a summary of the chronological events of the decontamination proceedings at the United Nuclear Corporation's Fuels Recovery plant at Wood River Junction.

Initial Decontamination by United Nuclear Corporation

Upon arrival at the Wood River Junction plant at 7:20 p.m. on 7/25/64, the CO:I inspector was informed by Mr. J. Geil, Health Physicist and Safety Specialist from United Nuclear Corporation's New Haven plant, that decontamination had commenced at approximately 8:00 a.m. on 7/25/64, and efforts discontinued at approximately 6:30 p.m. on 7/25/64. He further stated that no further decontamination attempts would be made until Monday morning, 7/27/64. Geil's records indicated the status of the plant as follows:

AMBIENT BETA-GAMMA RADIATION LEVELS

| Locations (see sketch of plant appended to this report) | Readings - mr/hr |
|---|---|
| Guard area, lunch room, vestibule, lobby, general office, office's cold and hot change rooms and utility room | <0.2 |
| Shipping and receiving, storage, maintenance | 0.4 |
| Lab and H&V equipment room | <0.5 |
| Process area office | 1.0 |
| Process area (north portion) | 2.5 to 4.0 |
| Process area (center portion) | 8.0 to 38.0 |
| Process area (south portion) | 50 to 100+ |

| Location (cont'd) | Readings - mr/hr (cont'd) |
|---|---|
| Contact with bottles containing incident material | 1500 |
| Liquor adjustment room | 6 to 14 |
| Roof over general office area | 5 to 10 |
| Tower Section | |
| Tower first floor (at opened door) | $100^{+}$ |
| Inside east exit door | 35 |
| Tower second floor (at opened door) | 50 |
| Tower third floor (at opened door) | 250 |
| Tower third floor (platform behind cement block) | 50 |

An alpha survey of the decontaminated area was made by United Nuclear Corporation personnel using an Eberline PAC-3G meter. The initial decontamination included the following areas: offices, lobby, vestibule, lunch room, guard area, cold and hot change rooms, shipping and receiving, storage, maintenance, utility room, lab, process area office, and north side process area to, but not including the liquor adjustment room. Alpha radiation levels in these areas were recorded by United Nuclear Corporation personnel as less than 2000 cpm or lower. Air activities during this decontamination as recorded by United Nuclear Corporation, indicated 0, 1.7 and 3 $d/m/m^3$ for alpha activity in the shipping and receiving, storage and north side process area locations. Gross beta-gamma activities were recorded as 0, 0, and 10.4 $d/m/m^3$ respectively for the above mentioned areas.

No decontamination was performed on Sunday, 7/26/64.

Activities of July 27, 1964

On Monday, 7/27/64, United Nuclear Corporation and AEC personnel reviewed the United Nuclear Corporation taped interviews of United Nuclear Corporation personnel involved in the incident. An inspection of the process and tower areas of the facility was made

by United Nuclear Corporation and AEC personnel to assess the present conditions. Later, samples were collected by United Nuclear Corporation and AEC personnel in an effort to calculate the criticality conditions. All persons entering the process and tower areas were instructed by Mr. Clemons, Health Physicist in Charge, to don lab coats, booties, wear film badges, and dosimeters and not to touch anything other than samples to be collected.

Activities of July 28, 1964

On Tuesday morning, 7/28/64, a meeting was held, attended by United Nuclear Corporation and AEC personnel regarding further proceedings. United Nuclear personnel ~~estimated~~ criteria under which they would operate. A summary of operating criteria follows. The limits for decontamination were 2000 d/m/smear (approximately 1 $ft^2$) for removable alpha contamination and 2000 d/m/smear (approximately 1 $ft^2$) for removable beta-gamma contamination. Acceptable airborne concentrations in which personnel were permitted to work without respirators were 220 $d/m/m^3$ alpha activity and 660 $d/m/m^3$ beta-gamma activity. In any decontamination operation where airborne activity was likely to be generated, respirators would be required. Protective clothing to be worn by decon-personnel included coveralls, inner surgeons gloves and outer rubber gloves, head covers and respirators as required, shoe covers, (1, 2, or 3 pair as required), and 0 - 200 mr dosimeters and film badges. A log was established on which was recorded the names of all persons entering the hot change room, or any other areas beyond that point, total time in the areas, and dosimeter readings. The areas included the fenced areas outside the building. Lab coats, shoe covers, and rubber gloves (as necessary) were required to be worn by all persons not performing decon work. A monitoring station was established between the cold and hot change room. Urinalysis samples were to be taken daily from all persons performing the decontamination. Mr. J. Geil was assigned by Mr. L. Allison to perform a repeat environmental survey of the area which is to be completed by 8/15/64. Mr. D. Karn was assigned to check all vehicles involved in the incident and to decontaminate cars as necessary.

Resumptions of Decontamination

Decontamination recommenced in the afternoon of 7/28/64, on a three shift basis with the United Nuclear Corporation health physics coverage on all shifts. Representatives of CO:I

reviewed decontamination progress through August 7, 1964. Decontamination is still proceeding at the time of this writing. Decontamination proceeded in the process area, the tower stairwell, and finally from the third floor tower to the second floor tower and to the first floor tower sections. Difficulty was experienced in decontaminating the tower floors and concrete block walls, ceilings and structural steel. As a result, tiles were removed from the three tower floors, and the walls, ceilings, and structural steel in these rooms were painted.

As decontamination progressed, smear survey, air samples, and direct radiation surveys were made and recorded by United Nuclear Corporation personnel on a continuing basis. All surveys were counted for alpha and beta-gamma activity.

The inspector noted that a weak nitric acid solution and sponge was used to decontaminate surfaces. Many one gallon polyethylene containers were used to contain the decontamination solutions. These containers were spaced two feet on centers, each line of containers five feet apart. Containers were located on the process area floor on paper. As they were filled, the one gallon containers were samples by United Nuclear Corporation for uranium content and condensed into 11 liter 5" diameter polyethylene containers and/or 55 gallon drums as the concentration dictated. Solid wastes, generated as a result of decontamination, were placed in 55 gallon drums and stored in a roped area within the fenced lagoon on the north side of the building.

Air concentrations taken by United Nuclear Corporation personnel during the decontamination ranged from 0 $d/m/m^3$ to a maximum of 119 $d/m/m^3$ for gross alpha activity and 3 to 926 $d/m/m^3$ for gross beta-gamma activity. No corrections were made for natural atmospheric radioactivity decay in these air samples. The highest air activity (926 $d/m/m^3$ beta-gamma activity, uncorrected) was noted during the tower third floor tile removal at which time decontamination personnel were wearing respirators. All other beta-gamma air activities indicated less than 660 $d/m/m^3$, uncorrected for decay. In general, gross alpha and beta-gamma air activity existing during the decontamination were 300 $d/m/m^3$ and 200 $d/m/m^3$, respectively, uncorrected for natural atmospheric radioactivity decay.

Surveys by CO:I

On Friday, 8/7/64, a smear survey was made of the controlled access area (commencing from the shipping and receiving area). These smears were submitted to the NYOO-HASL for counting. A survey was also made on 8/7/64 using GS-2 type survey meter and the results are as follows:

AMBIENT GAMMA RADIATION LEVELS

| Location | Mr/Hr |
|---|---|
| Shipping and Receiving | .05 |
| Storage | .05 |
| Maintenance | .1 |
| Maintenance - contact with wall opposite storage racks | max. 1.0 |
| Utility Room | .05 |
| Process Area (north side) | <2 |
| Process Area Office | .1 |
| Process Area (south side) | 2 to 5 |
| Process Area (entrance to two north storage aisles | >20 |
| Process Area (entrance to middle storage aisles) | 5 |
| Process Area (entrance to two south storage aisles) | <10 |
| Tower stairwell 1st, 2nd, & 3rd levels | .1 |
| Tower first floor | .5 to 3 |

| Location (cont'd | Mr/Hr (cont'd) |
|---|---|
| Tower first floor - contact with 1-C-9 column | 2 |
| Tower second floor | 1 to 2 |
| Tower third floor | <5 |

Status of the Facility as of Friday, August 7, 1964

1. Process area decontaminated to removable activity levels of less than 2000 d/m/smear for alpha and beta-gamma activities with minor exceptions of hot spot.

2. Tower stairwell decontaminated to within specified limits of smearable activity.

3. Tower room wall, ceilings, and structural steel painted.

4. Tower room floors - all floor tile removed.

5. Approximately 100 one gallon containers properly spaced on paper on the process area floor (including 23 specially marked solution from evaporator spill).

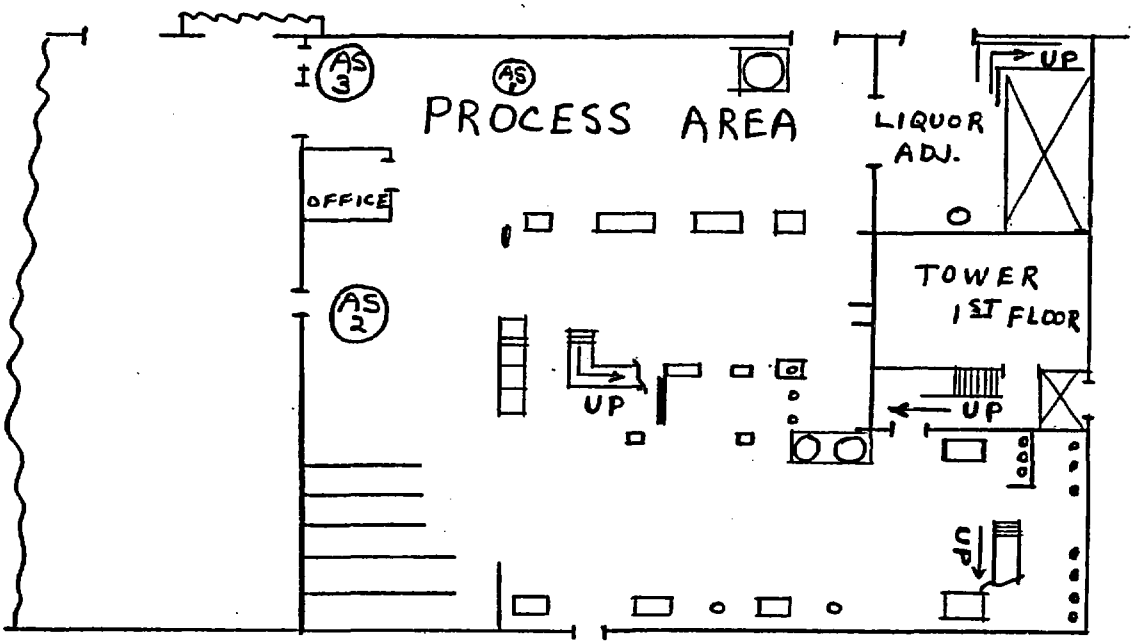
Planned Work for Week of August 10, 1964

United Nuclear Corporation personnel plan to have the facility decontaminated to smearable levels of less than 2000 d/m/smear alpha and beta-gamma on all equipment and floor areas by the latter part of the week beginning 8/10/64. New Tower room floor tile will be laid during the week starting 8/10/64.

Environmental Surveys, United Nuclear Corporation, Wood River Junction, Rhode Island

The following is a more or less chronological presentation of the environmental surveys performed by representatives of United Nuclear Corporation, NYOO, AEC, the State of Rhode Island, the Radiological Laboratory of the U. S. Department of Health, Education and Welfare at Winchester, Massachusetts, and representatives of Region I, Compliance Division, AEC. A wipe and alpha radiation survey was also conducted by Region I, Compliance personnel, as a possible indication of discharges or releases to the environment.

The first survey of an environmental nature following the incident was performed by Mr. Elmer Barton, the local health physicist, on the night of the incident, 7/24/64. Barton stated that at about 9:20 p.m. of that evening, he set up three air samplers in the plant Process Area at the locations marked AS on the diagram below.




Barton also took an air sample at the emergency shack during the period from 10:00 p.m. to 11:30 p.m. of 7/24/64. These samples are reported to have been counted by Mr. Karn who remembers counting them and says that he does not recall any significant activity. The air sample and the record of the results have been lost, according to Geil, and had not been found as of 8/12/64.

2100 liters of air were drawn through a Gelman GM four 1" filter paper by means of a Millipore air sampler. These filter papers were counted on Monday afternoon, July 27th, and the following activities noted:

| | Alpha | Beta-Gamma |
|---|---|---|
| AS 1 | $0.77 \times 10^{-12}$ uc/ml | $4.68 \times 10^{-12}$ uc/ml |
| AS 2 | $1.35 \times 10^{-12}$ uc/ml | 0 |
| AS 3 | $0 \times 10^{-12}$ uc/ml | 0 |

Upon their arrival at the plant at about 10:00 p.m. on Friday, 7/24/64, Messrs. Karn and Cutler of the New Haven facility of UNC recorded a dose rate of 0.3 mr/hr at the Plant Parking lot using three difference Nuclear Chicago Model 2612 portable GM type survey meters.

Two air samples were taken within the process area by Karn and Cutler, using a portable impactor unit. The results of this survey had not been determined at this writing.

Radiological Emergency Assistance Team, NYOO

At about 6:00 a.m. on Saturday, July 25th, Messrs. Sanna and O'Brien of the NYO Radiological Emergency Assistance Team arrived at the Wood River Junction Plant of UNC. Their activities and conclusions are indicated in the following excerpts from a report dated July 29, 1964 from Dr. John H. Harley, Director, Health and Safety Laboratory, NYO, to Mr. W. M. Johnson, Manager.

"Summary of Sanna and O'Brien Activities

On notification by McLaughlin to proceed to Wood River Junction, Rhode Island, and to be available for assistance if requested, I telephoned R. Sanna and asked him to go to the Laboratory and suitably to equip himself with instrumentation, coveralls, film-badges and cetera, and then to come to my residence in Monsey, NY. In the meanwhile, McLaughlin had sent Sam Rothenberg to the Laboratory to calibrate freshly all necessary survey meters.

At 2:00 AM Saturday, Sanna and I left Monsey for Wood River Junction and arrived there at 6:00 AM. I notified McLaughlin. He asked me to determine:

"1. Were any fission products released from the building, and

2. To what extent was AEC assistance required.

Taking the latter first, the Plant Superintendent, Holthaus, said that he felt sure they could clean up the plant. However, medical assistance would be needed.

As for the first point, air samples had been taken the night before, and showed no activity. The records were available for inspection should I so desire. Satisfied that these records would be preserved and would be available to inspectors, I declined: at this hour, no omission could conceivably be repaired. Sanna and I then approached the building.

We made alpha measurements with an Eberline PAC-3G and a PAC 1S. Outside the doorway, we were able to measure 50 to 150 c/m (about 2 - 6 $mg/m^2$ of U-235). Inside the office-space, and into the hallway leading to the work area, the levels ranged from 100 to 200 c/m (4 - 8 $mg/m^2$) on floors, walls windows, and cabinet tops, any exposed surface. Returning outdoors, and ascertaining the direction of the wind, we discovered that downwind levels remained at 150 - 200 c/m for several hundred yards, wherever flat exposed surfaces could be found for measurement.

We concluded that during the incident, steam and aerosols were generated, and escaped during the hurried exit of the personnel. Because no upwind levels were discovered, the hypothesis that these levels were generated during previous operations cannot be supported.

Gamma-ray levels in the office and hallway were 0.1 mr/hr. Outside the building they were indectable. These come as closely as we could get to test for activity escape.

The area roundabout is heavily wooded. No residences can be seen. A public health hazard resulting from the incident is not conceivable.

"We determined that no Nuclear Accident Dosimeter of any kind was on site. We picked up the film badge holder worn by Peabody (the cause and victim of the accident) so that its activity could be analyzed. We were assured in the strongest imaginable terms that no other workers were near the accident site, and that they showed no activity other than some contamination. In the light of some later reports, this assurance may have been given the lie by the facts.

When, at about 8:30 AM, Willis Brown of Compliance Region I returned to the scene, and assured us we were not needed, Sanna and I made our report to McLaughlin, and returned home."

United Nuclear Corporation

Messrs. Deluty and Chapman, of the local UNC staff, took two off-site air samples on Saturday, 7/25/64. One was taken at the Godden Read Estate Office, Crossland Park, Charlestown, Rhode Island, from 2:42 to 3:32 p.m. About 1000 liters of air were sampled, results were recorded as $4.995 \times 10^{-12}$ uc/ml alpha activity; zero beta-gamma activity with a notation, "alpha count is within statistical accuracy of 10CFR20 U-235 limit." The second sample was taken at 3:10 p.m. at the home of another UNC employee, Mr. R. Bitgood, 67 Main Street, Charlestown, Rhode Island, at a point about 200 yards north of the intersection of Routes 112 and 91. About 1000 liters of air were sampled and the results recorded as $2.83 \times 10^{-12}$ uc/ml alpha activity and $1.35 \times 10^{-12}$ uc/ml beta-gamma.

State of Rhode Island

Mr. Raymond J. Kelly of the State of Rhode Island Department of Health obtained air, soil and water samples in the vicinity of the plant on Sunday, July 26th. His findings are outlined in the following excerpt from his letter, dated August 10, 1964, to Fred N. Brandkamp, Region I, Division of Compliance, AEC.

"Please find below radioactivity found during a pre-operational survey of the United Nuclear plant area and the radioactivity found following a nuclear incident at the plant. The incident took place on July 24, 1964 and the post incident samples were taken on July 26, 1964.

The sites referred to below are:

| | | |
|---|---|---|
| "Water | - Site #1 | Taney Brook at Shannock Hill N.E. of United Nuclear Plant |
| " | - Site #2 | Pond 5/8 mile N.W. of United Nuclear Plant |
| " | - Site #3 | Cross Mill Pond at road junction of Post Road and South Country Trail, 4 miles S.E. of United Nuclear Plant |
| Soil | - Site #1 | Lookout Tower on Shannock Hill N.E. of United Nuclear Plant |
| " | - Site #2 | On Narragansett Trail, 0.3 miles east of Kings Factory Road, S.E. of United Nuclear Plant |
| " | - Site #3 | Same as Water Site #3 |
| Air | - Site #1 | Same as Soil Site #1 |

| Sample | Site | Preoperational Range (picocuries per liter) (gross alpha & beta) | Post Incident (picocuries per liter) |
|---|---|---|---|
| Water | #1 | 8.1 ---------- 51 | 10 |
| | #2 | 6.7 ---------- 79.5 | 7.2 |
| | #3 | None taken | 46.0 |

| Sample | Site | Preoperational Range (picocuries per gram) (gross alpha & beta) | Post Incident (picocuries per gram) |
|---|---|---|---|
| Soil | #1 | 21.5 --------- 76.0 | 62.0 |
| | #2 | 17.9 --------- 93.5 | 89.0 |
| | #3 | None taken | 112.0 |

| Sample | Site | Preoperational Range (picocuries per cubic meter) (gross beta & gamma) | Post Incident (picocuries per cubic meter) |
|---|---|---|---|
| Air | #1 | 0.63 --------- 6.5 | 1.57 (7/26-7/27/64)<br>1.8 ((7/27-7/28/64) |

"It should be noted that the location of preoperational sampling points northeast of the United Nuclear Plant were selected after having received information from the U. S. Weather Station at Hillsgrove, R. I. that the predominant prevailing wind for the last ten years had been from the southeast."

United Nuclear Corporation

At about 4:00 p.m. on 7/25/64, Messrs. Joseph and Cutler of UNC performed a wipe survey on the trees, signs, poles, etc. in the vicinity of the roadblock at the intersection of the plant service road and Narragansett Trail. The details of this survey, including results, are summarized in an attached exhibit which was reproduced from UNC records.

Region I, Division of Compliance, AEC

At various times during the period beginning Monday, 8/3/64, and ending at about noon on Friday, 8/7/64, environmental samples were collected by representatives of the Region I, Compliance office of AEC. The soil, drinking water and pond water samples obtained were representative of the samples taken in the pre-operational survey. Alpha and beta-gamma dose rates were also measured in the area of the plant site and at various points in all directions from the plant. A copy of the preoperational survey performed by UNC and submitted to the State of Rhode Island on 9/16/63 is attached as an exhibit for purposes of historical data.

The location of each of each of the samples is tabulated below and also indicated on Maps A, B and C, attached as exhibits. No analysis of the samples obtained had yet been made at this writing.

Soil Sample Locations

| | |
|---|---|
| 1 S thru 5 S | - Dirt Road, SE Boundary of Woods |
| 6 S | - Near Pole No. 196 |
| 7 S | - 250' S Pole No. 196 on Narragansett Trail |
| 8 S | - 250' N Pole No. 196 on Narragansett Trail |
| 9 S | - 250' E of turn on Narragansett Trail |
| 10 S | - 500' S of Pole No. 196 on turn, Narragansett Trail |

(See Map A)

DW 1 - Drinking Water, Gas Station at Route 91 at Intersection of Old Hopkinton Road, Westerly, Map C.

DW 2 - Drinking Water, Gas Station and Grocery, Dunn's corner, Intersection of Route 1 and Old Shore Road, Map C.

DW 3 - Quonochontaug area drinking water, gas station on south side Route 1, east of intersection of Ross Hill Road, Map C.

DW 5 - Hope Valley sample, Gulf Gas Station, S/S Route 138, Hope Valley, Map C.

DW 6 - Wood River Junction sample, Package Store, N/S Route 91, just west of Hope Valley Road, Wood River Junction, Map C.

DW 7 - Auto sales agency and Gas Station, NE corner, Intersection Route 91 and Route 112, Carolina, Map C.

DW 8 - Ice Cream, Candy and Grocery store, north side of road, entering Shannock from Route 112, Map C.

DW 9 - Alton sample from Holmes Garage, north side Route 91, Map C.

DW 10 - Bradford sample, Gas Station at N/W Intersection Route 91 and Route 216, Map C.

Vegetation Samples

V 1 - Composite of tree and bush foliage at downwind edge of woods, approximately 350' from plant, Map A.

V 2 - Burdickville Road between Route 91 and RR bridge, Map B.

V 3 - Buckeye Brook Road at Route 216, Map B.

V 4 - Route 95 at Route 138, Map C.

V 5 - Route 102, about 3 miles west of Exeter, Map C.

S 1 - Edge of Swamp, Kings Factory Road at Burdickville Road
S 2 - Burdickville Road at Shumukanuc Hill Road
S 3 - Shumunkanuc Hill Road at Buckeye Brook Road
S 4 - Route 112 at NYNH&H RR crossing
S 5 - Route 91 at Narragansett Trail
S 6 - Narragansett Trail at Route 112
S 7 - Burdickville Road at RR bridge
S 8 - Route 91 at Chapman Pond (Map C)
S 9 - Route 91, one mile north of Burdickville Road
S 10 - Burdickville Road at Route 91

(See Map B for all, except S 8)

Water Sample Locations

W 1 - Sample from tap on third floor tower from overhead tank. Drawn by P. Knapp, 11:15 a.m., 7/20/64 (Given to E. Resner for inclusion with activation analyses samples.)

W 2 - Lagoon Sample, obtained 7/30/64, Map A

W 3 - Aliquot of Lagoon Sample, taken 9:00 a.m., 7/24/64 (before incident) Note: No flow from lagoon since 7/20/64, Map A.

W 4 - Plant waste water discharged at Pawcatuck River outflow, 7/30/64, Map A.

W 5 - Pawcatuck River at Route 91 Bridge (upstream of plant), Map B.

W 6 - Cedar Swamp Brook, just north of Narragansett Trail Culvert, Map B.

W 7 - Burlington State Park (Watchaug Pond), Map B.

W 8 - Pawcatuck River, 100' downstream from United Nuclear Corporation outflow, Map A.

W 9 - Pond at intersection of Route 91 and Hope Valley Road, Map B.

W 10 - Watchaug Pond, Map B.

W 11 - Chapman Pond at Route 91, Map C.

U. S. Department of Health, Education & Welfare

Similar samples were taken by Mr. N. Gaeta of the U. S. Department of Health, Education & Welfare Radiological Laboratory, Winchester, Massachusetts, accompanied by F. Brandkamp, AEC, and Mr. R. Kelly, State of Rhode Island Department of Health, on Wednesday, July 29th. Analysis of the samples taken is incomplete at this writing, however, a telephone conversation on 8/5/64 with Mr. Gaeta revealed that Gaeta had found no short-lived activity at all, that he planned to count for gross alpha activity, and follow with a quantitative analysis for U if significant activity was indicated. He added that a copy of his final report would be forwarded to the Region I, Division of Compliance office, upon completion of his analysis.

Region I, Division of Compliance, AEC

An alpha and beta-gamma survey was also performed by Region I, Compliance representatives in the area surrounding the plant, including all locations where soil, water, or vegetation samples were obtained. An Eberline PAC 3-G alpha detector and a Nuclear Measurements thin end-window GM survey meter were used. No alpha activity was noted except for 200 - 300 counts per minute (approximately 50% efficiency) on the ground at the location near the emergency shack where the men working in the plant at the time of the incident had piled their contaminated clothing immediately after the incident, and small areas of contamination, up to 500 cpm, on the lower edges of the horizontal sections of the saw-horses used for roadblocks. The fact that these two saw-horses were found to be contaminated was drawn to the attention of Mr. Geil, plant health physicist, who indicated that he would have them brought indoors and decontaminated.

The beta-gamma background rate was noted to be 0.01 to 0.02 mr/hr, however, this rate increased by a factor of two to five when the (open) end-window was placed in contact with old dried leaves and duff a few yards into the woods from almost any roadway. This situation prevailed in all directions from the plant for a distance up to about four miles. A dose rate as high as 0.25 mr/hr was obtained with the open end-window probe in contact with a low-growing moss-like type of vegetation. It was concluded that this was probably attributable to uptake, by the plant, of some radionuclide. Samples V2, V3

V4 and V5 are examples of this type of growth, and they will be analyzed in an attempt to establish the nature of the activity. There appeared to be no reason to attribute either the relatively high background activity or the activity in the "moss" to operations at the UNC plant at Wood River.

An alpha dose rate survey, using an Eberline PAC-3G and a wipe survey of the main roof area were performed on Monday, August 3, by representatives of Region I, Division of Compliance, AEC. There are a total of 49 penetrations of the roof to accommodate an assortment of ducts and stacks of which all but three were examined. One of these is located on the roof of the tower, and two more on the one-story western wing of the building which houses the offices. These two sections of the roof were not accessible at the time of the survey.

Alpha count rates varying from zero to over 100,000 cpm were found on the roof. These were attributed by plant personnel to a spill which had occurred on July 20th in which a uranium solution had flowed onto the roof by way of a vent pipe. This spill is discussed in another section of this report under the title, "Evaluation of Health Physics Program at United Nuclear Corporation Facility, Wood River Junction, Rhode Island."

Of the 86 wipes taken during the roof survey, 30 indicated activity significantly (95% confidence) above background levels (12 cpm on the basis of a 5 minute count) when counted for gross beta gamma activity by means of the Region I, Division of Compliance, end-window (1.6 - 2.0 mg/cm$^2$) GM counter and scaler. A summary of the locations at which loose activity was noted is presented below:

| Wipe # | Location | Net cpm |
|---|---|---|
| 1 | Roof, west end | 5 |
| 2 | " | 10 |
| 3 | " | 5 |
| 4 | Cover, air intake A-64 | 9 |
| 9 | Roof under lab ventilator A-66 | 4 |
| 10 | Cover, F.A. Intake A-63 | 6 |
| 17 | Roof under Maintenance Area Vent A-61 | 7 |
| 20 | Cover, Process Area Vent A-52 | 4 |
| 21 | Roof under " | 3 |
| 23 | Roof near F.A. Intake A-63 | 2 |
| 24 | Roof between A-63 and A-52 | 7 |
| 25 | Cover, Process Area Vent A-53 | 6 |

| Wipe # | Location | Net cpm |
|---|---|---|
| 26 | Roof under Process Area Vent A-53 | 17 |
| 27 | Cover, Process Area Vent A-59 | 8 |
| 28 | Roof under " | 7 |
| 37 | Roof near vent stack 1-B-8 | 2 |
| 41 | Roof near All-purpose vent 1-B-16 | 7 |
| 44 | Cover, Declad vent 1-B-15 | 10 |
| 47 | Roof near calciner vent 1-B-13 | 4 |
| 50 | Roof near future calciner vent 1-B-18 | 2 |
| 52 | Roof near counting and degreasing vent 1-B-2 | 7 |
| 53 | Inside exhaust stack 1-B-3 | 4 |
| 54 | Roof near 1-B-3 | 2 |
| 55 | Inside of stack, Dissolver 1-B-4 | 4 |
| 56 | Roof near 1-B-4 | 47 |
| 57 | Inside Weigh & Package Hood 1-B-7 | 12 |
| 58 | Roof near 1-B-7 | 4 |
| 77 | Inside exhaust stack, teflon-lined dissolver | 34 |
| 81 | Inside exhaust stack, pyro furnace | 16 |
| 86 | Inside exhaust, declad vent 1-B-15 | 4 |

Post-Incident Environmental Survey - UNC

Mr. John Geil, health physicist, reported that during the period 7/30/64 through 8/8/64, environmental samples were collected at all points where preoperational samples had been taken. The only exceptions were water sampling points 26 and 27 (see exhibit, preoperational environmental survey) which were dry. Two additional soil samples were taken at points about 300' south of the plant and about 50' east and west of the emergency shack. These samples were shipped to the Nuclear Science and Engineering Company, Pittsburgh, Pa., on 8/10/64, for analysis. No report has been received by UNC at this writing.

INQUIRY ON PERSONNEL MONITORING FILM EVALUATION

R. S. Landauer, Jr., President of the Company of the same name which processed the personnel monitoring films worn by the United Nuclear Corporation employees, was contacted. He gave the following information relating to the film badge processing and results. He reported that a bi-weekly service is furnished to United Nuclear. The films involved were Dupont 544 packets, which contained a sensitive film, designated 555, and useful up to a 5 r exposure, and the insensitive film, designated 854, which is useful in the range from approximately 5 r to somewhere above 500 r with a maximum useable exposure value of 700 r. Landauer stated that these were the only films which were provided for United Nuclear and no neutron films had been ordered by the company. The films are worn within a plastic badge provided with filters placed in such a manner that identical filters are located opposite each other on each side of the film. The following filters are used; lead 0.032 inches thick, aluminum 0.040 inches thick and plastic, 0.065 inches thick. Landauer noted that indium strips approximately 0.010 inches thick were mounted on the back of each of the badges assigned to United Nuclear. He pointed out that the indium strip is expected to give a significant gamma reading immediately after a few rads of thermal neutron exposure and further noted that the clip on the back of the badge will give a significant gamma reading a short time after an exposure to a somewhat larger neutron dose.

The films which were mounted within the badges at the time of the incident were dated July 13, 1964. The last batch of films which had been worn and returned to Landauer were dated June 29, 1964, and had been received at Landauer on July 15, 1964.

Landauer said that at approximately 10 a.m. Saturday, July 28, he had received a telephone call from R. C. Johnson and had also talked with John Geil, both employees of United Nuclear. He said that Geil asked him if the company still provided an emergency processing service in New York and when Landauer said that it did, Geil informed him that the films of United Nuclear were already on their way to New York. He said that the films were being brought back to the NYOO,AEC by the REAT Team. He emphasized that he was particularly concerned with film 7009, which had been assigned to Peabody.

Landauer stated that in order to furnish emergency monitoring service he had provided that a small dark room with appropriate processing chemicals be set up in the New York Office of the company which is predominately a sales office. He stated that a female employee, Patricia Wright, was employed both as a secretary and a film processor. He noted that Wright, who had been employed by his company since October 1963, had had three years of training as an X-ray technician and had received further training from the female employee she was to replace during a six week period. He stated that the New York film processing facility had never been used for processing and evaluating an actual exposure before the processing done

on Saturday, July 25. He noted that the office is located in the Empire State Building. Landauer said that the film processing was completed by 8 p.m. on Saturday evening. He stated that the films had not been checked for contamination. However, a series of measurements made by John Geil between 8 and 9 a.m. on July 25, using a Nuclear-Chicago, Model 2650 GM survey meter indicated that the film of some employees was contaminated to some degree. The results of this survey are summarized in the table below.

Activity Measured on Film Holders, Film Packets and Attached Indium Foils on July 25, 1964 Between 8 and 9 a.m.

| Badge No. | Name of Wearer | Readings in mr/hr Film Badge | Film Packet | Foil |
|---|---|---|---|---|
| 2211 | [redacted] | 2.2 | 0.1 | 0.07 |
| 7000 | | 0.08 | 0.06 | 0.05 |
| 7003 | | 0.07 | 0.06 | 0.05 |
| 7009 | Peabody, R. | 100 | 75 | 31 |
| 7010 | [redacted] | 0.60 | 0.15 | 0.07 |
| 7016 | | 0.06 | 0.05 | 0.07 |
| 7021 | | 0.17 | 0.07 | 0.10 |

Ex. 6

Ex. 6

Of the other badges, films and foils of the 25 sets which were checked in this manner, only slight contamination of a few of the badges was noted. The results of the survey of Pearson's set, 7003, have been included because during the time of the incident Pearson had inadvertantly left his badge home, so it was not exposed to any unusual radiation or contamination.

Landauer said the film was processed at a temperature of 68° F ± 2° and noted that the solution which was used was probably one month old. He noted, however, that it had been stored in covered, one gallon tanks and that he had instructed the employee, Wright, to test the solution by first developing a few unexposed and a few exposed films in it and then examining these films. He stated that she did not report whether or not she had performed this test, but he assumed that she had. Solutions used were Dupont Liquid X-ray Developer and Dupont Liquid X-ray Fixer. A short wash in clear water was used immediately following development. Landauer further noted that a set of a calibration films which had been exposed to the following total doses of Cesium 137 gamma radiation; 0.5 r, 1 r, 2.5 r, 5 r, 10 r, 25 r, 50 r, and 100 r had been prepared a few days earlier and was sent to the New York Office by air

freight. These calibration films were developed with the United Nuclear films.

Landauer stated that Wright called him around 8 p.m. on Saturday, July 25, and reported that they had read the density of the films on a photovolt densitometer which is also on hand at the New York Office. He said that Wright reported that two of the films had a higher density than could be read with the densitometer on hand, which, he reported, could read a maximum density of 3. Landauer said he then asked Wright to give him the results of the density measurements over the telephone. During this transfer of information, Landauer said, either through an error of Wright's reporting or of his recording of the information, some of the density readings attributable to Peabody's film were inadvertently applied to other films. He stated that this is why the initial report given by telephone had indicated a dose in excess of 300 r for [ ] film. He further noted that 300 r + had been reported for Peabody's film because this was the highest density that could be read on the New York densitometer. Ex. 6

Landauer then asked that the films be sent to him by air freight so that he could examine them. He reported that the films were received some time after 7 p.m. on Sunday, July 26, at O'Hare Air Field in Chicago. He stated that he took the films to his plant and reread the density on an Ansco MacBeth Densitometer. He noted that this densitometer could read up to 4.72 density units. He further noted that the reproducible readings were possible to within .05 to .1 density units. He stated that he re-evaluated the films and based his results on the reading beneath the lead filter on the three high exposure films. The table below presents information on the initial readings done in New York and the final readings done in Chicago:

| Film Number | New York Dose Report | Chicago Dose Report |
|---|---|---|
| 7009 (Peabody) | over 300 r | over 700 r |
| [ 2211 ] | over 300 r | 50 r |
| [ 7000 ] | 1 r | 1 r |
| [ 7010 ] | 2.5 r | 2.5 r |
| [ 7021 ] | 45 r | 3.5 r |

Ex. 6

All of the other exposures were less than 310 mr and can be found in the copy of the Landauer dosimetry report attached as an exhibit to the report. Identification of the films is positive because both the film number and the name of the individual is stamped into the film itself.

With regard to the film worn by Peabody, Landauer pointed out that the insensitive film had been exposed to such a degree that it had reached saturation. That is, that a very large increase in dose will result in only a very small change in density. For example, in a typical calibration curve, an exposure of 500 r might produce a density of 3.45, and exposure of 600 r might produce 3.55 while 800 r might produce 3.6. Since the reproducibility of the instrument is 0.05 density units at best, and any slight variation in density along the surface of the film might produce a larger variation in reproducibility, such as .1 density units or more, it is apparent that it is impossible to report the actual exposure on the film in more concrete terms than to simply indicate that it is in excess of some figure. In this case, that figure was 700 r.

The film worn by [ ] number 2211, was the only film which proved to be difficult to evaluate. While all other films revealed a pattern which was consistent with exposure to high energy gamma radiation, this film displayed an uneven density pattern. Filters could not be distinguished. Narrow bands at the top and bottom of the film displayed much less density that the major portion of the film. A few small spots were discernible and the rest of the film was characterized by a rather an uneven density pattern. Landauer's opinion was that it did not appear characteristic of improper processing, that reversal did not appear to have occurred because the more sensitive film had not displayed the characteristics of the reversal, that the film could not be said to display clearly the results of contamination in that only a few spots were discernible and these were not very dark, and that although the film bore the faint resemblance to one which had been exposed in a cloud of radioactive gas, that on the whole it was impossible to determine from examining the film just what had caused the unusual density pattern. He noted that the 50 r which was reported for this film was determined from a reading taken at thecenter of the badge and from an assumption that it resulted from a high energy radiation.

Ex.6

A check was made of the sensitive films worn by Peabody and [ ] to determine whether or not any sign of radioactivity could be observed. The check was performed using a Nuclear Measurements Corporation Model DS 1A scaler and a thin end window GM tube. The GM tube was positioned in such a manner that the film being counted was located less than 0.2" from the thin end window. The GM tube was unshielded. After instrument warm up and a check of the geiger plateau, alternate counts of background and the film worn by Peabody and that worn by Holthaus were made. No indication of radioactivity was noted on [ ] badge. However, Peabody's badge displayed activity of about four times background. With the geiger tube at 850 volts a background of 29 counts per minute was noted from a one minute count. With the same settings, Peabody's film showed a count rate of 144 counts per minute as a result of a three minute count. This work was done at about 4:20 p.m. on August 6, 1964.

Ex.6

Ex.6

Alan Kawaters, eastern sales manager, and Patricia Wright, secretary and technician for R. S. Landauer in New York were contacted. Information they provided was essentially the same as that given above. Significant additions are discussed in the following paragraphs.

Wright stated that Peabody's film was partially covered with what appeared to be a yellow splash. In addition, she noted that the sensitive and insensitive component films in Peabody's packet were stuck together but she was able to separate them with her gloved hands in the darkroom. She further noted that the Peabody films did not display unusual markings when examined in the after-fix washing. She pointed out that both films were quite black.

Kawaters noted that Geil had notified him that Peabody's film packet was contaminated and that it read 70 mr/hr on contact. He said that the films, as he received them at NYOO, had been packaged in such a way that Peabody's film packet was separately boxed and was kept about eight inches to a maximum of one foot from the other film packets.

Wright noted that water temperature was maintained at $68^{o} \pm 1/4^{o}$ during processing by means of a Bar-Ray Positemp A, temperature control unit. She noted that the sensitive films were first developed together with the 0.5, 1, 2.5, 5 and 10 R calibration films and two unexposed films. The same processing was then done for the insensitive films which were processed with the 25, 50 and 100 R calibration films and two unexposed films. She noted that blank test films had not been run first to test the solutions but that the solutions were only a few days old. She said that density readings were done on a Photovolt, model 400 R densitometer, which has the ability to read a maximum density of 3.

The processing rack was examined to see if the bands on [Holthaus] film could have been caused by improper loading or by having the film extend above the solution level. It was found that because of the construction of the film processing rack, it would be impossible for a single film to display the effect of low solution level without all other films showing the same pattern as well. Wright said she was sure she had not loaded two films into the same slot because she spaced each film about 5 slots beyond the preceding film.

Kawaters said he believed the erroneous first dose report might have resulted because, through an error, the density on a sensitive film might have been read to Landauer when he was expecting the density readings from an insensitive film.

## VEHICLE SURVEY

All vehicles which were known to have been in the United Nuclear parking lot, or within 1300 feet of the plant (principally on the plant service road) between 6 p.m. and midnight on the night of July 24, 1964 were located and surveyed. The survey consisted of an instrument probing both inside and outside of each vehicle, with an Eberline, Model PAC-3G, Alpha Survey instrument and a Nuclear Measurements, Model GS-2, GM Survey instrument (equipped with a 1.8 mg/cm$^2$ window GM tube). In addition, wipes were taken at the following locations on each vehicle: front tires, rear tires, all door handles, front floor and pedals, rear floor, steering wheel and buttons.

The instrument survey, which was done either alone or with a United Nuclear employee, revealed contamination in only one case. This was the Westerly ambulance, where a PAC-3G detected a spot on the ambulance floor under the stretcher which displayed 1500 disintigrations per minute alpha. The wipes are still being evaluated.

A member of the Westerly Volunteer Ambulance Corp. was informed of the contaminated spot. He was told that it did not represent a health hazard but that if he wished to he could scrub the spot which had been marked. He expressed his desire to clean the spot.

Information on the surveyed vehicles is presented on the attached sheets.

| License Number | Owner | Vehicle Location on 24-25 July, '64 | Time at Location | Date and Time of Survey | Vehicle Location at Time of Survey |
|---|---|---|---|---|---|
| [redacted] Ex. 6 | R. A. Holthaus UNC Plant Supervisor | Emergency Shack | 6:30 p.m. to 6:50 p.m. | 29 July 10:20 a.m. | [redacted] Ex. 6 |
| | C. E. Smith UNC Shift Supervisor | UNC Parking Lot | Time of Incident More Than One Hour Thereafter | 29 July 11:20 a.m. | [redacted] |
| | R. Peabody UNC Operator | UNC Parking Lot | Time of Incident More Than One Hour Thereafter | 27 July 9:15 p.m. | [redacted] |
| | R. Mastriani UNC Operator | UNC Parking Lot | Time of Incident More Than One Hour Thereafter | 27 July Afternoon | UNC Parking Lot |
| | G. J. Spencer UNC Operator | UNC Parking Lot | Time of Incident More Than One Hour Thereafter | 27 July Morning | UNC Parking Lot |
| 49670 Commercial (RI) | H. Coon Burns Plant Guard | UNC Parking Lot | Time of Incident More Than One Hour Thereafter | 27 July 4:30 p.m. | UNC Parking Lot |

| License Number | Owner | Vehicle Location on 24-25 July, '64 | Time at Location | Date and Time of Survey | Vehicle Location at Time of Survey |
|---|---|---|---|---|---|
| 20038 Commercial (RI) | UNC Chevy Pickup | UNC Parking Lot | Time of Incident More Than One Hour Thereafter | 27 July 10:30 a.m. | UNC Parking Lot |
| State Police 70 (RI) | Lt. Jack-vany State Police | Within 1300 Feet | After 6:30 p.m. | 29 July 9:15 a.m. | State Police Barracks Hope Valley |
| State Police 76 (RI) | Trooper T. G. Griffin State Police | Within 1300 Feet | After 6:30 p.m. | 27 July 5:10 p.m. | State Police Barracks Hope Valley |
| State Police 79 (RI) | Trooper State Police | Within 1300 Feet | After 6:30 p.m. | 27 July 5:35 p.m. | State Police Barracks Hope Valley |
| Ex. 6 [redacted] | Major James Iacoi, State Police | Within 1300 Feet on Plant Service Road | After 6:30 p.m. | 28 July 8:45 a.m. | State Police Barracks |
| A 585 (Ambulance) (RI) | John Sheppard Westerly Volunteer Ambulance Corp | Emergency Shack on Plant Service Road | After 6:40 p.m. | 28 July 6:25 p.m. | Westerly Oldsmobile 100 Main - Westerly |
| Police 151 (RI) | Chief Richards Charles-town Police | Within 1300 Feet on Plant Service Road | After 7:30 p.m. | 28 July 4:30 p.m. | UNC Parking Lot |

| License Number | Owner | Vehicle Location on 24-25 July, '64 | Time at Location | Date and Time of Survey | Vehicle Location at Time of Survey |
|---|---|---|---|---|---|
| State of R. I. 4 (RI) | Santo Amato State Civil Defense | Within 400 Feet Intersection Roundhouse Road And Plant Service Road | After 7:30 p.m. | 27 July 8:00 p.m. | UNC Parking Lot |
| [redacted] | E. A. Barton UNC Operator And Health Physicist | Emergency Shack | After 8:45 p.m. | 27 July 4:10 p.m. | UNC Parking Lot |
| [redacted] | R. C. Johnson UNC Supervisor | Within 1300 Feet on Plant Service Road | After 8:30 p.m. | 27 July 12:30 p.m. | UNC Parking Lot |
| [redacted] | J. B. Geil UNC Health Physicist | Within 1300 Feet on Plant Service Road | After 10:00 p.m. | 27 July Noon | UNC Parking Lot |
| [redacted] | J. S. Stallak UNC Security Officer | Within 1300 Feet on Plant Service Road | After 10:00 p.m. | 27 July Afternoon | UNC Parking Lot |
| [redacted] | Dr. Lasky UNC Consulting Physician | Within 1300 Feet on Plant Service Road | After 7:45 p.m. | 28 July 8:30 p.m. | [redacted] |

Ex. 6

84

| License Number | Owner | Vehicle Location on 24-25 July, '64 | Time at Location | Date and Time of Survey | Vehicle Location at Time of Survey |
|---|---|---|---|---|---|
| (The following vehicle was not present at the time of the incident and first came within the vicinity of the plant during the early morning hours of 27 July. It was surveyed to provide background data.) | | | | | |
| Ex. 6 [ ] | P. J. Knapp USAEC | UNC Parking Lot | 27 July 3:00 a.m. | 28 July 11:35 a.m. | UNC Parking Lot |
| (The following two vehicles were not available for survey at Rhode Island. UNC Health Physicists reported that they were surveyed at New Haven by Health Physicists of the Company and that no trace of contamination was found.) | | | | | |
| | Dr. Brubaker | Within 1300 Feet on Plant Service Road | After 10:00 p.m. | Completed by 28 July | New Haven |
| | Charles Joseph - Materials Control Superintendent | Within 1300 Feet on Plant Service Road | 10:10 p.m. | Completed by 28 July | New Haven |
| (The following vehicle arrived after midnight 27 July. One employee who had been contaminated slept for a few hours in the back seat of this car on the morning of 28 July.) | | | | | |
| Ex. 6 [ ] | W. R. Pearson UNC Supervisor | Within 1300 Feet on Plant Service Road | After Midnight 27 July | 30 July 4:45 p.m. | UNC Parking Lot |

ACTIVITIES AT THE RHODE ISLAND HOSPITAL, PROVIDENCE, RHODE ISLAND

7/25/64 THROUGH 7/28/64

The Compliance representative arrived at the hospital at approximately 0400 on 7/25/64. At this time, Peabody was being attended by two staff physicians and one nurse. Dr. T. Forsythe, Associate in Radiology and Radiation Safety Officer for the hospital, had just left. A phone call was made to Dr. Forsythe and he stated he had just gone to bed and would be back early that morning. He volunteered to return immediately to the hospital if I felt it was necessary. He was advised that it would not be necessary for him to return immediately.

The situation existing upon arrival was that Peabody had been placed in an isolation room in an emergency holding ward. He was under intensive medical support. Medical personnel were wearing pocket ion chambers and using X-ray aprons and rubber gloves when attendant upon the patient. They stated that the patient had been decontaminated but still appeared to be radioactive. A portable GM survey meter was in evidence in the ward. The ward had been emptied of beds but contained the ambulance stretcher upon which the patient had been brought in, and the stretcher upon which he had been while being decontaminated. The usual medical accouterments for hospital wards were also present.

A preliminary check for contamination in the ward and adjacent areas revealed that low level contamination existed randomly in these areas. Dose rates up to one (1) mr/hr (beta-gamma) at 1 centimeter from the floor were obtained at this time. Control procedures were instituted and attendant medical personnel were instructed in these control procedures. In the absence of regular shoe covers, the use of paper bedroom shoes and paper bags was employed. The shoes of the attending nurse and one physician were confiscated because of contamination (0.5 to 1.5 mr/hr, beta-gamma). These were decontaminated and returned at a later period.

An examination of the patient's chart indicated that the admittance work-up had been done by Dr. R. F. Judkins and that Dr. J. Karas was the physician responsible for the medical management of the patient. Dr. Judkins is a resident at the hospital, and Dr. Karas is in private practice but also holds a position as director of the Accident Room. He was in the accident ward when Peabody was brought in and assumed medical management of the patient although the decontamination and radiological safety procedures for handling the patient were set up and carried out by Dr. T. Forsythe and Dr. S. Frater, both of whom are Diplomates in Radiology and both are authorized users under License No. 38-1763-2. Dr. Forsythe is also an authorized user under 38-1763-1 and additionally serves as Radiological Safety Officer for the hospital.

Information from Dr. Stephen Frater, M.D.

Dr. Frater stated he had been at Rhode Island Hospital since 1958 and was a Diplomate in Radiology. He had just arrived at the hospital when Peabody was brought in by Westerly Ambulance Corps. The ambulance driver, his assistant and Mr. G. Spencer accompanied the patient. Spencer had been sitting inside the ambulance with the patient. Peabody's clothes were removed, and he was transferred in a clean sheet on to a stretcher. The dose rate from Peabody (midline of body) was 20 mr/hr (beta-gamma) at two feet. He informed Dr. Karas who was passing by that the patient had the above dose rate and recommended that the patient be decontaminated, and warned him to use rubber gloves. He states that some confusion existed, while Karas worked on the patient Dr. Frater set up a contamination area. Westerly Hospital had alerted Rhode Island Hospital that they were sending a person over who had been exposed to large doses of radiation. The accident Ward received the call and immediately notified Dr. Forsythe and Dr. Frater. Decontamination took about two hours. The hospital does not have a room with a floor drain so Dr. Frater used an old time stretcher with metal strips instead of a solid metal support. The patient was transferred to it. Two orderlies washed him down. The orderlies were in full protective clothing including plastic aprons, rubber gloves, and slippers. All wash fluids were saved in jugs, as were all articles of clothing and linen that was used on Peabody or had come in contact with him. After this, they moved the patient back to the stretcher bed. About this time, the phones began to ring constantly with calls coming in from all sources. A good part of the night was spent in taking care of the ambulance personnel (2). The ambulance was also checked with a GM survey meter. Highest reading obtained was less than 2.0 mr/hr. The ambulance stretcher was found to be contaminated and retained. Some activity was found on the driver's shirt and hands. (0.1 - 0.2 mr/hr.) The driver was the one holding the head end of the stretcher. [ ] had a reading of 40 mr/hr on one hand, 10 mr/hr on the other. He had low level activity on his clothes and was decontaminated. His hands remained active to about 2 mr/hr. His finger nails were cut and fingers rescrubbed. He was discharged when the dose rate reduced to less than 2.0 mr/hr. His clothing was checked, both shoes and wrist watch were hot (levels not recorded). About this time, the police called in that four men were coming in to be checked (exact time unknown). Ex. 6

Dr. Frater stated that at 8 p.m. he obtained the following readings on Peabody:

30 mr/hr at 2 feet from midline of torso.
18 mr/hr at 2 feet from midline of torso after decontamination.
10 mr/hr at 2 feet from his feet.

Dr. Frater stated that at about 8 p.m. he obtained the following readings on Spencer:

40 mr/hr at contact with left hand
10 mr/hr at contact with right hand

At 12 p.m. after repeated washing the following readings were obtained on Spencer:

1.5 mr/hr at contact with left hand
0.4 mr/hr at contact with right hand

He was discharged at this point. All readings taken by Dr. Frater were with an open window GM survey meter.

The following information from Dr. Frater relates to the four men who arrived by police cruiser between 11 p.m. and 12 p.m. on 7/24/64.

[ ] July 24 11 p.m. Ex. 6

Contamination of right hand 40 mr/hr (beta-gamma) at contact. Decontaminated to 1.5 mr/hr and released

[ ] July 24 11 p.m. Ex. 6

No detectible contamination - released

[ ] July 24 11:06 p.m. Ex. 6

0.2 mr/hr on hands - cleaned up and released

[ ] July 24 11:06 p.m. Ex. 6

15.0 mr/hr on badge, 1.2 - 1.5 mr/hr on hands, badge retained and bagged, hands decontaminated down to 0.4 mr/hr then released.

Information from Dr. Thomas Forsythe, M.D.

Dr. Forsythe stated he has been on the staff at Rhode Island Hospital for eleven years, three years of which were as a resident. He is the Radiation Safety Officer at the hospital.

Dr. Forsythe received a phone call from Dr. Judkins stating that there had been a nuclear accident in Westerly and that a man (severly exposed) was coming in. Almost immediately an ambulance arrived and Peabody was wheeled out by ambulance personnel. [Spencer] was noted to be sitting next to the patient. Dr. Karas and Dr. Judkins were waiting. Peabody complained Ex. 6

of severe cramping belly pains, he was moved into the ward and treatment was started. He asked [ ] what had happened and he [ ] made Forsythe identify himself. [ ] stated that Peabody had received a fatal dose. While the patient was being cared for, the area was isolated and decontamination procedures were started. Forsythe requested plastic bags, lead aprons, radiation signs, etc., to be brought to the ward. Peabody was monitored as were the others with him. The phone began ringing. First call came from a Mr. Graveson in Scarsdale, New York, Division of Radiation Safety, AEC, then Dr. Albert of NYO. Dr. Forsythe then called Mr. R. Cowing of the Cancer Research Institute. New England Deaconess Hospital, radiological consultant for Rhode Island Hospital. Forsythe stated that Cowing told him to "isolate, monitor, and contain." Next call was that a representative from CO:I would be arriving. Dr. Forsythe next contacted a Dr. Malone, reportedly with experience from work in Japan in radiation injuries. Was advised by Malone that the patient's condition and blood work indicated nothing serious.

At 0630 on 7/25/64, the Director, Region I, Division of Compliance, was contacted and advised that the patient had probably received a fatal exposure, that the hospital staff was not capable of making an evaluation of the patient's exposure, and that a Commission Medical Representative should be in attendance. Three names were supplied by the Director and Dr. John B. Stanbury, the first name on the list was contacted at approximately 0700 that day. Dr. Stanbury subsequently arrived at Rhode Island Hospital between 0900 and 1000 that day.

Shortly after 0700, the linen on Peabody's bed was changed and a reading of one (1) mr/hr, beta-gamma was obtained on the linens. The following readings were obtained:

Face and Forehead - at 1 cm with Juno

| | | | |
|---|---|---|---|
| | | Gamma | - 10 mr/hr |
| | | Beta, Gamma | - 100 mr/hr |
| | | Alpha, Beta, Gamma | - 200 mr/hr |
| Chest | | Gamma | - 5 mr/hr |
| | | Beta, Gamma | - 7 mr/hr |
| | | Alpha, Beta, Gamma | - 10 mr/hr |
| Left Hand | GM | Beta, Gamma | - 5 mr/hr |
| Chest | GM | Beta, Gamma | - 5 mr/hr |
| Feet | GM | Beta, Gamma | - 2 mr/hr |

At approximately 0800, permission was obtained from Dr. Karas to talk to Peabody. At this time Peabody was lucid, but talked with difficulty because of a pronounced dyspnea. The following is Peabody's statement:

According to Peabody, he was looking for an empty bottle, but had not located any. In the past, he had taken eleven liter flasks of TCE with low concentrations of U-235, that is, less than 1000 ppm and had emptied them in the "carbonate wash tank." At this time there were about six full bottles, three were marked TCE "sampled" no assay on them, 2 were marked TCE with either 640 or 680 ppm marked on them, and one other bottle of TCE - no assay on it. This was the one he took. The label was held on with an elastic band and he stated that the labels could easily be knocked or dropped off. Peabody stated that just before the accident he had talked to both foreman about this. He stated he had discussed the fact that apparently some bottles were not properly labeled with Clifford Smith, Dale Chapman, George Spencer and Bob Mastriani. According to Peabody he picked up the bottle in his arms and carried it to the wash tank. He said the wash tank was about 18" in diameter and 25" in depth and was about half full of sodium carbonate solution. He had gotten all but about the last liter into the tank when something happened. He believes he saw a bluish white light, was knocked back about six feet, was dazed but not unconcious, heard the criticality siren, got up and started running down three flights of stairs toward the gate, stripping off his clothes as he went. He stated his film badge was somehwere on his clothes.

Following the talk with Peabody, a call was made to W. Browne of this office at the plant site to advise him to get hold of the film badge. K. O'Brien, a member of the REAT group from NYO answered the phone. This information was given to him and he said he would take care of it. Subsequently, it was learned that this had been done.

Dr. Stanbury arrived some where between 0900 - 1000 a.m. and upon his question as to what his authority was he was informed that he was there as an observer for the Commission, that he was free to offer advice and assistance if requested, that he should contact Dr. Dunham, AEC should he not be satisfied that the treatment and care of Peabody was adequate. He was also told that in a case of this kind it was extremely important that biological samples be obtained and counted as quickly as possible in order to assist in estimating the exposure. He was told that the hospital staff was not equipped nor staffed to carry this out and in this matter he should take the initiative. Following this, Stanbury stated he had made arrangements with G. Brownell at Massachusetts General Hospital to make these evaluations. Arrangements were also made with the hospital staff to save all body excreta and completely identify such materials as to volume, time, etc. These samples were to be used in further evaluations of the patients exposure.

During Saturday 7/25/64 the following events transpired at the Hospital:

Peabody's left hand was extremely swollen and attendant medical personnel had wanted to remove a gold wedding band from his left hand. Peabody had told them he would not allow them to remove it, an explanation to Peabody that the gold ring would be extremely valuable in estimating the actual radiation exposure, resulted in obtaining his permission to have the ring removed after promising to have it returned to him. The ring was cut off and readings obtained with a Juno ion chamber were:

| | |
|---|---|
| Shielded gamma | - 13 mr/hr |
| Beta-Gamma | - 80 mr/hr |
| Alpha-Beta-Gamma | - 150 mr/hr |

The ring was delivered to Dr. Stanbury along with a sample of hair from Peabody's head for evaluation at Massachusetts General Hospital. Two calls were received from Vice Admiral H. G. Richover. The first call was for general information on the accident. The admiral was informed that the CO:I representative had not been at the plant and could not factually discuss that phase. He asked how the accident had happened and he was told that apparently it had occurred while pouring from a safe geometry vessel to an unsafe container. He pointed out that he had no responsibility in that this was a licensed operation, but that he had some interest inasmuch as they had been processing navy material. He asked that his regrets be conveyed to Mrs. Peabody and to send him any newspaper clippings on the accident. Both requests were complied with. The second call from Admiral Richover requested medical information on the condition of Peabody. This call was referred to Dr. J. Karas.

Some concern was expressed by the Chief of Pathology and the Chief of Medicine concerning the safety of their laboratory personnel carrying out blood counts and other biological procedures on specimens from Peabody. It was mentioned that two of the technicians were pregnant and that they were concerned about this. It was pointed out to them that there would be no hazard to personnel doing this work and asked them if they were concerned when they handled specimens routinely received from patients treated with isotopes. They replied in the negative and it was pointed out that in both cases the hazard was in the same order of magnitude. They were advised to follow the same procedures as to disposal and washing of the slides and glassware used for Peabody's specimens as would ordinarily be used on specimens from radioisotope patients.

On 7/26/64, at approximately 0900, information from the Compliance Division indicated that the film badge of [ ] had been evaluated at 300 r plus and that [ ] badge had been evaluated at 45 r. [ ] was immediately contacted and he was told that he, [ ] were to report back immediately to the hospital.

Ex. 6

He agreed to this and all but [ ] were at the hospital by 1100. Upon consultation with medical personnel the decision to hospitalize [ ] for observation was reached. [ ] was released, but was to be followed medically until further notice. The same would apply to [ ] Biological samples from these men were taken by Dr. Stanbury to Massachusetts General Hospital for evaluations.

Ex. 6

Mr. E. Keith, News Service Branch, Division of Public Information, AEC, arrived the night of 7/25/64 and he was briefed on the situation by Dr. Karas and myself.

Dr. M. Mann, Assistant Director for Nuclear Safety, AEC, arrived the afternoon of 7/26/64 and talked to Holthaus. Peabody's condition was such that it was medically inadvisable to talk to him at that time.

Peabody expired at approximately 7:20 p.m. on 7/26/64. Following removal of the body to the morgue, the ward was secured and was to remain secured until the area had been checked by Mr. R. Cowing who was expected to arrive at 10 a.m. on Monday. At approximately 11 p.m., a Dr. Lushbough and a Miss C. Gooch arrived from Oak Ridge National Laboratories. Reportedly, Dr. Lushbough is an expert in radiation syndrome pathology and Miss Gooch is carrying out studies in chromosomal aberrations from radiation exposure.

Information was received that Dr. Lushbough was at the hospital and that he was disturbed by the fact that the post mortem on Peabody had been scheduled for the next day. Lushbough stated that the longer the autopsy was delayed the less information could be obtained from the pathology specimens. He had spoken to the Chief of Pathology, to Dr. Karas, and to anyone else who would listen to him but had been unable to have the autopsy moved up. Inasmuch as the possibility existed that Lushbough was right, he was told to talk again to Dr. Fanger, Chief of Pathology and tell him that radiological health coverage for the autopsy would be provided, if Dr. Fanger would authorize the autopsy. The post mortem commenced at about 1:00 a.m. on 7/27/64 after assurance had been given to Dr. Fanger that a personnel hazard did not exist and that the operation would be monitored. Pocket chambers were issued and monitoring was carried out during the post mortem. The autopsy lasted until about 0530 that morning and personnel exposures in excess of five (5) millirem did not occur. The area was surveyed and contamination was not detected after completion of the autopsy. Dose rate readings taken on internal organs; brains, lungs, heart, liver, spleen, etc., did not reveal dose rates in excess of 0.5 mr/hr (beta-gamma) at 1 cm with a GM survey meter. Dose rates taken on the body immediately prior to the autopsy gave the following readings:

| | |
|---|---|
| Head (top) | 13.0 mr/hr beta-gamma |
| Forehead & face | 3.0 mr/hr beta-gamma |
| Left Ear | 3.0 mr/hr beta-gamma |
| Right Ear | 0.5 mr/hr beta-gamma |
| Thyroid | 3.0 mr/hr beta-gamma |
| Thorax | 3.0 mr/hr beta-gamma |
| Right Breast | 1.5 mr/hr beta-gamma |
| Left Breast | 1.8 mr/hr beta-gamma |
| Left Shoulder | 1.5 mr/hr beta-gamma |
| Right Shoulder | 1.5 mr/hr beta-gamma |
| Left Elbow | 1.0 mr/hr beta-gamma |
| Right Elbow | 1.0 mr/hr beta-gamma |
| Umbilius | 4.0 mr/hr beta-gamma |
| Pubic Area | 5.0 mr/hr beta-gamma |
| Left Hand | 5.0 mr/hr beta-gamma |
| Right Hand | 3.0 mr/hr beta-gamma |
| Left Thigh | 1.5 mr/hr beta-gamma |
| Right Thigh | 1.3 mr/hr beta-gamma |
| Dorsal surface upper Right Leg | 1.5 mr/hr beta-gamma |
| Dorsal surface upper Left Leg | 1.5 mr/hr beta-gamma |
| Right Knee | 1.1 mr/hr beta-gamma |
| Left Knee | 2.0 mr/hr beta-gamma |
| Teet | 0.5 mr/hr beta-gamma |

Dr. R. Cowing, the radiological consultant for the hospital arrived Monday morning with two assistants. The survey conducted by him in all areas failed to reveal evidence of contamination. In a discussion with Mr. Cowing it was agreed that the body should be released to the mortician without restrictions as to radiation. Mr. H. Olsen, Assistant Hospital Administrator was so informed as were the medical staff.

On Tuesday, a request was made to attend a staff meeting in the office of the Executive Director of the Hospital. The hospital planned to release a statement to the staff that the hospital was clean and that a radiation hazard did not exist, nor had any staff personnel received excessive exposures. Attendant at this meeting were:

Mr. Herlof V. Olsen, Assistant Director
Dr. Thomas P. Forsythe, Radiologist
Dr. Stephen Frater, Radiologist
Dr. Joseph Karn, Internal Medicine
Dr. Milton Homolsky, Chief of Medicine
Mr. Oliver G. Pratt, Executive Vice President
Mr. Lloyd Hughes, Executive Director

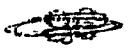
The medical records of Peabody, Holthaus and Smith contain additional information as to dose rates, contamination levels, etc., and are appended to this report.

C. Smith Interview at R.I.H. by E. Resner at 8 p.m. on 7/26/64

Smith stated he had been at United Nuclear since January 20, 1964 as a shift supervisor. Prior to this he had been with Byrd and Son, East Walpole, Massachusetts as a quality control chemist. This work did not involve radioactive materials. In regard to radiation safety training at the plant, Smith stated that John Geil was down once to give a program and that Barton had not given any formal instructions. Smith stated he has never seen or heard of Part 20, 30 or 70 regulations. In answer to the question as to what the permissible levels of radiation were, Smith stated that Mr. Holthaus had set this at 7 to 8 mr/day. Smith stated that three people worked under him, Bob Mastriani, George Spencer and Robert Peabody.

Smith stated that on an estimate of the time of the accident Coon told him the accident had happened at 6:06. Previously, he (Smith) had looked at his watch at 6 p.m. This was prior to the accident. Smith stated that at the time of the accident he was on the first floor at the south side of the stainless steel dissolver and that the siren gave the first indication of an accident. According to Smith his actions were that he ran toward the west, inside the building, there is a retaining wall between the storage tanks and three tray dissolver hoods; went into the shipping and receiving area, then through the hot and cold change rooms, out the north exit by the guards desk, up the road to the emergency shack. On the way he noticed Bob Mastriani behind him. Coon was already outside. He noted that Coon's station at the guard desk is at the northwest corner of the building. As Smith ran he looked to the south side and saw George Spencer running, and then saw Peabody run. He (Peabody) stopped, shed his clothes outside the south gate and then kept on running. Stopping before he got to the emergency shack at approximately 20 to 30 yards distance and then sat down. Smith went to him and asked him what had happened. Peabody said he had poured ICE into the sodium carbonate make-up tank. Both went to the shack. Peabody sat outside about 20' away to the south, then layed down and was nauseated. Someone got blankets and covered him. Smith obtained a beta-gamma survey instrument turned it on, put it on battery check, then switched to the maximum scale (100 X scale is the first position). He did not use this setting because he thought there would be a high reading, but because it is the first position on the meter. He obtained a reading between 90 and 100 mr/hr with the meter set on the desk. He got on the phone and called Mr. Holthaus who was not home at the time. His wife told him where Holthaus was. He informed Holthaus' wife what had happened, then started to call people on the emergency list. Smith states he did not call the Civilian Defense but that he did call the State Police. During the time he was calling, he instructed the guard to block the road, and sent someone around the plant to block the north road, (Smith was confused as to what people were blocking which road). Bob Mastriani was waiting at the north road for Dr. Lasky. At 6:25 p.m. calls were completed. Rechecking

between 6:30 and 7:00 the reading had dropped to 80 - 90 mr/hr. At 7:00 p.m. Smith checked the Indium foil on the film badges. Readings obtained were 20 to 30 mr/hr on his badge, Coon's read 10 to 30 mr/hr, Mastriani and Spencer were around 40 mr/hr. Background reading in the shack had dropped to 12 mr/hr at this time. Peabody's removal - ambulance came - two men in the ambulance picked him up and put him on a stretcher then put him in the ambulance. Sent George Spencer with him. Does not know where George Spencer sat. At this time Mastriani was at the north road. Dr. Lasky arrived from the south road and asked where Peabody was. He was informed and Dr. Lasky followed the ambulance. Holthaus arrived before the ambulance. Holthaus took a beta-gamma meter and went towards the plant, returned after the ambulance left and received telephone calls. Smith stated that Holthaus was instructed from Washington on one call to get the stuff out of the make-up tank into a safe geometry. Smith assumed that the caller was an assistant to Rickover. (Iltis). Smith assumed Johnson called Rickover. Smith stated that Holthaus told him that he was going to try to open a tank valve. Smith put Mastriani on guard over Peabody's clothes. Holthaus and Smith entered the north door by the guard desk. Went into the shipping and receiving room and on to the production floor. On the production floor the meter read 100 mr/hr. They decided to get to the third floor via the roof. They took a ladder and got up on the roof. They measured 100 mr/hr at 15 to 20' from the tower area. Left the area by the same route. On arrival at the north gate, there was a state police wagon or a state police car (not sure which). They gave them two 500 r meters and re-entered the plant at 7:45. They went to the north, the instrument on 100 X scale and did not observe a reading on the first floor with the high range instrument. The low range instrument was off scale on the first floor. In the pulse column room they noticed a green-yellow liquid splashed on the floor. They did not get a dose rate reading on the liquid. On the second floor they looked in, still did not get a reading on the high range instrument. Holthaus went into the second floor area and opened the valve from the make-up tank. (Smith not sure of this.) Next went to the third floor, noticed liquid all over the floor. Holthaus went in, Smith stayed at the door. Bottle was in tank up-side-down with the bottom turned toward the west. Holthaus pulled the bottle out with his bare left hand and dropped it on the floor then said, let's go down and drain it. 100 to 150 r/hr at the door. Holthaus stated he read 300 r at the kettle. They went to the second floor, there was nothing to drain it in. Went to the first after Holthaus. Went and got gallon bottles. Holthaus went to the second floor and opened the drain to the IC9 pulse column. Smith drained this into one gallon bottles while Holthaus was on the second floor. They kept draining until the tank on the third floor was empty. He states some material was left in the IC9 column. Smith states these bottles read 100 to 200 r/hr and were placed around the first floor and along the south side line. Then they left the building going straight west to the emergency shack.



Got there at 8:30. Changed clothes, put their hot clothes in the roped off area, then sat down at the end of the road going south. At 9:15, Holthaus and Smith went to the building to shower, changed clothes and monitored themselves. Smith's left hand read 2 mr/hr after showering. Then they went to the hospital. Stated he was checked by the radiologist who used a beta-gamma survey meter. Left at 12:20 or 12:30 went to the plant, and then went home. (The following relates to direct questions asked Smith and his answers in response to the questions.)

1. Was the taking of 11 liter flasks to the third floor considered standard procedure?

   This had been done before to scrub TCE. States this was a routine written procedure if tank was empty of sodium carbonate. Stated this was not a plant authorized procedure and was authorized by Smith only.

2. What discussion did Peabody have with you concerning improper labeling?

   On that shift, Peabody stated that he thought some of the bottles were mis-labeled. Smith stated he told Peabody that he assumed what was on the labels was true. Smith further states that he believes he and Peabody were alone during this conversation.

Holthaus Interview at R.I.H. by E. Resner at 6 p.m. on 7/26/64

According to Mr. Holthaus, he has been at United Nuclear since last October as Plant Superintendent. Prior to this, he had been a Supervisor of Decontamination and Recovery Procedures for 10 years at the Goodyear Atomic Corporation. In college, he majored in chemical engineering. He has received no formal training in radiological safety. He stated that he reports directly to John Lindberg, Vice-President. Holthaus stated that he has three shift supervisors under him. These are Dale Chapman, Bill Pearson and Cliff Smith. Holthaus stated that he is the Radiation Safety Supervisor at the plant and that Mr. Elmer Barton functions as the Health Physics Technician under him. He stated that the duties of Barton include the taking of air samples which are sent to New Haven for counting. He also takes wipes which are sent to New Haven for counting. He conducts alpha surveys with portable instruments. He is responsible for checking the nuclear alarm system, for obtaining samples of effluents and samples from the lagoon, with these samples being evaluated at New Haven. Additionally, he is responsible for flow and pumping procesures to the lagoon. Barton is also responsible for acting as safety supervisor in that he checks personnel to see that they wear safety galsses or goggles. Barton also conducts surveys to check for safety geometry storage. He also monitors trash but does not make a record of these surveys. On Wednesday, Barton is required to go to New Haven to discuss problems in radiation safety and additionally to pick up the pay checks for the plant. During this time, he also checks and calibrates instruments. Holthaus stated that the health physicist from New Haven has visited the plant three times in the past on a once a month average. Barton also gives some instructions in health physics to plant personnel.

According to Holthaus, a total of 19 people are employed in the plant. There are 9 operators, one mechanic, one janitor, one chemist, one Health Physics Technician, three supervisors, two secretaries and himself as plant superintendent. According to Barton, they have had formal health physics training for a total of six hours.

He stated that Mr. Swallow is the (formal) criticality supervisor. Mr. Swallow is permanently located at Hematite, Mo. According to Holthaus, Swallow has been to the plant once and this was at a pre-licensing inspection. Holthaus stated that in the event of any change in specific license procedures Swallow is notified and approval is requested. To date, there have been no refusals from him. Holthaus stated that Swallow had called and offered his services after the accident (result not known). According to Holthaus, a standard operating procedure is written down, and that only pickle liquor has been processed to date. The posting of this procedure has not been required. Upon Dr. Mann's question as to who wrote this procedure Holthaus replied that it had probably been written by a member of supervision and probably reviewed by himself (Holthaus). However,

he stated he was not sure of this. He also stated that there are no administrative procedures for the issuing of operating procedures, reviewing these procedures, and approving these procedures. Copies have not been issued to people of the procedures that do exist. The initialing of the instructions by the operator to assure that they understand the operating procedures has not been done.

A health physics manual was submitted for licensing. Barton also has a copy of this but individual copies have not been issued to supervisor or to operators. He stated that this manual had been written by Swallow, Shearer and himself. Holthaus stated that formerly he reported to Shearer and did not know whether Swallow had submitted a change in these administrative procedures to the Commission. Reportedly, Shearer has left the company.

According to Holthaus, pickle liquor is received with a certificate of assay. The shipment arrives in 55 gallon drums and he noted that the solution is poisoned with cadmium nitrate. He believes that it is poisoned in a 1 to 1 ratio, but he is not sure. He stated he knows that it is poisoned because it is a license condition.

Holthaus stated that he was not in the plant at the time of the incident. He believes he was notified at 6:20 p.m. that night. He took a company truck part of the way to pick up his own car. He believes he arrived at 6:30 p.m. but it could have been 6:50 p.m. Ordinarily, this trip takes 20 to 30 minutes. He estimates the distance at 16 miles. Upon arrival, he parked his car at the emergency shack at the plant approach. The sirens were still on. He reported to Cliff Smith at the emergency shack. He asked Smith if he had notified the proper authorities according to the emergency plan. Holthaus stated this plan had been submitted to the Commission. According to Holthaus, the people to be notified in New Haven are Lindberg, Briggs, Johnson and Stallak. Then the state police are notified. Holthaus asked him (Smith) what had happened and at this time Peabody was outside of the shack lying on the ground covered with blankets. He was completely undressed. He was suffering from nausea and was disoriented. He noted that he was roped off. Holthaus stated he does not know if he was monitored at this time.

According to Holthaus, when he arrived at the shack, Peabody, Smith Spencer and Coon were there. Mastriani was missing at this time. He stated the roads had been blocked off (two roads) and that Mastriani was at the north road block.

Holthaus stated he took a beta-gamma survey meter of up to 100 mr/hr range, type unknown. He stated this instrument is kept at the shack. He discussed with Smith as to what had happened. According to Holthaus, Smith stated that the operator had told him Peabody was washing TCE in

the carbonate tank. Somehow, Holthaus had learned that Peabody had poured an 11 liter bottle containing TCE into the tank. He stated that this was an example of safe geometry into unsafe geometry. Following this discussion with Smith, he left the group, took the meter and proceeded toward the plant looking for a 100 mr/hr level. Holthaus stated that the meter was on and that he had checked it prior to leaving the shack. He stated he had put the instrument on the 100 mr/hr range. According to Holthaus, he did not make a reading at the shack. While walking towards the plant he noticed a 12 to 15 mr/hr reading, constant, on the way to the inside of the plant. Entered via the offices, his meter still read 12 to 15 mr/hr and commenced walking around surveying the plant at the walls. He found he could not get close to the doorway to the pickle room on the first floor. The meter read 100 mr/hr at 10' from the door. He went to the right, passed the assay tanks, stopped in the vicintiy of the filtrate tank, backed off toward the south side of the building. Holthaus stated he did not believe he had his badge on and that his badge was at the rack at the guard station and that he had not put it on. He stated that the background reading on the [secretaries] badge was 125 mr after being processed, and he referred to a 12 to 15 mr/hr field at the badge station rack. He went out the side door and tried to open the gate. He found he could not get in. Later, he found out that the guard had broken a key off trying to unlock it. He did not check the radiation level at the gate. About 1/3 of the way down to the building (the point on the fence nearest the building to the west). He then went around the lagoon and into the back drive gate. At this time he did not obtain a near maximum reading, might be 30 mr/hr at this point. He started to survey outside of the building from the drive. He found that he could approach the side of the building and could go anywhere with the exception to the door at the pickle room which was open. Approached 100 mr/hr at this point. He backed off around the tanks then went towards the back door of the building. The meter went off scale at a point where the empty drums were stored at the rear of the building. He back tracked and went to door at the shipping and receiving area at the north side of the building and surveyed the side of the building back to the point where the door was open. Meter again went off scale. He then back tracked again, left the perimeter fence via the emergency exit and outside of the fence noticed Peabody's clothing, coveralls, shoes, and rubber gloves. He obtained a reading of 100 mr/hr at 15' from the clothing. He then returned to the emergency shack. By this time the ambulance had come and Peabody was gone with Spencer. Coon, Smith and Mastriani were left at the shack. He stated he did not know if these men had assisted in carring Peabody to the ambulance.

He then took Smith. Both men had meters and went through the front door of the office. He picked up his film badge. Smith had picked up a visitor's ID badge. Smith's film badge was on the clothes that he

had already taken off and he had put on coveralls that he had kept at the shack. They went down the hall, outside of the first door. They set up an extension ladder and went on the roof above the office area. They pulled the ladder up and they went up on top of the main building (no reading was taken on top of the office). On top of the main building at the west side he obtained 12 to 15 mr/hr. They went towards the tower. When they got within 10' of the northwest corner the meter went off scale. Then they went back to the emergency shack. Holthaus stated that he had received some phone calls during the period between the surveys. Iltis requested a news release. He refused at this time and advised him to contact Lindberg or Johnson. He found to Civil Defense people in a state car parked near the building within 25' of the guard office. The reading in this area was 12 to 15 mr/hr. He advised the Civil Defense people that he did not have a high range instrument. The Civil Defense people offered two Civil Defense instruments, (CD 720) range up to 500 r. Then he went back into the plant with Smith. They also had low range instruments. He set the low range instruments down out side of the door to the filtrate room. Then he went upstairs with the high range instruments. He did not get a reading on the high scale of the instrument. Went up to the second floor then to the third floor and looked in the room. Did not see anything on the meter except two or three divisions on the high scale. Noticed that the valve on the tank was open. Left Smith at the door went to the tank and with his left hand removed the 11 liter flask and dropped it on the floor, flask was empty at this time, also turned off stirrer on the tank. Took a reading on the tank midsection but obtained no reading. Over the lip of the tank he obtained 200 to 300 r/hr reading and left immediately. Stated he was in the area about 50 to 10 seconds. Then they went down to the second floor and looked in. Noticed the valve was shut and there was a tygon hose attached to the stainless steel pipe. There was one empty poly bottle there. Then they went to the first floor and started to drain the carbonate solution from the column on the first floor. They drained out 3 gallons. He noticed as they drained the solution, the meter read 200 r. Each bottle reading about 200 r/hr. They spent about 5 minutes on this operation and then went out to a low dose rate area 30 mr/hr and obtained some more bottles, (three a piece). They went back and did the same thing over, filling five bottles. These bottles are now setting in the process area. In between this operation, Holthaus stated he went back to the third floor and observed that the tank was empty. Holthaus stated that at this time he was wearing street clothes, film badge, street shoes, and did not have gloves. Smith was wearing coveralls, rubber gloves, ID badge, but had no film badge. They left the building and went back to the emergency shack. Stated Smith was with him through the whole period. Estimated time spent in the radioactive area, about five minutes on each bottle, and then he stated that he felt he had spent 20 minutes overall in hot operation. They monitored their clothes, found them contaminated and

changed clothes. Stated the Civil Defense man told him that he had measured 50 r at the back door of the plant. Holthaus stated his outer garments were contaminated but his underwear was not. Stated Smith and he needed a shower and that Smith particularly planned to go to the police barracks but they went to the locker room in the plant and showered instead. Coon and Mastriani also showered there. After washing, they put on clean coveralls. He stated Barton had arrived by this time. (Exact time not known.) Johnson had arrived. After some discussion they went to Rhode Island Hospital in a police cruiser, arriving at 10:30 p.m. Stated Spencer was at the hospital at that time. According to Holthaus, at the time of the incident Smith was on the first floor south of the stainless steel dissolver. Mastriani was on the platform of the stainless steel dissolver parallel with Smith but 10' higher. Spencer was in the precipitation area. All had film badges on. Holthaus stated that from the nature of the spill on the third floor, it appeared that it had splashed almost to the door and that it had come over Peabody. Approximately 12 square feet contaminated. Holthaus stated that he was not aware that TCE was being washed in the sodium carbonate tank. Holthaus stated that he was not aware that there was a labeling problem in the plant. He states bottles are labeled as to content and samples are pulled for uranium analysis. Holthaus stated that the tank on the third floor is a make-up tank for the carbonate scrub column. Holthaus stated he had not given specific instructions that 11 liter bottles were not to be taken to the third floor. Holthaus stated that in regard to the labeling problem they put large tags taped with ½" red scotch tape on these bottles. They have also used labels held by rubber bands.

Holthaus stated that in the past he had trouble on the evaporators and had drained concentrated material into bottles (high assay up to 400 g/l) so concentrated it was almost a crystal. He did not submit this material to the chemist but labeled it high concentration (check with William Pearson on this.)

## Activities in Exposure Evaluations

### General

At the present time, there are four separate efforts being made to estimate the magnitude of the excursion and the resultant exposure to Peabody. The Health and Safety Laboratory, USAEC, Idaho Falls, Idaho, as primary agent for the Compliance Division; the Health and Safety Laboratory, NYO USAEC; a joint effort by Mr. John Auxier, ORNL, and Dr. G. Brownell, Massachusetts General Hospital, Boston, Massachusetts; and the United Nuclear Corporation. An additional effort to evaluate the exposures of personnel present in the plant during the excursion and making the initial entry into the plant following the excursion is being carried out as a research project by C. Gooch, ORNL. A formal paper on the medical management and pathological findings on the Peabody case is being prepared jointly by Dr. J. Karas, the physician in charge of the medical management of Peabody at Rhode Island Hospital, Providence, R.I., Dr. Fanger, Chief of Pathology at the Hospital and Dr. Lushbough, Pathologist at ORNL. Additionally, Dr. Stanbury of Massachusetts General Hospital, Boston, Massachusetts is preparing a report in his capacity as Commission Consultant in the Peabody case.

### Sample Distribution

There were three general types of samples collected to assist the Commission, the licensee, and outside competent personnel in evaluating the magnitude of the excursion and the exposure to Peabody. The first group consisted of biological samples taken from Peabody prior to his death and at the post mortem. The biological samples collected prior to his death consisted of blood, hair, urine, vomitus and feces. These were transported to Massachusetts General Hospital, Boston, Mass., by Dr. Stanbury. The gold ring worn by Peabody was also included in this group of samples. Evaluation of these samples is being made by Dr. G. Brownell at Massachusetts General Hospital. Pathology samples obtained at the post mortem are being studied by Drs. Fanger and Lushbough.

A number of metal artifacts were obtained in the area of the excursion. These specimens were split, with samples going to Mr. John Auxier, ORNL; to the United Nuclear Corporation; to the Nuclear Science and Engineering Corp., Pittsburgh, Pennsylvania; and to the Health and Safety Laboratory, Idaho Falls, Idaho. The third major group of samples consisted of the solution; drained from the tank in which the excursion occurred. These samples contained a precipitate and the first samples obtained were of the supernate only. At a later date, the precipitate was redissolved in the solution and homogenous samples were distributed to the above personnel and/or activities.

An additional sample consisting of the film badge worn by Peabody was first evaluated by HASL, NYO and then delivered to HASL, Idaho Falls, Idaho.

Project Status

A discussion with Mr. K. O'Brien, NYO on 8/12/64 indicated that the preliminary report of a 2500 rad neutron exposure to Peabody was made by assuming a moderated fission spectrum and an absorption cross section proportional to 1/v. According to O'Brien, this figure could be off by a factor of two. Upon receipt of additional information from UNC, a more accurate neutron dose estimate will be made. It is pointed out that the evaluations made by NYO were primarily based on the Ihidium-114m activity on the film badge. A more complete report from NYO can be expected within two weeks.

A preliminary report was submitted to CO:I by Dr. J. B. Stanbury on 8/5/64. This report did not contain any definitive information as to Peabody's exposure. A discussion with John Auxier and Dr. Brownell on 8/11/64 indicated that their work would be completed in about one week. The evaluations made by Auxier are based on the analysis and measurement of the solutions drained from the tank in which the excursion took place and measurements made on specimens of metal artifacts collected in the area of the excursion. Preliminary information from Auxier indicated that Peabody could have received an exposure of 2100 rem from fast neutrons with a total neutron plus gamma dose of 8100 rem being possible.

Dr. M. Shapiro, United Nuclear Corporation, is also engaged in making evaluations based on solution activities and induced activities in the metal artifacts. Nuclear Science and Engineering, Pittsburgh, Pa., as a consultant to United Nuclear Corporation has made some evaluations for Dr. Shapiro in regard to fission product activity in the solutions.

Mr. F. Nakache at United Nuclear Corporation reported that he has completed his evaluations in regard to determining the fast and thermal flux values incident to the excursion. First order approximation is that $2 - 5 \times 10^{17}$ fissions occurred. Refinement of calculations may change this to $10^{18}$ fissions. Nakache also plans to conduct measurements on the tank itself. Final calculations are expected to be complete in 2 - 3 weeks. The calculations for total dose are expected to be complete in about 2 weeks.

Preliminary information from C. Gooch based on chromosome aberrations indicated that Holthaus received approximately 44 rem. As this value compares favorably with the 50 rem film badge reading on Holthaus, it is expected that an approximation of the exposure received by Smith can be made. These studies are being carried out on all UNC personnel who might have been exposed. Completion of this work may be expected in about 3 weeks.

It is contemplated that the work being carried on at the Health and Safety Laboratory, Idaho Falls, Idaho will be completed in about two weeks. The work at this facility is being conducted under the supervision of Mr. H.J. Paas.

Exhibits

The exhibits showing the location of the samples are appended to this report.