WESTINGHOUSE HANFORD COMPANY

RADIOLOGICAL HISTORY OF THE PUREX FACILITY 1955 TO 1989

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INTRODUCTION

This reference manual was written to be used by the Health Physics Techs. and Supervisors who work or may work in PUREX now or in the future. It was composed for the sole purpose to provide these people with information regarding the results of radiological incidents and status of certain PUREX geographical areas.

It is hoped that H.P. personnel will use this article and can benefit from the incidents that occurred in the early operational days of the PUREX plant.

It may also be useful as a historical information guide for future D & D work in and around the PUREX facility.

In early 1943, the United States Army Corps of Engineers selected the Hanford site on the Columbia River as the location for reactor and chemical separation facilities for the production and purification of plutonium for use in nuclear weapons. The Hanford Reservation occupies about 570 square miles of the southeastern part of the State of Washington. The reactor facilities were located along the Columbia River and the reactor fuel processing and waste management facilities were situated on a plateau about 7 miles from the river and approximately 300 feet from the water table. Early day nuclear industry pioneers had the foresight and care for the future in mind to engineer the location of the PUREX facility in an area to prevent discharges directly to the groundwater and river.

The first reactor fuel processing plants recovered only the plutonium through bismuth phosphate precipitation dissolution batch process and in the early 1950's were supplanted by the Redox process which recovered the unused uranium as well. The PUREX plant is the most recent of the Hanford irradiated fuel processing plants, having been constructed between April 1953 and October 1955. This solvent extraction process, which recovers neptunium in addition to the uranium and plutonium, was more economical to operate than its predecessors, gave more efficient recovery of products and lower volume of waste output per unit of fuel processed.

The primary mission of the PUREX plant remains the separation of plutonium and uranium for defense and for Government agency research and development programs. It has been used occasionally for the processing of specialty fuels related to nondefense programs.

The PUREX plant is a complex of several different buildings and supporting facilities. The principal building, 202-A, in which the fuels are processed is reinforced concrete and is about 1,000 feet long, 120 feet wide at its maximum, and 100 feet high with about 40 feet of this height below ground level.

The portion of the canyon below grade is sub-divided into a single row of 12 process equipment cells 813 feet long overall, a ventilation air tunnel, and a pipe tunnel through which intercell solution transfers are made.

The air tunnel exhausts the ventilation air from the cells to the main ventilation filter and out through a 200-foot stack. Running the length of the canyon building above the cells is a craneway for the cranes used for remotely removing and replacing process cell equipment and for charging irradiated fuels into the dissolvers.

The galleries contain service piping to the cells and samplers for obtaining process samples.

The service section annex (276-AB) contains the maintenance shops, offices, control room and the analytical laboratory.

The PUREX design and operating plans were to operate the plant at 90 percent of its rated capacity an average of 80 percent of the time for an overall time-operated-efficiency (TOE) of 72 percent. In actual performance, TOE was limited more by availability of fuels to be processed than by plant and equipment availability. During peak production years, many operating campaigns extended over periods of more than 30 days at 100 percent plant capacity factor and 100 percent plant availability. Overall plant on-line efficiency, excluding the time periods during which the plant was not scheduled to operate, is estimated to have been about 75 percent.

The construction cost of the original PUREX plant was about $80 million in 1955. It is estimated that a new PUREX plant meeting today's licensing and environmental protection criteria would cost greater than $800 million.

At the original PUREX startup, operating controls and decontamination methods differed significantly from present day methods. State-of-the-art radiation detection instrument changes have improved the detection of beta radiation by 15 percent. This improvement was due to the adoption of a new micro window "pancake" probe used in conjunction with a geiger meter, rather than the 1B85 "hard wall" probe that was used up until 1975.

The development of better survey techniques and analytical methods have greatly improved decontamination results. The more stringent release limits have complicated operations in that if an area is recontaminated, it becomes extremely difficult to separate the old problem from the new which may cause a significant increase in cleanup operations to reach a non-detectable level.

During the <u>early</u> PUREX campaign there was a failure to anticipate increasingly restrictive controls and regulations governing stack emissions. This resulted in the lack of capability to retain certain gaseous radionuclides such as C^{14}, Kr^{85}, H^{3}, I^{129} and I^{131}. Discharges of contaminated liquid effluents to ponds, ditches and cribs were considered low risk which ultimately compounded control problems. The technology needed for the design of engineered facilities for lower release capability had not been developed in the 1950's because it was not considered necessary to achieve lower releases at that particular time.

Contamination spreads that occurred during the early day PUREX high-production campaigns were often weighed in regards to the importance of temporarily containing the problem versus maximum cleanup.

In the event of a Pu alpha contamination spread, the decision was usually made to immediately anchor the contamination by the use of a fixative such as D-1000 stripcoat or paint. This method of covering alpha spreads, until decontamination could be initiated, was often used based on the fact that the covering effectively shielded the alpha particles and prevented the contamination from spreading with the airflow and compounding the problem. In the case of the White Room contamination spread, (discussed in the text) this method of covering alpha contamination more than likely saved the facility.

The primary objective was to decontaminate equipment and materials to non-detectable, nonsmearable or in a fixed condition in that order so they could be either released or controlled for normal access or handling. Covering or painting over contamination was not the initial objective and was not permitted on areas contaminated with beta/gamma until dose rates were significantly reduced by physical removal of materials.

A yellow primer was always the first coat of paint to be applied over surface contamination, then followed by at least two coats of appropriate cover color. When yellow paint is encountered during paint removal or structure modifications it is presumed that it is covering contamination from a previous spread.

Outside areas, blacktop and roadways, contamination from stack fallout and other sources were flushed with water, chipped and treated with solvent as soon as possible after detection. The washing method resulted in the particulate contamination being washed to the edge of the roadways where it could be graded into windrows and removed by scooping and picked up with a front loader. There were many instances when decontamination of concrete and blacktop were cleaned to the point where it was economically feasible to cease cleaning and generally these areas only had low level fixed contamination and posed no risk to personnel. These areas were usually resurfaced to enhance contamination control after the incident and in case of future incidents. In other cases, the contamination was completely removed and the area returned to normal status.

In the text it is mentioned that certain radiological areas do not have air sampling capability. It is not meant that they should have that capability, but merely stated as a point of reference. Radiological areas that do not have air sampling capability have been evaluated by radiological engineering as to the need.

The radiological safety of PUREX personnel has always been viewed from a conservative side. The following are some examples:

- Respiratory protection. Supplied air was often prescribed when an MSA mask would have given adequate protection.
- Timekeeping. Timekeeping calculations are rounded off on the conservative side.
- CAM alarm setpoints are conservative and all cam alarms are treated as legitimate until evaluated and proven otherwise.
- Dose rate settings are rounded off on the high side. Extremity and nonpenetrating radiation were often interpreted as whole body penetrating when determining stay-time.
- Nasal smears and irrigation were sometimes performed as precautionary measures.

There are numerous inaccessible areas inside and outside the PUREX facility where a contamination potential may exist from past radiological incidents, which are not included in specific radiation controlled areas. The following are some of those areas:

- Pipe and Operating Gallery
- Ventilation supply rooms
- Roofs
- Loading docks
- Exhaust and supply ductwork
- Road and walkways inside the PUREX exclusion area

The above locations should be considered as suspect areas, and contact with the Health Physics Department should be made prior to any structure modification that may disturb the original surfaces.

More explicit information dealing with curie quantities resulting from gaseous effluent and liquid effluent emissions, leaks or spreads may be found in other documents dealing with assays and quantities,

In the text, personnel skin contamination incidents are often mentioned. In every case, decontamination of the individuals was successful.

Much of the forthcoming information found in this "Reference Manual" was gleaned from many sources and individual memories. A large part of the historical data obtained from documented incidents, occurrences and survey reports was brief, lacked detail and was not precise. In some cases information concerning radiation/contamination measurements were reported in disintegrations per minute, counts per minute or as simply being grossly or highly contaminated and are not necessarily associated to the risk of dose rate and internal deposition to personnel. Consequently many of the measurements in this historical summary are relative and should not be alarming.

PUREX RADIOLOGICAL HISTORY 1955 TO 1989

EAST CHANGE ROOM:

The east change room was originally constructed with a room exhaust fan mounted in the northeast section of the change room ceiling. This fan exhausted the east change room plus the east locker room via the overhead ductwork into the crane maintenance platform.

Sometime between 1957 and 1958, a contamination spread occurred on the ECMP. During decontamination efforts, water was used and found its way into the exhaust fan and migrated to the east change room exhaust ductwork during a period when the exhaust fan was shut down for maintenance.

The floor and walls were decontaminated to non-smearable status and painted. Direct measurements on the floor along the north side of the change room are still detectable through the paint. This area is now behind an SWP clothing bin.

CMP = Crane Maintenance Platform

The original room exhaust fan has been removed and some ductwork replaced. One section of the ductwork that extends from the change room into the locker room is original and is internally contaminated with low level beta contamination. This ductwork should be identified as being internally contaminated.

EAST P & O GALLERY, MEZZANINE, LOCKER ROOM AND EQUIPMENT ROOMS:

When the east crane maintenance platform was constructed in 1956, the three ft. thick shielding doors were included and designated A, B & C doors. These doors were designed to be lowered or raised into place for the purpose of providing shielding for the CMP during charging operations and canyon process cell work. Maintenance work on the CMP and on the east crane bridge, during charging, is possible with no detectable increase in dose-rates, when the three shielding doors are in place.

A-door is lowered into place electrically by a 1" cable. The mechanism is located in the A-equipment room which is beneath the floor of the ECMP.

B & C shielding doors are raised into position by use of a hydraulic ram. The hydraulics are located in the B & C equipment rooms beneath the ECMP.

D-switchgrear room is located adjacent to the C-equipment room.

A, B & C equipment rooms have openings in the ceiling directly to the ECMP. These equipment rooms have become contaminated from previous air reversals and during decontamination work on the CMP.

Original contamination levels in the A, B amd C equipment rooms were 50,000 d/m beta—Loose and dusty. A rubber boot was later fabricated and installed over the hydraulic assembly to seal off the opening to the CMP. This was only partially successful.

D-switchgear room is contaminated with low level beta contamination from 5,000 d/m beta to 20,000 d/m beta. The cause of this contamination was by tracking from the C-equipment room.

No significant alpha contamination has been detected in the equipment room.

EAST LOCKER ROOM

A contamination spread was detected in 1960 when beta contamination was washed out from beneath the north wall of the B-equipment room into the locker room. Approximately 16 ft^2 of floor was contaminated in the locker room along the south wall. Contamination levels were from 20,000 d/m to 45,000 d/m beta. The floor was decontaminated and repainted. Fixed contamination to 40,000 d/m beta is still detectable along the south wall and baseboard of the locker room.

PIPE AND OPERATING GALLERY MEZZANINE

No significant spread of contamination has ever occurred in the east or west mezzanine areas.

A "Potential Surface Contamination" area is posted along the south wall of the west mezzanine room. This area is not contaminated, but was used as a temporary storage for radioactive waste boxes.

PIPE AND OPERATING GALLERY

The Purex Pipe and Operating Gallery has a high potential for contamination spreads and high radiation due to equipment leaks from blowbacks in the operating systems and piping.

Since 1956, nearly all piping along the south wall of the P & O Gallery have been internally contaminated to various degrees of activity. Most of the contaminated piping systems have been flushed internally and decontaminated at one time or another, but low level residual contamination is still detectable in and on some piping systems.

The following pieces of equipment and piping are known to have been contaminated in the past and care must be taken when opening these systems:

- Steam lines
- Chemical addition lines
- Dov's
- Hand operated valves
- Gang valve vent lines
- Instrument air and transmitter lines
- Seal pots
- Strainers
- Fire fog lines
- Acid lines

Floor surface areas along the south wall of the P&O gallery have been contaminated to various degrees of activity.

In the past, when these problems occurred, an attempt was made at decontamination. When the activity levels were reduced to less than 10,000 d/m beta, the floor areas were repainted, with yellow paint being used as the first coat.

Direct radiation readings of contamination through the paint is not uncommon and is occasionally initially mistaken for surface contamination associated with recent incidents.

SECTIONS A THROUGH C. RACK #1 THROUGH #9

This section has experienced few blowbacks during PUREX operation, but has the potential for high radiation due to its association with dissolver operations.

The blowbacks that have occurred in this section were minor in nature and only resulted in low level radiation in the piping. Leaks to the floor were in the 5,000 d/m to 50,000 d/m beta range. Some residual contamination still exists under painted floor surfaces in this section.

SECTION D THROUGH E. RACK #8 THROUGH #22

At instrument rack #22 there is an electrical terminal box that is internally contaminated to 200,000 d/m beta. The contamination occurred during wire pulls from the canyon, utilizing this box.

The E2A chemical addition tank and associated piping and pump were internally contaminated to 12,000 d/m beta from a blowback in the early 1960's. Extensive flushing and decontamination reduced the activity levels to non detectable. The tank is posted as being potentially contaminated internally.

In 1983 at E-section, Rack #22, a valve on the silver nitrate addition line was inadvertently left open. A tank in this system pressurized causing airborne radioactive particulate to emit from the open valve and follow the normal room airflow east. All beta cam's alarmed from rack #22 to the east change room. Seven JAJ Construction personnel, who were working in this area at the time, were exposed to airborne radiation. Nasal smears and subsequent irrigation were performed. No internal depositions were detected. Horizontal surfaces east of rack #22 were contaminated and were smearing 5,000 d/m beta. The area was decontaminated and released.

Remote canyon air sampling lines exist throughout the P & O Gallery and were used during the original startup, but they were discontinued and valved off due to high levels of contamination that accumulated inside the sample piping. These systems could be activated again if necessary, but would require internal flushing. Controls would have to be maintained so as not to sample when process cell work is in progress. The air sampling line pick-up points are located in the canyon along the north wall approximately 2 feet above the cell cover blocks.

All overhead P & O Gallery electrical wireways must be approached with caution when opening. Several sections of wireway that were used during wire pulls from the canyon, are known to be highly contaminated with beta contamination. The wireway at rack #21 near the ceiling, over the walkway is known to be internally contaminated in excess of 200,000 d/m beta.

F-SECTION, RACK #22 TO RACK #39

F-section of the P & O Gallery has the highest potential for high radiation and contamination problems due to blowbacks in the piping system. From the years 1956 to 1972, numerous radiation incidents and contamination spreads occurred throughout F-section.

The detection of alpha activity from contamination leaks at F-section is insignificant compared to that of B/G activity. In the early days of the PUREX campaign, steam lines and water lines to the F-5 and F-6 tube bundles at rack #26 were internally contaminated to the point where the dose rates through the lines were several hundred mR/hr, including 50 mR/hr in the P and O Gallery walkway. This activity has been significantly reduced to background levels, but the potential for a similar type incident to occur again exists.

The entire floor area from rack #23 through rack #37 has been contaminated several times in the past. Floor contamination originated from piping flange and valve stem packing leaks. Activity levels have ranged from 5,000 d/m beta to mrad readings. The floor surfaces were decontaminated to the point where further decontamination proved unproductive, then repainted with yellow being used as the first coat. Beta/gamma activity is still detectable through the paint and any repainting or paint removal in this section should be closely controlled.

F-section is one of the few sections of the P & O Gallery where contamination and dose rates have been detected on piping along the north wall. The steam to F-11 tube bundles on the north wall experienced a blowback in the 1960's, resulting in contaminated steam condensate leaks to the P & O Gallery floor. One blowback at this location resulted in the steam line pop-off valve activating, which caused contaminated specks to 1200 mrads/hr on the ground next to the north side of the building near the old lab dock. This outside area was completely decontaminated.

All overhead electrical wireways in the Pipe and Operating Gallery should be considered internally contaminated until proven otherwise.

Several instances of high dose rates have occurred at F-section throughout the PUREX campaign. They were caused as a result of blowbacks and most commonly occurred in seal pots, strainers, gang valves and vent lines.

An incident involving airborne contamination occurred at F-section when an air sample repeatedly indicated higher-than-normal levels for this location. No source of the contamination was discovered at that time. Later, when contaminated shoes started showing up on personnel who had been in the P & O Gallery, a more diligent search for the source was started. After several

shifts had elapsed, the source was finally discovered to be a weight factor air line that had been inadvertently left open, allowing contaminated air to escape. By this time, most of the horizontal surfaces to the east of the problem area were smearing from 2,000 d/m to 80,000 d/m beta. The contaminated surfaces were decontaminated.

G-SECTION

Very few contamination incidents have occurred in this section of the P & O Gallery.

In 1970 a DOV on a medium pressure steam line leaked low level contamination to the floor. It was readily decontaminated.

H-Section

A radiation incident occurred in 1958 when an "air to H-2 pulse leg" line experienced a blowback. This line is located to the east of the H-2 Col. "dog house" on the south wall just opposite the AMU elevator. The incident was discovered soon after it occurred by an alert RPT who happened to have his survey instrument on as he passed by. The dose rate was found to be 180 R/hr at contact on the pulse leg line and 5 R/hr in the P & O Gallery walkway. Backflushing by Operations effectively reduced the activity to normal background levels. The line did not leak and no contamination was detected. No over exposures to personnel resulted.

Strainers and instrument air lines have a history of internal contamination throughout H-section, although very little floor contamination has occurred in this area.

Some instrument air lines on top of the H-2 "dog house" are internally contaminated, and the top and front of the "dog house" have been contaminated as a result of maintenance on these lines.

J-SECTION

J-Cell air and water pulse leg backflush lines have been contaminated internally, in the past, but activity is not now detectable at this location.

Strainers on the west side of the J-Cell "dog house" have experienced blow-backs and have had dose rates as high as 450 mR/hr at contact. Time and flushing have reduced this activity down to less than 10 mR/hr.

The front side of the J-cell "dog house" was contaminated with low level beta contamination originating from maintenance work on overhead acid lines.

Alpha as well as beta/gamma activity is sometimes detected on open process lines throughout J-section.

Two test tanks (J6-A & J6-B) and overhead piping along the north wall were internally contaminated during a misvalving. The contamination is low level beta from 2,000 d/m to 5,000 d/m beta.

All air and water backflush lines to the pulsers in J-Section are potentially contaminated.

An electrical terminal box at rack #59 is internally contaminated to 200,000 d/m beta.

K-SECTION

At rack #65, a section of piping split, resulting in 600,000 d/m beta and 2,000 d/m alpha leaking to the floor and out to the center floor drain. This incident occurred in 1988. The piping was repaired, the floor decontaminated, and the section was designated as a potential surface contamination area.

Ceiling electrical wireways and ductwork east of the white room east barrier door are potentially contaminated from the white room incident.

L-SECTION (WHITE ROOM)

On February 22, 1956, on the 4-12 shift, PUREX processing Supervision had been experiencing difficulty with the weight factor readout on the L-6 tank, located in the L-Cell package. An Instrument Technician was instructed to check out the weight factor to the L-6 tank, and in so doing, connected the manometer to the appropriate line at Rack #73, by using a section of tygon tubing. Prior to completing this task, the Instrument Tech. stopped work for lunch break at approximately 1900. During this time the manometer was left unattended. The L-6 tank experienced a pressurization which, in turn, blew off the tygon tubing from the instrument rack and proceeded to spew plutonium nitrate and plutonium mist into the west end of the P & O Gallery. An Operations Chief Operator entered the west end of the P & O Gallery to check out the situation and observed green liquid on the floor. He immediately evacuated the area and proceeded to the instrument shop to inform the Instrument Foreman, not realizing that he was grossly contaminated. The Foreman also became contaminated during the conversation. When it was realized what had happened, the ventilation system was shut down at the west end of the P & O Gallery. Health Physics personnel were dispatched to determine the extent of the spread. Activity levels greater than 7×10^6 d/m alpha were detected on the floor in the vicinity of Rack #73 and 2×10^5 d/m to 1×10^6 d/m was detected on smears of all horizontal surfaces and piping. Follow-up contamination surveys revealed alpha contamination in the canyon lobby, west stairwell, west PRV room, on the R-cell cover blocks and on the outer vertical, north wall of the 202-A building, around the exhaust opening. No P & O Gallery exhaust filtration was in place at this time.

Temporary barriers were erected, isolating the contaminated area. Operations personnel were sent in to attempt decontamination wearing chemox masks and later, supplied air for respiratory protection. Initial decontamination efforts were unsuccessful because decontaminated areas were being recontaminated almost immediately. The decision was finally made to call in spray painters. All surfaces were initially painted yellow, then numerous coats of white paint were applied over all surfaces of the last 100 feet of

the west end of the P & O Gallery. The paint effectively covered, shielded and fixed the contamination, but under the painted surfaces remains high levels of alpha contamination.

Results of the White Room Incident:

- Two Purex personnel received gross skin contamination. One individual received an internal deposition.
- Decontamination of the P & O Gallery, with water, resulted in contamination of mud and water in the chemical sewer up to 10^{-3} uci/ml.
- The west end of the P & O Gallery was isolated and converted to a permanent surface contamination area and nicknamed the "White Room."
- A short time later, the west section of the P & O Gallery floor drain line was opened in the sample gallery in an attempt to unplug the system. No containment was used, resulting in another major spread of alpha contamination from J-section in the Sample Gallery to the west end. This area was decontaminated and sections of the floor painted.

All Purex radiation workers must be aware of the potential for alpha contamination on equipment from the White Room that is painted white.

CANYON LOBBY

The canyon lobby area was first contaminated during the White Room incident in February, 1956. Alpha contamination to 40,000 d/m was detected on the floor and walls. The area was decontaminated and repainted. Several instances of minor alpha/beta contamination occurred in the canyon lobby as a result of personnel exiting the canyon deck via door #5, but was readily decontaminated.

Two contamination incidents occurred in the canyon lobby in 1985 and 1986 when pumps, removed from the N-cell hood and contained in "lard cans", leaked contamination to the floor. Activity levels were from 50,000 d/m to 150,000 d/m alpha. The floor area was effectively decontaminated and repainted.

VENTILATION SUPPLY FANS

SF-1, SF-1A, SF-2, SF-2A, SF-3 and SF-3A supply fans provide ventilation for the Purex canyon, sample gallery, and office areas. These units have all been internally contaminated to some degree since Purex original startup. Stack emissions on 7-4-57 and on 9-10-57 were responsible for particulate contamination of 10,000 d/m beta being drawn into the fan units. No alpha contamination was ever detected inside the fan housings. On 7-1-61, a trap pit #2 emission and on 10-7-61, an eruption of steam from the 151-A diversion box were responsible for the building supply fans ingesting more radioactive particulate into the fan units. Decontamination was successful in removing loose contamination, but very low level fixed contamination is still detectable in some of the fan bearings and in other inaccessible places throughout the fan housings.

STORAGE GALLERY

At the east end and adjacent to the storage gallery are three large rooms under the RR tunnel floor. This area has been nicknamed "the tomb." Physical access to "the tomb" is gained through a small door located at the bottom of the east stairwell. "The tomb" can be used for access to the RR tunnel floor drain system piping and catch tank. Contamination to 500,000 d/m beta can be found on the floor of "the tomb" beneath the drain piping that occurred as a result of leaking pipe flanges. No whole body dose rates greater than 10 mR/hr are evident. "The tomb" is posted as an airborne contamination area. Occasional portable air samples taken in this area reveal very high levels of short lived activities due to the lack of ventilation.

The floor and wall at the very east end of the storage gallery between B and C sections have been contaminated on three different occasions. The first two occasions occurred in 1968 and 1970 when the B-cell dissolver cell sump overflowed, allowing contaminated liquid to seep out of B-cell by way of a slightly separated wall expansion joint and onto the storage gallery floor. Radiation readings on the liquid were 3 Rads/hr. A temporary fix of the joint was attempted by regrouting.

In 1985, a process tube bundle was placed on the canyon deck at B-cell and was hosed down with water in preparation for burial. Contaminated liquid from the flushing ran down the north B-cell wall into the expansion joint and out to the floor in the storage gallery at B-section. Initial dose rates on the liquid were 12 Rads/hr at contact. The liquid was partially decontaminated and covered with rubber and lead for shielding purposes. A greenhouse was erected around the problem area, and extensive decontamination was initiated but never completed. Dose rates are approximately 20 mR/hr in the walkway adjacent to the greenhouse as of 1989. In the same year, a liquid leak was discovered at a concrete fracture in the ceiling over the walkway at C-section in the storage gallery. Contaminated liquid to 80,000 d/m beta was dripping to the floor of the storage gallery from the ceiling crack. The liquid was thought to originate under an acid tray in the sample gallery at C-cell. The area was decontaminated, and the fracture in the ceiling repaired.

On February 20, 1959, a routine survey of the Purex storage gallery revealed a radiation level of 4.5 R/hr at 2 inches from the floor adjacent to the canyon wall at F-section at column 30. Concrete bricks were used for shielding with an access port incorporated for the purpose of obtaining future dose rate measurements. The maximum radiation detected was 50 R/hr and stabilized at that rate. No surface contamination was ever detected.

It was later determined that the radiation originated from an acidic liquid on the floor of F-cell, which migrated under the storage gallery floor by way of a concrete reinforcement steel bar. Dose rates surrounding the shielding blocks are less than 1 mR/hr.

Floor expansion joints in the storage gallery have been an ongoing problem since the original Purex startup. The floor joint at column #38 measures 15 mR/hr.

Floor sumps at column #38 and #41, along the north wall, are contaminated to 200,000 d/m beta. This contamination is fixed.

A small section of the gutter along the north wall at column #41 is contaminated to 200,000 d/m beta. The gutter area was used for long term storage of contaminated jumpers.

A small section of the floor and gutter at the very west end of the storage gallery (PIV) room was contaminated to 5,000 d/m alpha, and also spots under the paint exist in the 20 mrads/hr range. This contamination is fixed.

No removable contamination has ever been detected on the surface of the storage gallery expansion joints. Some have been recaulked with lead wool and some are covered with lead. The storage gallery floor sumps at the east end at column. #38 and #40 are contaminated and are responsible for the sump drain line, which runs the length of the storage gallery along the north wall, to be internally contaminated. This line empties into the AMU pipe chase.

AMU = Aqueous make up

AMU PIPE CHASE

The access door to the pipe chase at the bottom of the AMU stairwell is posted as a Surface Contamination Area. The lower section of the pipe chase was contaminated to 15,000 d/m beta in 1959 as a result of contaminated liquid being pumped into the pit from the storage gallery sumps via the drain line. The AMU sump has overflowed several times in the past with liquid running out of the access door, down the steps, and onto the storage gallery floor and also into the freight elevator shaft. A low indication of contamination was detected on the floor of the storage gallery and in the elevator shaft the first time the overflow occurred. The contamination was cleaned to non-detectable status. Subsequent liquid overflows in this area have not resulted in contamination spreads. Although the AMU sump is posted as a Surface Contamination Area, the detection of radioactivity greater than 15,000 d/m beta in the sump enclosure is rare.

CONTROL ROOMS

Central Control Room - (CCR)
Power Unit Control Room - (PUCR)
Head End Control Room - (HECR)

In the 1960's, an instrument air line was hooked up directly from the Pipe and Operating Gallery to a recording instrument behind the Central Control Room. During a test, alpha contamination backed up into the air line. When the line at the instrument behind Central was disconnected, a contamination spread occurred. Levels of alpha contamination to 120,000 d/m were detected on tubing, recording instruments and on the floor behind Central. The area was decontaminated, the floor repainted, and the area appropriately posted.

The potential for another contamination spread to occur in this area is high and appropriate controls must be taken before instrument lines at this section are opened. No contamination or radiation has ever been detected in the HECR or PUCR or on associated piping.

In the 1960's, a PUREX Power Operator decided to remove the face of his wristwatch while in the Power Unit Control Room. Later in the shift, he was found to have contaminated his hands to 10,000 d/m beta. Further investigation revealed contamination was spread throughout the PUCR. The employee was not aware that his watch had a radium dial.

AQUEOUS MAKEUP (AMU):

Only one AMU chemical addition tank has been internally contaminated since Purex original startup. Tank 222 became contaminated when a valve was left open in 1983, and recovered acid backed up into the tank and lines. A radiation measurement of 100,000 d/m gamma was detected through the bottom of the tank. Subsequent flushings of the tank and associated piping reduced radiation levels through the piping and tank to non-detectable. Fixed beta/gamma contamination may still be detected inside the tank and piping interior.

324 HEAD TANK:

The 324 Head Tank was internally contaminated from a blowback in the early 1960's. The piping and pumps in the Head Tank Room were also involved. The maximum radiation measurement through the side of the tank was 5 mR/hr at contact. Leaks from the tank drain line and from the pump seals, contaminated the floor to 150,000 d/m beta. 1,000 d/m alpha was also detected on the floor. The tank was flushed the floor and pumps decontaminated. This effectively reduced the contamination to less than 5,000 d/m beta.

SWP LOBBY:

No major spread of contamination has ever occurred in the SWP lobby. The SWP lobby floor has been contaminated with low level particulate alpha/beta contamination on numerous occasions. The source of most of the SWP lobby contamination has been from contaminated waste boxes, laundry bags, tools and equipment that had been brought there from Surface Contamination Areas. The SWP lobby has always been decontaminated as soon as the problem was detected.

PERSONNEL DECONTAMINATION ROOMS:

East Decontamination Room
Lab. Decontamination Room
SWP Lobby Decontamination Room

The East Decontamination Room is seldom used. Direct low level beta/gamma activity is present under the floor paint, originating from a past contamination spread in the east change room.

The Lab Decontamination Room has been contaminated with low level alpha and beta contamination during the process of decontaminating personnel, but was always immediately decontaminated.

The SWP Lobby Decontamination Room is most often used for personnel decontamination. The floor has been contaminated on many occasions in the process of personnel decontamination. Low level, fixed contamination to 5,000 d/m beta, has been painted over.

Appropriate control measures must be taken when any of the decontamination room floor, shower, and sink drain lines are opened.

Q-CELL

Neptunium^{237} recovery was first started at Purex in August, 1958. Np recovery on a continuous basis began in 1967.

There are five major rooms associated with Q-Cell:

1. AMU
2. Control Room
3. Hot Cell
4. Maintenance Hood Room
5. Loadout Room

AMU: The steam lines along the west wall: JGV 2, 3, 4, 5, 6 & 7 have been internally contaminated with alpha. Contaminated condensate has leaked from the steam lines, to the floor, but was readily decontaminated.

CONTROL ROOM: Alpha contamination to 40,000 d/m alpha, including 10,000 d/m smearable was painted over on the floor as a result of the Control Room becoming contaminated when liquid, from a major leak in the PR Room migrated to the control room by way of the PR corridor.

HOT CELL: The floor in the Hot Cell has been contaminated on many occasions from maintenance work in the hood (sometimes performed with the glove box panel removed). The outside of the panel and some vertical supports are contaminated to 60,000 d/m alpha and smearable.

During the Np campaign, dose rate measurements in the Hot Cell, from Np storage tanks, to 3 R/hr at the hood front have been detected. During normal operations, dose rates averaged 5 to 20 mR/hr at the hood front in the Hot Cell. The Hot Cell is posted as an Airborne Area because of the alpha contamination on the hood front.

MAINTENANCE HOOD ROOM: Extensive maintenance work has been performed on pumps and other equipment through the glove ports in the Maintenance Hood Room. Hood glove ruptures, bagging in and out problems plus, HEPA filter changes have been responsible for numerous contamination spreads in the Maintenance Hood Room. The floor, being constructed of polished stainless steel, enabled the contamination spreads to be easily decontaminated.

The "PI Head Pump" at the west end of the Maintenance Hood Room was contaminated to 5,000 d/m alpha in the drip pan, at one time. Contamination is not presently detectable at this location.

The average dose rate to work in the maintenance hood, through the hood gloves, were 10 to 30 mR/hr during the recovery campaign.

Contamination measurements inside the maintenance hood were in excess of $5x10^6$ d/m alpha.

LOAD-OUT ROOM

Contamination measurements to 40,000 d/m alpha can be detected inside the Load-Out hood through the access door. The floor area of the Load-Out Room was repeatedly contaminated during product loading-out operations. Rather than decontaminating the floor, "strip coat" (D-1000) was applied over the contamination and allowed to dry. This "strip coat" is still evident on the floor of the Load-Out Room and care must be taken when it is removed to prevent contamination from spreading.

Personnel dose rates in the load-out room during normal load-out of Np were in the 5 to 20 mR/hr range.

The following are personal observations, gained from experience, during the Neptunium recovery campaign at Purex:

1. Neptunium contamination spreads are more easily controlled and decontaminated than Plutonium spreads.
2 Neptunium contamination does not appear to become airborne as readily as Pu alpha.
3. Gamma radiation tends to be higher on Np storage tanks, piping, and in operating hoods than in Pu handling areas.
4. Dose rates on storage containers of Np nitrate will increase when stored over a period of time due to decay to daughter products and Pa^{233}.

WEST PR ELEVATOR AND SHAFT

On September 23, 1966, at 1430, a PR can containing Pu nitrate was accidentally tipped over on its side by two operators as it was being loaded onto the PR elevator from the PR corridor. The incident occurred when the PR can dolly contacted the lip of the elevator, causing the PR jacket (which contained the PR can) to tip forward onto the elevator and fall on its side. After the jacket was uprighted, it was noted that some "green liquid" had leaked out from under the lid of the jacket onto the elevator floor, was running over the edge, and dripping into the elevator shaft below. Operators were dispatched to the elevator to decontaminate the spill. They reported back that brown fumes were coming from under the rim of the jacket. The jacket was then removed to the PR room; and after consulting with the criticality engineer, water was introduced into the jacket and slurped to the L-11 tank for rework. During the movement of the jacket to the PR room, the entire length of the PR corridor floor was contaminated in excess of

40,000 d/m alpha. Contamination surveys of the elevator floor and bottom of the elevator shaft indicated levels greater than $5x10^6$ d/m alpha on the elevator and up to $1x10^6$ d/m alpha at the bottom and walls of the elevator shaft. After extensive decontamination efforts, the contamination in the elevator and in the shaft was cleaned and repainted. Alpha contamination may still be present on inaccessible surfaces beneath the elevator floor.

HOT SHOP

The Purex "Hot Shop" was originally designed to be used as an area where contact maintenance could be performed on contaminated process jumpers and equipment after they had been initially decontaminated in M-cell.

Hot Shop contamination spreads are not uncommon. Hot Shop contamination spreads primarily originate from tracking contamination out of M-cell, when exiting and also from equipment that is not decontaminated sufficiently prior to being placed into the Hot Shop.

It is not uncommon for floor smears in the Hot Shop to be 20,000 d/m alpha to 60,000 d/m beta.

A fire in a radioactive waste box, that had been stored in the Hot Shop, occurred on February 23, 1958. The fire was thought to have started from internal combustion of acid and oil soaked rags in the waste box. Low level alpha and beta contamination was spread over all horizontal and vertical surfaces.

The walls of the Hot Shop and the floor have been repainted several times.

The M-2 pump storage tank, located in the north east corner of the Hot Shop, was seldom used and caused no radiological problems.

Water is often used to decontaminate the floor of the Hot Shop. When water is used, care must be taken to ensure that it does not run out from under the door into the Hot Shop lobby. This has occurred several times in the past, contaminating the floor of the Hot Shop lobby.

High radiation is not normally a problem in the Hot Shop, but on occasion high unexpected levels of radiation have been detected when process equipment was lowered down into the Hot Shop from the canyon without first being decontaminated in M-cell.

In the 1960's, a considerable amount of personnel radiation exposure was expended during contact maintenance work on pulsers and other equipment in the Hot Shop before it was decided that it was not worth the time, money and radiation exposure.

PR CORRIDOR

The floor of the PR corridor has been contaminated with alpha several times in the past.

Contamination levels under the floor paint in some sections measure 80,000 d/m alpha. The vertical walls, up one foot from the floor, on both sides of the corridor are also highly contaminated and covered with paint.

The majority of the PR corridor floor contamination originated from contaminated water leaks in the PR room and the Pipe Chase.

Water leakage to the floor from expansion joints in the PR corridor ceiling have been detected. This occurs in the overhead pipeway from the pipe chase to the east R-cell room. Low level beta contamination to 10,000 d/m beta has been detected on the PR corridor floor from these leaks.

Dose rates to 150 mR/hr were detected at the very west end of the PR corridor, in the late 1950's. The radiation originated from the R-1 tank, inside of R-cell. An eight inch labyrinth wall was constructed in R-cell, in front of the west door, to alleviate the radiation problem in the corridor. This incident will be described further under R-Cell section.

In 1982, JAJ Construction forces were drilling a hole through the south wall of the pipe chase into L-cell for the purpose of installing an N-cell criticality drain. The core drilling was completed and the hole was left unsealed. A liquid leak in L-cell found the opening and a large amount of highly contaminated water from L-cell leaked into the pipe chase room and down the PR corridor. Contamination levels in excess of $1x10^6$ d/m alpha were detected. After a decontamination effort, removable alpha contamination of 100,000 d/m was painted over.

R-CELL

In the late 1950's a process upset occurred and highly contaminated organic solution was inadvertently moved to the R-1 tank by way of a "cross-tie" from G-cell. Dose rates were found to be 150 mR/hr at the west end of the PR corridor coming from R-cell. Further investigation revealed that the R-1 tank radiation level was 10 R/hr at contact.

As a result of the original high radiation incident in the R-1 tank, a concrete shielding wall was built inside R-cell, at the west PR Corridor entrance door, This proved to be an effective radiation shielding for the west end of the PR corridor.

Similar incidents have occurred in R-cell, but not as momentous as the one just described. When the R-cell piping system became internally contaminated, leaks occurred from flanges and other equipment, resulting in beta contamination to 150 mrads/hr and alpha to 60,000 d/m on the floor, in the sump, and gutters of the west room of R-cell.

Average dose rates in the west room of R-cell during normal operating periods average from 5 to 20 mR/hr and 5 mR/hr in the east room. The east room of R-cell contains two large organic holding tanks: Tk-R-5 and Tk-R-7. These tanks are internally contaminated, but radiation measurements through the sides of R-5 & R-7 tanks is seldom higher than 50 mR/hr.

Medium levels of contamination exist on the floor of the east room, resulting from flange leaks on the bottom of the tank drain lines and from maintenance work on the R-5/7 pumps.

Air sampling heads were originally installed in the east and west room of R-cell, but were not utilized after 1972. Air sampling results from R-cell during early Purex campaigns revealed no serious airborne problems. This was attributed to the oily base of the organic solutions which prevented the contamination from becoming readily airborne.

R-cell mezzanine contains two centrifuges. This area has never proven to be a radiological concern. Dose rates are negligible and contamination levels are low.

PR ROOM

The PR room has had many radiological incidents. This section will highlight, not all, but a significant few.

On January 24, 1958, the PR room L-11 sump overflowed, and solution leaked from the L-11 hood to the PR room floor. Contamination levels in excess of 40,000 d/m were measured on the overflow liquid. The area was immediately wiped down and covered with strip coat. Two hours later the sump again overflowed onto the freshly cleaned area, and the above procedure was repeated. It was then determined what caused the overflow, and the L-12 condenser water was turned on, alleviating the overflow problem. The contamination spread was confined to the L-11 hood exterior and floor areas adjacent to the L-11 labyrinth.

In 1960, an Operator was decontaminating a Pu nitrate can, utilizing the old original PR can decontamination hood. The Operator inadvertently left the water valve open. The decontamination hood drain was designed to empty into the L-11 sump. The L-11 sump overflowed, and liquid made its way out of the L-11 hood by way of ruptured hood gloves and from around and through the L-11 hood HEPA filter housing. The liquid was first detected on the floor at the bottom of the SWP lobby stairwell near the Q-cell entrance door. Contamination levels were in excess of 40,000 d/m. The solution flooded the PR room and migrated both ways down the PR corridor into the pipechase room and east into the Q-cell control room. The liquid was soaked up with rags, and the paint was removed from the floor and walls of the flooded areas. Contamination levels were finally reduced to 10,000 d/m smearable, and the decision was made to repaint.

In 1961, a water leak occurred in L-cell. The cell was filled to the point where liquid overflowed into the airlock and out from beneath the L-cell door into the PR room. Measurements of greater than 100,000 d/m were detected on the liquid.

The liquid traveled across the PR room floor, out into the corridor, and as far west as the N-cell door. Liquid also migrated through the Q-cell control room and out into the PIV room. A major decontamination effort was successful, and the floor was repainted.

A valve, located on the east wall of the L-11 labyrinth, has leaked many times in the past, resulting in gross amounts of alpha contamination on the L-11 hood front and east wall of the labyrinth. The valve was later removed and the contamination was painted over. Contamination leaching through the paint in this area has caused the L-11 labyrinth to remain posted as an airborne area.

Dose rates in the L-11 hood have been detected to 2 R/hr in the past, but average dose rates at L-11, during normal operating conditions are from 5 to 30 mR/hr.

Steam lines along the west wall at the L-11 labyrinth are internally contaminated and have leaked contaminated condensate to 40,000 d/m down the west wall to the floor. This area has been decontaminated and painted. The condensate leaks have been repaired, but still leak occasionally, and should be watched closely.

L-9, L-10 and L-11 process tank samplers were once a source of many contamination spreads in the PR room. The samplers have since been removed and sampling is now done inside the hoods. The L-9 sampler was once located on the south wall to the right of the PR room entrance door. The entire wall, surrounding the sample port and the floor beneath, were at one time contaminated to greater than 100,000 d/m alpha. This spread was the result of an L-9 sampler pressurization and blowback. Smearable contamination on the floor and walls has been painted over in this area.

Radiation levels inside the L-10 hood on the L-10 tank were measured up to 10 R/hr during a process upset, at one time.

Condensate from steam lines along the north wall of the L-9 labyrinth has leaked, contaminating the wall and floor to 40,000 d/m. This area was repainted, but fixed levels of contamination are still detectable on the wall directly beneath the condensate leak.

The tops of the L-9 and L-10 hoods have both been highly contaminated in the past as a result of unsealed tubing penetrations, leaks in the tubing fittings, and from contamination spreads that occurred when equipment was removed from the tops of the hoods through bag-out ports.

All of the PR room ceiling exhaust ductwork is internally contaminated to various levels with alpha. Most of the original ductwork has been replaced. Highly contaminated condensate has been found leaking from the vessel vent ductwork and has been proven to be responsible for high airborne levels in the PR room.

In 1983, PR room air sample results were consistently near mask limits. The PR room was placed on respiratory protection status as a precautionary measure, and a full scale decontamination effort was initiated. All walls, ceiling, ductwork exteriors, and other surfaces were wiped down. Subsequent air samples indicated background levels, and the PR room was released from mask status.

HOT SHOP LOBBY

In 1961, a fire started in a radiation waste box that was in the Hot Shop Lobby. Alpha contamination to 5,000 d/m and low level beta contamination was spread to the walls, floor, and horizontal surfaces. The Lobby was decontaminated and repainted.

The Hot Shop Lobby floor has been contaminated many times from waste box leaks, improper personnel and equipment exits from the Hot Shop, and from water leakage out from under the Hot Shop door into the lobby.

The remote, M-cell air sample inlet line that extends into the Hot Shop Lobby is internally contaminated.

M-Cell

High dose rates can be detected behind the M-1 tank in and around the floor sump.

Average field whole body dose rates in M-cell, with the cell empty of jumpers and other failed equipment, are from 5 to 30 mR/hr.

Radiation/contamination levels are subject to change in M-cell, depending upon the radiological condition of jumpers and other equipment that have been placed there for maintenance work.

F-cell jumpers are the largest contributors to high radiation dose rate in M-cell. Radiation measurements to 5 R/hr have been detected at the M-cell entrance door when jumpers from F-cell have been brought in. The M-cell deck is constructed of stainless steel and can be successfully decontaminated if the effort is made.

A near miss occurred in M-cell when a millwright was working on the crane trolley while it was positioned over the M-cell opening. A wrench was dropped from the crane to the M-cell deck, narrowly missing an employee who was working in M-cell at the time.

When contamination levels are not controlled by periodic decontamination, contamination is invariably tracked from M-cell into the Hot Shop. Step-off procedures between M-cell and the Hot Shop were never strictly enforced. Several skin contaminations have occurred when working in M-cell, the majority resulting from improper dress or an occasional failure of protective clothing.

A near over-exposure to a maintenance person occurred when an F-cell jumper was placed in M-cell for repair. The jumper was flushed externally, but not internally. When the maintenance person opened a flange, highly radioactive liquid leaked from it, causing the dose rate to increase sharply. This condition was not realized immediately. The employee was not over exposed and the incident was used as a learning experience.

L-CELL

L-cell is the radiation area that poses the highest risk for high-level skin contamination, internal deposition and contaminated injuries.

In 1965 a pipefitter was working in L-cell when he became claustrophobic and panicked. He dropped his tools, rushed out of L-cell through the airlock and entered the containment greenhouse without removing his plastic suit. At this point he was calmed down and removed from the area, but not before contaminating the airlock, greenhouse, and two of the undressers.

All L-cell entries are in close quarters and extreme care must be maintained to ensure that supplied air hoses do not become pinched restricting breathing air.

Early day entries to L-cell (1950's) were performed wearing "assault masks" for respiratory protection. Supplied air or SCBA has been the minimum requirement since the 1960's.

The primary cause of most skin contaminations, that have occurred as a result of L-cell entries, have been due to improper protective clothing removal by inexperienced or untrained personnel.

Personnel radiation dose rates in L-cell may vary from one entry to another. Dose rates are usually dependent upon the amount of time that was spent flushing the L-cell package and the floor prior to the entry. The sumps, gutters, and general floor areas are the major contributors to L-cell dose rates.

Neutron radiation has never been a contributing factor during L-cell entries if the process tanks have been properly flushed. The maximum neutron radiation observed in L-cell during personnel entries has been 20 mrem/hr.

Maintenance personnel suffering heat fatigue is always a problem when making L-cell entries. Suit coolers should be given serious consideration for maintenance personnel when performing tasks that may take longer than one-half hour to complete.

U-CELL

U-cell contains four large tanks: U-1 and U-2 (recovered acid storage) and U-3 and U-4 (Lab. liquid waste).

Dose rates in U-cell have the potential to vary considerably during different operating modes.

In December 1985 and early 1986, the F-15/F-16 tanks "burped" and carried fission products over into the F-5 acid absorber, which became saturated. This allowed the fission products to enter the U-6 tank in 206-A and then into U-cell's U-1 and U-2 tanks.

Prior to the above described process upset, dose rates to work in U-cell were from 10 to 150 mR/hr, depending upon location. At the time of the upset, dose rates were measured to 1500 mR/hr at the inner door to U-cell. All access to U-cell was restricted during this period. The results of the above incident were observable throughout the sample gallery and 206-A for several months. Dose rates were finally reduced to near normal by repeated flushings and the addition of fresh acid into the system.

Contamination spreads in U-cell occur primarily from leaks in the acid piping systems and from maintenance work involving pump exchanges.

In 1961, an acid leak occurred in U-cell; and as a result, contaminated liquid to 100,000 d/m beta leaked out from under the entrance doors into the stairwell. The U-cell cover blocks will leak water into U-cell from rainy or snow melt conditions. Up until 1961 this condition existed and liquid would migrate from the floor out the entrance doors. An 18-inch high, two wall barrier was constructed to isolate the exit doors and airlock from tank leakage.

Floor contamination will vary in U-cell, depending upon the extent of decontamination efforts by operations. Floor smears to 600,000 d/m beta and 1,500 d/m alpha are not uncommon, depending upon the size of the floor smear.

Alpha contamination has not proven to be a problem in U-cell, but the potential for high levels of alpha does exist if leaks occur in the piping to U-3 or U-4 Lab. waste tanks.

Air sampling heads were originally installed in U-cell, utilizing the building vacuum system. High nitric acid atmosphere soon destroyed the sample piping. No continuous air sampling is performed in U-cell, but an occasional high-volume air sample is sometimes taken for verification of airborne conditions.

N-CELL

The original N-cell was much smaller in physical size as opposed to the present N-cell. Many contamination spreads occurred in the original N-cell; the most prominent was a fire in the original N-cell hood that occurred on February 25, 1960. JAJ Construction forces were in the process of modifying piping in the N-cell hood. During welding a fire occurred in the hood. Later investigations determined the fire may have started from ignition of an inflammable chemical, such as organic. The fire quickly spread to the HEPA hood inlet filters. An operator, in an attempt to extinguish the fire, cut open a glove port and inserted a fire extinguisher. The fire was extinguished, but not before a hood airflow reversal occurred. As a result of the fire, the hood room, AMU, control room, sections of the regulated shop, (a large room used for maintenance work on low-level contaminated equipment, located to the west of N-cell and to the east of the Hot Shop Lobby), and the PR corridor were contaminated in excess of 60,000 d/m/100cm^2. Three construction personnel received skin contaminations to a varying degree. The most severe was 40,000 d/m alpha on face and other exposed skin surfaces.

Several months of decontamination efforts were required before the N-cell areas were decontaminated sufficiently to be released from mask status.

In 1961 and also in 1970 Thorium load-out campaigns got underway. The thorium load-out hood was located in the northeast corner of the N-cell hood room. No major, thorium contamination spreads occurred during the thoria runs.

In the late 1960's, an incident occurred in the "old" N-cell hood room that could have had serious consequences. An N-cell hood glove was pulled wrong-side-out and left hanging out of the glove port. A line to a process tank, inside the hood, sprung a leak and proceeded to spew a stream of process solution through the glove port opening, slowly filling the hood glove that was attached to the glove port. An operator discovered the problem and quickly tipped up the hood glove, emptying the solution back into the hood before the liquid in the glove reached a critical configuration.
Several instances of puncture wounds occurred while personnel were working in the "old" N-cell glove port hood. Due to the high acid atmosphere in the hood, tools and other ferrous metals sometimes became "needle sharp" and would easily puncture hood gloves. Some instances of internal deposition did occur from puncture wounds during this period of time. All ferrous metal tools in the hood were replaced with stainless steel tools.

Thermal temperatures in the "old" N-cell hood were always high while operating; and this problem, plus the high acid atmosphere, resulted in a very short life for hood gloves. Discovering ten to twenty ruptured hood gloves per week was not uncommon.

Dose rates in the "old" N-cell hood room averaged 5 to 15 mR/hr during normal operations, but radiation measurements, on occasion, have been detected up to 300 mR/hr on the N-1 tank.

Neutron radiation averaged from less than 1 to 3 mrem/hr in the N-cell glove box room.

The "old" N-cell hoods were removed by JAJ Construction forces and the present N-cell complex was installed in 1974. The new complex incorporated the space where the Regulated Shop was once located. JAJ Construction forces experienced many skin contaminations during the removal of the original N-cell hoods, but none were of a serious nature.

Although contamination spreads in N-cell have been numerous, few have been momentous. The majority of spreads in N-cell occur during glove changes or bagging in or out of the glove box hood. The use of the "down comer" vacuum hose, placed beneath the glove ports during glove changes, has significantly reduced the number of contamination spreads in the glove box room.

On occasion, there have been contamination spreads in the glove box room where nearly all of the surfaces of the room were contaminated with low level alpha. The surfaces were wiped down and decontaminated. The floor of the glove box room, first level, is concrete. Alpha contamination has been painted over, on numerous occasions.

In 1984, a pipefitter was highly contaminated while working in the N-cell glove box room. A hood glove he was using ruptured. The employee removed his arms from the glove, spreading alpha contamination to his face. Bioassay checks were positive. Further investigation revealed that he had received 1% of his whole body burden.

Many serious spreads throughout N-cell have been averted by the use of alpha cam's. Cam's, when set up properly, will detect extremely low levels of alpha contamination in aerosol form before it can be detected from smears on horizontal surfaces.

Radiation dose rate in the vicinity of the glove boxes will normally range from 2 to 20 mR/hr at the hood front while operating. Neutron radiation in the glove box rooms average 1 to 5 mrem/hr. Neutron measurements on the final product cans seldom exceed 20 mrem/hr.

SAMPLE GALLERY

Sections A, B and C:

The manipulator repair shop, at the very east end of the sample gallery, has been maintained in good radiological condition. Occasionally, removable contamination up to 10,000 d/m beta will be detected on the floor during a routine contamination status survey.

When the doors to the manipulator shop are kept closed, a buildup of radon gas and other short lived activities usually occur, due to the lack of room ventilation.

A-3, B-3 & C-3 A-type, dissolver cell sample ports were used very infrequently and dose rates to sample were always less than 20 mR/hr.

A, B & C Iodine offgas sampling hood, located between A-3 & B-3 sample ports is internally contaminated to 200,000 d/m beta. The interior of the hood became contaminated during maintenance work when contaminated condensate leaked from piping onto the floor of the hood.

The sample gallery pipe chase, top surface area extends nearly the entire length of the gallery and has always been a contamination "catch-all". It has proven difficult to maintain the pipechase free of removable contamination. From A section through J section, smears to 50,000 d/m beta are common. From J section through L section removable alpha (from uranium and) contamination is frequently found in the 5,000 to 200,000 d/m alpha range. Contaminated material found on the pipechase is relatively stable because of its oily texture and does not readily become airborne. Special air samples have confirmed this.

The sample port exhaust ductwork runs the entire length of the sample gallery and has been a major source of contamination spreads since its conception. The exhaust ductwork is flange connected, approximately every 24 feet. When the exhaust fans are shut down for maintenance or inspection, condensate

quickly builds up in the ductwork interior and leaks from the bottom of the flanges to the floor. This ongoing problem has had fixes that have only proven to be temporary. The leakage problem most often occurs from the ductwork flanges along the western half of the sample gallery. Many times in the past, sample gallery cam's have indicated airborne contamination and the source was found to be leakage from the ductwork.

High airborne contamination problems have occurred in the sample gallery that were also traced to sample gallery floor drains. The floor drains empty into various canyon cell sumps and are constructed with water seal traps. If the traps become low on water and lose their seals, sample gallery exhaust negative will withdraw canyon air through the drain system into the sample gallery resulting in high airborne activity. Operations have increased their frequency for filling the floor drains virtually eliminating the problem.

The recovered acid piping systems located throughout the sample gallery along the pipechase, have been another major contributor to sample gallery radiation and contamination spreads.

In December, 1986, a process problem occurred in the F-15/F-16 tanks. The material contained in the tanks "burped", resulting in high level fission products moving to the F-5 acid absorber and then into 206-A U-6 tank. From 206-A the solution moved to U-cell U-1 and U-2 tanks. Radiation levels were high in 206-A building and U-cell. From U-cell the recovered acid, contaminated by the fission products, started working its way into the sample gallery and into the following recovered acid systems: A-3, B-3, C-3, E-6, HAS, H-2, J-4, K-1 and K-2.

Radiation dose rates in the sample gallery, increased rapidly and by early January, 1986, radiation readings were found to be from 100 mR/hr to 10 R/hr at the acid stations throughout the sample gallery. The maximum radiation dose rate obtained in the normal walkway of the sample gallery was 1.5 R/hr opposite the E-6 station. Leaks in the acid system piping and flanges further compounded the problem. Not only was there high radiation to deal with, but contaminated acid was leaking into the catch trays, overflowing and running onto the sample gallery floor where in some cases, it was being tracked throughout the sample gallery.

All personnel stay-time in the sample gallery was reduced. Operations personnel were only taking samples that were absolutely necessary and would leave the sample gallery when finished sampling. During this period, operations were performing extensive internal flushes of the system and adding clean nitric acid.

Dose rates finally started to decline. By January 21, 1986, dose rates were averaging 45 mR/hr to 1 R/hr at the acid stations. New type valves and gaskets were installed on the recovered acid piping in the sample gallery, which greatly reduced the leakage problems. By August, 1986, the dose rate on the acid systems had dropped to the point where background radiation levels in the sample gallery walkway were near normal.

The sample gallery floor has been repainted numerous times. Alpha/beta/gamma contamination is present under all sample gallery floor paint.

Significant alpha contamination is seldom detected east of J-1 sample port, except when alpha contaminated materials and waste boxes are taken to the east end and then develop leaks. An exception to this occurred in 1983.

All sample gallery air samples taken from E-6 east indicated alpha activity. A week of investigative monitoring proved fruitless. No source could be located. An individual with years of PUREX experience volunteered to look for the source and soon found it. An instrument Dp indicator air line located along the north wall opposite F-1 sample port, was found to be leaking liquid to the floor. Alpha contamination migrated into this system from a canyon vessel vent line. Contamination levels to 120,000 d/m alpha were detected on the piping and floor. The leak was repaired and a lucite enclosure built around the instrument rack. No other significant alpha problems have occurred at the east end of the sample gallery.

D-2, D-3 and D-4, A-type samplers were seldom utilized. When process samples were withdrawn from these ports radiation levels were low.

The "old" manipulator cave located between C-3 and D-2 sample port was in use for several years by Laboratory personnel. High dose rates due to sample storage and waste buildup were detectable to 5 R/hr at the load-in door and from the light-wells. Tubing extending out through the bottom of the cave became internally contaminated and was causing unnecessary radiation exposure to manipulator operators.

Operation of this manipulator cave was discontinued in the 1960's when the new remote cave at D-5 was constructed.

The new manipulator cave at the D-5 location has caused few major contamination spreads in the past. When waste and old samples were removed from the cave by the bagout method through the bottom opening, radiation exposure rates to personnel did pose a problem. Occasionally, personnel dose rates to 5 R/hr were encountered during this procedure. Improved techniques, remote tools plus shielding remedied the exposure problem. In 1964, a new D-5 cave drain system was installed. Working under the hood in cramped quarters, was difficult and personnel exposure rates to 2 R/hr were given to pipefitters to complete the job. Several piping leaks from the underside of the cave have occurred, resulting in contaminated liquid leaking out to the floor of the sample gallery walkway and on some occasions tracked throughout the sample gallery.

The E3A product recycle tank is located inside a large lucite enclosure between E-1 and E-3 sample ports. Product that did not meet specifications was jetted into the E3A tank from the recycle hood. From the E3A tank it was introduced back into the process for rework. Dose rates at the E3A enclosure were never in excess of 10 mR/hr. Several spills occurred inside the E3A enclosure during sampling and alpha contamination to 300,000 d/m was detected on the floor of the enclosure the last time it was opened in 1975.

During the early campaign an operator received facial contamination to 40,000 d/m alpha as he was sampling the E3A tank. The sample bottle pressurized, spraying liquid on his face. Decontamination was successful and no internal deposition occurred.

E-1, E-3, E-5 and E-6 sample ports were often used when the process was operating.

An intermittent airborne problem at the east end of the sample gallery took several weeks before the problem could be identified. By pulling numerous air samples on and around the east end sample ports, the problem was narrowed down to the E-6 sampler valve pit. After further investigation it was discovered that whenever the E-6 sampler jet-air line was turned on, contamination from a leaking diaphragm in the valve pit would introduce contaminated air into the sample gallery room airflow. Air samples from this incident were as high as 100 mrads/hr. The diaphragm was replaced and conditions returned to normal.

Sample gallery contamination spreads have occurred from various causes throughout the PUREX campaign. One of the most chronic and troublesome source was from liquid leaks stemming from A-type sample port valve pits. When pit valves or flanges leaked, highly contaminated liquid tended to migrate to the outside of the sample ports by way of cracks (faults) in the concrete piping penetrations and from around unsealed inspection ports. In 1957, a Health Physics Tech. discovered liquid in the sample gallery walkway at F-15 sample pit location. Radiation measurements on the liquid were 40 Rads/hr at 1 inch. The liquid had seeped out from the bottom of the inspection plate on the east side of the sample port.

When maintenance work was performed in the sampler valve pits, water was introduced into the pits to provide radiation shielding so contact maintenance on the valves could be implemented. Invariably the water would find its way out of the pit, causing high radiation and contamination spreads around the vicinity of the sample port. To rectify the leakage problem it was decided to contract JAJ Construction forces to install stainless steel liners in the valve pits for the following sample ports: E-1, E-3, E-5, F-8, F-10, F-13, F-15, F-16 and H-2. Construction commenced on September 25, 1967. The liner installation took approximately 6 months to complete and has proven to have been be well worth the expenditure.

The sample port proper will still leak liquid to the exterior if liquid is used for flushing the interior of the sample ports for decontamination purposes. Liquid will also migrate out of the sample port if the sample port drains plug and water is backed up into the port interior.

In 1959, two instances occurred in the same year where personnel became highly contaminated as a result of a sample line pressurization and blowback. In both cases misvalving was found to be the cause of the incident. Sample solution under pressure, was forced from the sampler riser valve inside the sample port, contaminating the port interior and splashing out onto the personnel by way of the pipette slot openings.

Slot openings have a splash protective curtain, but this was not in place, as per procedure, when the pressurization occurred

During sampling operations in A-type sample ports, occasionally a sampler would not withdraw the sample pipette from the riser completely. When this occurred and the riser valve was then closed, a small section of the very end of the pipette would be cut off and would remain in the riser cup, preventing further sampling. Elaborate tools were designed to be remotely inserted into the riser for tip removal.

In 1965, an operator experienced in the operation and valving of sample ports, determined that the broken pipette tip could be floated from the riser by applying just the right amount of air pressure. When this procedure was attempted, too much pressure was used, subsequently contaminating the internal surfaces of the F-16 sample port. The operator also received facial and hand contamination during the incident.

Repair work in the A-type sample port valve pits and hood interiors have been responsible for numerous skin contaminations and high radiation exposures. By 1960, PUREX maintenance personnel had developed remote tools for valve replacement which greatly reduced the instances of high exposures. Riser valve and valve pit maintenance techniques were refined to the point where this type of work could be completed in a short time with relatively low exposure and little or no contamination spreads. After 1982, the specifically designed remote tools were discarded to radioactive waste in the interest of "good housekeeping."

A few maintenance entries have been made into the A-type sample ports through the lower door, to repair the cup valve. Radiation measurements to 500 R/hr have been recorded during this work at F-15 /F-16 when the sampling system had not been flushed adequately.

Dropped or spilled samples happen occasionally during sampling operations in the sample gallery. An F-15 sample carrier gilmont was dropped to the floor and spilled when it contacted the bottom edge of the sampler door as it was being removed from the port. The lids were not on the gilmonts at this time. Sample solution splashed onto the sample cart and onto the floor. Measurements of 3 Rads/hr at 1 foot were obtained on the solution. The spill was washed down carelessly with water which further increased the area of the contamination spread. Extensive decontamination efforts were required. No personnel contaminations or over exposures occurred as a result of this incident. Procedures were changed to require that the lids would be set in place on the gilmonts while they were still in the hood.

The majority of dropped samples have occurred during sampling of B and C type samplers because of the necessity for hand contact with the bottle or sample container

In 1986, an operator spilled a Pu bottle sample in the L5-B sample enclosure when it slipped from his hand. Solution splashed on to his face and coveralls. Levels of alpha contamination on the employee's chest and face were measured at 750,000 d/m. Decontamination was very difficult, but

eventually successful. The employee said his surgeons gloves were slippery, making it difficult for him to maintain his grasp.

The decontamination hood is located along the north wall of the sample gallery across from F-3 sample port. The hood is equipped with nitric acid and water flush lines and is used for decontamination of highly contaminated equipment, namely, gilmont sample carriers that have become contaminated during sampling. The decontamination hood is exhausted by way of the sample gallery hood exhaust ductwork.

Very little effort is put forth to keep the decontamination hood interior decontaminated. Removable alpha/beta contamination is readily detectable inside the hood to 40,000 d/m alpha and up to 10 mrads/hr.

The water trap on the decontamination hood drain system is always internally contaminated and appropriate controls need to be followed when this system is opened. The decontamination hood will also leak from the door opening if copious amounts of water are allowed to splash onto the shelf.

Other instances of unnecessary radiation exposure to personnel have occurred when operations personnel become used to routinely low radiation exposure rates on B and C type samples. Personnel tend to become complacent and do not regularly monitor dose rates before removing the sample containers. One such instance occurred when an operator removed an R-cell bottle sample without first checking his dose rate. R-cell samples usually are of low activity, but in this case were high due to a process organic upset. The sample bottle measured 4 Rad/hr and the employee hand carried it to the east end of the sample gallery. An investigation into this incident concluded that extremity dose limits were not exceeded.

An ongoing, historical problem has been to impress and convince sampling personnel of the potential for changing radiological dose rate conditions and to always obtain a dose rate prior to handling any process sample.

When pipettes used in A-type samplers fail and need replacing, they must be removed from the sample port and transported to the pipette repair table in the sample gallery for reconditioning. High radiation exposure rates and contamination spread potential exists when this task is performed. Numerous contamination spreads have occurred in the sample gallery as a result of mishandling the pipettes when they are removed from the port. The sample gallery floor contamination spreads due to pipette removal are too numerous to list, but two skin contamination cases resulting from pipette repair, stand out and may be worth mentioning:

In 1961, a welder was repairing a 12 inch length of pipette capillary tubing. In an attempt to test the tubing to ensure that it was not plugged, he held the tubing up to his ear to listen as he applied air pressure to the other end of the tubing. This resulted in the blowing of contaminated oil to 300,000 d/m beta, into the employee's ear. Decontamination was successful.

Sometime in the early 1960's, an operator received facial contamination to 250,000 d/m beta as he was removing a pipette from the F-15 sample port.

During removal the tip of the pipette did not clear the bottom of the gilmont slot. As it suddenly came free, contaminated oil was flipped into the employee's face. Contamination levels were in the 50,000 d/m to 200,000 d/m beta range.

Two other significant occasions of substantial skin contamination to personnel occurred in the sample gallery as a result of handling contaminated process equipment and not performing an adequate personal survey. In 1959 or 1960, a Health Physics Tech. contaminated his gloves while surveying an F-16 process sample carrier. The individual failed to perform a personal survey at the completion of the task and then proceeded to the laboratory shift office for a smoke break. As a result of not knowing his gloves were highly contaminated, contamination was spread to his hands, face and false teeth. Maximum contamination detected was 300,000 d/m beta. Various other levels of contamination were detected, spread throughout the lab. shift office. The laboratory areas were decontaminated and the contaminated employee received no significant deposition.

The second case involved a process operator in 1963, who unknowingly became contaminated during sampling operations. The employee exited the sample gallery through the AMU airlock without surveying himself and proceeded to spread beta contamination throughout the operations shift office, central control room and the lavatory. By the time the operator was discovered to be contaminated, several other personnel had received clothing contamination. The operator was found to have beta contamination to 600,000 d/m on his face, chest and hands. Several hours of decontamination effort were expended before the employee and the office areas were released from radiological control.

On July 22, 1961, a PUREX operator received an over exposure to his hand as a result of his protective glove coming in contact with a source. The employee had taken a process (F-16) sample and replaced the lid on the gilmont carrier. The HP Tech. then surveyed the carrier and detected a high beta radiation level indicating external carrier contamination. The cotton gloves worn over surgical gloves were removed immediately. A survey of the cotton glove disclosed two spots of contamination on the thumb and forefinger to the extent of 40 rads/hr at 2 inches. The contaminated glove was sent to "HLO" for autoradiographing and based on examination of the glove and conservative time estimate of exposure the operator received about 150 Rads, including 0.04 R to a significant skin area of one hand. No skin irritation was observed after the incident and the employee's total whole body radiation dose was estimated at 40 mrem including 25 mR. The cause of the incident was attributed to a small drop of sample solution contacting the sample carrier and was then transferred to the employee's glove.

On September 1, 1984 a PUREX operator took an L5-B Pu bottle sample wearing only cotton liner gloves--no surgicals. As a result, the employee sustained hand contamination to 650,000 d/m. Decontamination was successful in removing the majority of the skin contamination. The employee was sent home wearing a glove with 1,000 d/m on his hand in order to let the skin toughen and the pores to weep. He was successfully decontaminated on the following day.

During the early PUREX campaign (1950's) a criticality detection chamber was located in the sample gallery on the north wall opposite the L-3 sample port. The chamber was positioned over a section of exhaust ductwork that was common to the PR room. At this time, a high radiation reading existed on the L-9 process tank in the PR room. Sufficient radiation was present to cause shine through the ductwork and up into the sample gallery, setting-off the criticality alarm. The building was evacuated. Further follow-up revealed the problem, which was corrected from happening again by reducing the radiation on the L-9 tank and repositioning the detection chamber.

Another PUREX criticality alarm was activated when a radioactive waste drum was transported down the PR elevator. A high dose rate, non-transuranic waste drum was being moved from the sample gallery to the hot shop where it could be disposed of remotely. As the drum, (reading 2.3 R/hr at contact) was moving down the elevator shaft, it passed by criticality detectors set to activate at 100 mR/hr. The audible criticality alarms energized, and personnel evacuated from the affected areas within the facility. No contamination was spread outside existing radiation areas. Evacuation of the rest of the facility was not initiated as it was immediately determined that the waste drum had activated the alarm. The area was re-entered by RPT's who verified that no elevated dose rates existed within the facility and that the criticality alarm was false.

An extremity overdose was received by a pipefitter on August 23, 1986. High dose rates (320 Rads/hr including 70 R/hr) were encountered on an F-16 sample port riser valve that was to be replaced. The craftsman completed removing the bolts, holding the faulty riser valve in place by remote means. He then attempted to remove the valve without success. There was a brief discussion between the craftsman and the HP Tech; and the decision was made to manually reach inside the sampler hood, break loose the valve, and remove it, thereby reducing total exposure time. After completing the riser valve removal, the same craftsman was permitted to manually hand-start the four bolts that held the valve in place. Finger ring dosimeter results indicated that the craftsman received an extremity dose of 11 Rem, exceeding the quarterly exposure limits of 5 Rem. to the hands. The corrective action was to emphasize the need for special RWP's and <u>pre-job discussions</u> when elevated personal dose rate levels are anticipated.

In 1985, air samples at the west half of the sample gallery were intermittently indicating activity concentrations at mask levels. The west half of the sample gallery was placed on respiratory protection status. Several days would elapse with low air samples and then suddenly they would sharply increase in activity. Investigation by process engineering could not tie anything into the process that might be causing the problem. The area was kept on mask because no conclusive source could be identified. After several weeks of intense follow-up investigation using portable air samplers in different locations, the problem area was narrowed down to three suspect sample ports. Isolation tents were constructed around two of the ports, and air sampling was continued inside and outside of the isolation tents. It was finally determined that the H-1 sampler valve pit was the culprit. The sample return leg was partially plugged, and there was also a

leaking flange on the sample jumper inside the valve pit. Airborne contamination in aerosol form was being emitted from around the valve pit cover block. The jumper was repaired and the airborne problem ceased.

The Neptunium 237 recycle hood is located at the west end of the sample gallery near L-4 sample port. This enclosed hood was originally used to recycle Np^{237} product which did not meet specifications, back into the process for rework. No major spills ever occurred in the recycle hood, but the hood is contaminated to greater than 40,000 d/m alpha due to normal operations, using the manual jet nozzle. The hood is sealed and appropriate radiological controls will need to be set up prior to entry.

The Np^{237} sampler hood, located next to the Np recycle hood was seldom used for sampling. Removable contamination in the interior of the individual sample ports is minimal.

The secondary N-cell hood HEPA filter box is located at the west end of the sample gallery along the south wall. Shortly after this system was installed, condensate leaked from the east filter box to the floor beneath. Levels of alpha contamination to 100,000 d/m were detected. The contamination was cleaned and the leak in the filter box gasket was repaired. Extremely high levels of alpha contamination exist inside the filter box.

Instrument sensing and differential pressure lines to N-cell were installed along the south wall of the sample gallery, east of the N-cell filter box. On occasion, these lines will plug and must be cleaned out. Several of the lines are known to be internally contaminated to greater than 40,000 d/m alpha. The Dp lines also extend through the ceiling into the White Room and have been found to be internally contaminated at that point.

EAST CRANE MAINTENANCE PLATFORM (ECMP)

The PUREX facility was originally constructed with one CMP and one shielded crane. One year after original startup it was decided to construct an east CMP and equip it with a second shielded crane. This project was started in 1957 and completed in 1958. While the east CMP was being constructed, a wooden barrier was erected to block off the rest of the canyon from the new CMP so construction forces could work without protective clothing or respiratory protection. Approximately two-thirds of the way through the construction, contaminated dust was detected on the "clean" side of the barrier, necessitating appropriate radiological control measures for the completion of construction. The new shielded east crane was to be used for fuel charging operations and the west crane for process cell work. Three concrete shielding doors were constructed for the purpose of shielding the east CMP during fuel charging operations. The shielding doors proved to provide adequate shielding for maintenance personnel on the ECMP, but their use was limited. The major contributor of contamination on the ECMP is the east crane. When the west crane was down for maintenance, the east crane was used for process cell work. Contaminated crane tools (impact wrenches and hooks) became highly contaminated from working in the process cells and consequently contaminated the ECMP. Floor contamination on the ECMP, for the most part, consists of beta contamination, but as the E-crane was used

more often for work in the product cells, alpha contamination began to make an appearance on the ECMP.

When periodic CMP decontamination is not performed, it is not unusual to measure removable contamination to 100 mrads/hr beta and 20,000 d/m alpha from floor smears. Radiation dose rates exist along the front edge of the canyon shielding door as a result of highly contaminated crane tools dragging over the door when the east crane enters the CMP. Other contact dose rates are detectable on the floor where highly contaminated impact wrenches were placed for maintenance or storage.

Decontamination of the ECMP floor must <u>not</u> be accomplished with large amounts of water, e.g., from a water hose. Experience has proven that water will leak though the floor expansion joints to the mezzanine and locker room below. The decontamination method that has been the most effective in the past has been sweeping with dust retardant compound. Radiation dose rates will build up quickly on dust accumulations.

Radiation dose rates to 400 mR/hr have been measured on the ECMP in front of the viewing window, during charging of short-time cooled fuel. Dose rates were also 40 mR/hr through the ECMP entry door at this time.

WEST CRANE MAINTENANCE PLATFORM (WCMP)

The WCMP has a history of contamination problems. Like the ECMP, it becomes contaminated due to maintenance work on the west crane and from highly contaminated crane equipment, hooks, impact wrenches, etc.

Radiological conditions are subject to change on the WCMP. This was demonstrated in a near incident that occurred in 1967 when a maintenance crew had spent the morning on the WCMP repairing a jumper cutter. During the job, the established average dose rate to perform the work was 30 mrads/hr. The crew broke for lunch and upon return the HP Technician found the dose rate had increased to 1Rad/hr. Follow-up investigations revealed that the crane had been working in F-cell during lunch which resulted in the cell impact wrench becoming highly contaminated to 500 Rads/hr at 1 foot. Consequently the background radiation increased dramatically. Due to the alertness of the HP Technician, no over-exposure occurred.

There have been occasions when the WCMP has been used as a "buffer" area for the purpose of inspecting failed, highly radioactive equipment. In 1965 the process engineering organization was interested in obtaining a radiation measurement on a failed process tank. A TPC (high range radiation detection instrument) probe was positioned on the east edge of the WCMP with an extension cable running across the CMP, out the exit door and attached to the instrument body at the viewing window. When the crane positioned the tank close to the edge of the CMP, a radiation measurement of 50 Rads/hr was obtained. Minimal personnel radiation exposure was expended using this method.

Both beta and alpha contamination is detectable on the WCMP. Floor smears to 10 mrads/hr and 20,000 d/m alpha are not unusual in this area.

A water and scrub brushes were once used to decontaminate the WCMP floor. It was found that water used for decontamination tended to back up from the CMP floor drain and out of the floor drain into the west end of the sample gallery. Contamination was spread over a large area of the west sample gallery before it was realized where the contamination had originated. Water is no longer recommended for decontaminating the CMP floor.

High contact surface dose rates are found along the east edge of the WCMP. This section is constructed of "diamond plate" approximately 30 inches wide. The diamond plate becomes contaminated when crane tools (hooks and impact wrenches) are dragged across it as the crane enters the CMP.

CRANEWAY

The craneway floor surfaces are normally contaminated with alpha and beta particles that are dusty and highly smearable. Floor surface dose rates do exist, but are usually low in intensity and originate from beta contamination buildup in greasy areas on the floor. Major contamination spreads, though few in nature, have occurred in the craneway. The following incident is the most severe craneway contamination spread recorded at PUREX:

In 1960 an Atomic Energy Commission "Tech. Grad." received skin and clothing contamination as a result of entering the craneway on the way into the crane cab for an inspection. Prior to the entry the crane had removed a highly contaminated tube bundle from F-cell and placed it on the canyon deck at K-cell. The tube bundle was extremely radioactive and was also thermally hot due to residual radiation. Contaminated dust particles from the tube bundle traveled upward with the heat waves and settled onto the craneway floor surfaces. Walking across the craneway to the crane cab and back to door #7 resulted in skin contamination on the Tech. Grad's legs and under-clothing to 200,000 d/m beta. Follow-up entries to the craneway discovered that radiation field dose rates were not excessive, but a significant smear of a large area of the craneway floor surfaces measured 5 Rads/hr. The Tech. Grad. and the craneway were successfully decontaminated.

Removable beta contamination will accumulate to high levels in the craneway if it is not decontaminated on a regular basis. The best method for craneway decontamination was found to be sweeping with push-brooms and using dust retardant compound. If copious amounts of water are used, water will migrate into the P&O Gallery by way of the expansion joints.

In the early 1960's a self propelled street sweeper type machine was purchased for craneway decontamination. The machine used soap and water and was equipped with revolving brushes. The water the machine used for scrubbing, along with the contamination was sucked back into a holding tank. The machine was used several times and performed well. Its use was later discontinued when problems with contaminated water disposal from the CMP, proved to be excessive.

The dose rate to traverse the craneway with all cell blocks in place will usually average from 5 to 30 mR/hr.

Field radiation dose rates up to 500 mR/hr have been measured in the craneway when F-cell cover blocks are removed.

No personnel entries are allowed into the craneway during fuel charging operations. If the radiation background is found to be excessive in the craneway and all cells are covered, it is an indication that there may be highly radioactive process equipment stored on the canyon deck.

The craneway does not have air sampling capabilities. Unfiltered canyon air is sampled only at the east and west CMP's by the use of remote CAM's.

REMOTE CRANES

Contamination levels on the exterior surfaces of the remote cranes vary and are dependent upon crane usage for process cell work and also on the amount of decontamination effort expended for decontamination. Usually the exterior of the west crane is more highly contaminated than the east crane and alpha activity is more readily detectable on the exterior surfaces of the west crane. Contamination levels on the exteriors of the remote cranes will show a marked increase during periods when extensive process cell work is in progress. Smears of the crane exteriors usually average from 50,000 to 500,000 d/m beta and 5,000 d/m alpha.

The greatest contributors to dose rates on the crane bridge are from the cable drums and crane cab inlet HEPA filters.

Crane tools such as impact wrenches and hooks are the most likely sources for high dose rates and contamination found on the remote cranes.

Instances of radiation measurements in excess of 500 Rads/hr have been recorded on crane hooks and impact wrenches. When maintenance work is required on highly radioactive crane tools, radiation exposure controls are initiated such as shielding and/or decontamination of the tools in M-cell prior to the work.

When maintenance work is performed on the CMP's, but not necessarily on the crane tools, personnel radiation exposures can be reduced significantly if the tools are lowered below the lip of the CMP. If this is not possible, the trolley holding the tools can be repositioned at a distance away form the maintenance crew.

On 3-14-88 low level beta contamination was detected on the floor in the PUREX SWP Lobby. At approximately the same time, a crane operator was found to have 13,000 d/m beta on the palms of his hands. A decision was made to survey all the PUREX crane operators for contamination. One other crane operator was found to have skin contamination to the following levels: Face, head, neck, hair from 2,000 d/m to 10,000 d/m beta and on both hands from 5,000 d/m to 12,000 d/m beta. An investigative contamination survey was made of the west crane cab. The air lock was found to be smearing 1,000,000 d/m

beta and the inside crane cab surfaces were found to be smearing 400,000 d/m beta. The decision was made to survey the crane operator's residence with the following results: Hand towel 4,000 d/m, beta, undershirt 35,000 d/m beta, bath towel 10,000 d/m beta, wash cloth 6,000 d/m beta and electric razor 3,000 d/m beta. The contaminated personal belongings were returned to the site and appropriately discarded to contaminated waste. Nasal irrigation was performed on the crane operator as a precautionary measure. No internal deposition was detected from bioassay results. The cause of the event was never actually proven, but evidence indicated that the crane operator had probably exited the crane cab while on the west CMP and replaced or adjusted the crane's auxiliary hook and in the process contaminated his hands and clothing. Contamination was carried off-site as a result of the employee bypassing three personnel survey checkout stations without performing an adequate release survey. This incident occurred at the time when a Technical Safety Appraisal team (TSA), was auditing PUREX.

Numerous skin contaminations have occurred to maintenance personnel while working on the crane bridge. Most occurrences can be attributed to "soak throughs" resulting from perspiration, protective clothing failure and from kneeling on contaminated greasy surfaces.

Two instances of personnel fainting while working on the cranes and CMP's have been recorded. One millwright experienced a fainting spell while working on top of the crane bridge and had to be removed from the crane and taken to the PR Dock where he was revived.

A process operator also fainted on the WCMP from breathing cleaning solvent fumes, (tri-chloroethylene) which he was using as a decontamination agent. No skin contamination occurred in either case and the employees showed no obvious side effects. This type of solvent is no longer used.

Decontamination of the crane exterior surfaces has always been a difficult ongoing problem. Steam cleaning was attempted in the 1950's on the Redox crane, but was quickly discontinued when it was found that the steam cleaning destroyed the crane's electrical system. Flushing the crane with an industrial, fast drying solvent has possibilities, but has yet to be tried on PUREX cranes. Hand wiping with detergent and wet rags has been the most practical method used, though skin contamination incidents and higher personnel exposures are greater using this method.

The west CMP was originally designed with a built-in high volume vacuum system with the vacuum exhaust piped to an underground filter box located on the south side of the PUREX facility. This system was designed to be used with a three-inch flex suction hose attached to an exhaust port on the south wall of the WCMP and was to be used for vacuuming radioactive dust particles from the crane exteriors. The vacuum system was used in 1956, but was found to be ineffective due to the vacuum system's inability to remove dust from greasy crane surfaces. The system would also plug if rags or other debris were sucked into the system. The vacuum system, though still in place, is plugged and has not been used since 1956.

The shielded crane cabs were designed to be free of contamination. When contamination is detected inside the crane cab it is usually tracked in when protective clothing is removed improperly or the cab inlet air filter experiences a breakthrough.

Low levels of fixed beta contamination can normally be found inside both east and west crane cabs. The most common locations are under the operating consoles, in the floor wireways and around the cab inlet ventilation opening.

In 1964 a crane operator placed glassware in a plastic bag and attached it to an auxiliary hook on the west crane. He then lowered the hook into F-cell, positioning the plastic bag next to a highly radioactive concentrator for the purpose of coloring the glassware by irradiation. When the crane operator removed the plastic bag he became contaminated and also proceeded to contaminate the inside of the crane cab.

The original metal floors of both crane cabs have been recovered with floor tile. Beneath the tile and in the seams, fixed contamination to 10,000 d/m beta is detectable.

Crane cab contamination spreads have occurred when the crane cab air supply HEPA filters were replaced. The interior surfaces of the inlet ductwork down-stream from the filters becomes contaminated. When this occurs and the crane cab inlet fan is turned back on, contamination is then blown into the crane cab. Improved contamination control practices during filter changes have eliminated this problem.

The west crane electrical relay room became contaminated in 1983. Investigation of this incident revealed an opening from the upper motor control room into the electrical relay room. The opening was sealed, solving the problem.

Radiation dose rates in the remote crane cabs are usually non-existent because of the extensive shielding surrounding the cab. One instance where the crane cab shielding did not prove to be adequate occurred when an F-cell concentrator was being removed from the cell for burial. The slave crane was working in conjunction with the west crane during the removal; and in order for the concentrator to clear the canyon deck it had to be lifted up to a position where the upper portion was above the parapet shielding wall. Consequently, radiation levels in the west crane cab were measured at 30 mR/hr for a short duration.

SLAVE CRANE

The slave crane was designed to be used in conjunction with the remote crane by the use of a "umbilical" electrical cable. It may also be operated manually from the slave cab. The slave crane does not have the extensive shielding that the remote cranes have because of the distance of the cab from the canyon deck.

The exterior surfaces of the slave crane bridge and trolley areas are much less contaminated than the shielded remote cranes. This is due to the slave crane's proximity to the canyon deck, as opposed to the remote cranes, and also because of its infrequent use for process cell work.

Radiation measurements on the slave crane hooks seldom exceed 20 mrads/hr at contact.

The slave crane was designed with a cab ventilation fan and in the 1950's and early 1960's the slave crane was operated without the operator using respiratory protection. During this era, the step-off procedures in and out of the slave crane cab were strictly enforced. It was later decided that since the slave crane was not equipped with air sampling capabilities, the practice of operating the slave crane without respiratory protection would be discontinued.

Dose rates in the slave crane cab to 2 R/hr have been recorded while traversing over certain sections of F-cell with one cell cover block off. Dose rates must be monitored closely when traversing the canyon in the slave crane. High dose rates may originate, not only from open process cells, but also from process equipment and burial containers that may be stored on the canyon deck. One instance of particular interest occurred when the slave crane was traversing the canyon with one cover block removed from F-cell. The RPT in the slave crane cab was closely monitoring the dose rate as the slave crane moved slowly over the open cell. Dose rates were minimal approaching the cell and also directly over the cell. As the slave moved further east, dose rates in the slave crane cab unexpectedly increased sharply from 400 mR/hr to 2 R/hr. Radiation shine from a different angle and emanating from an in-cell process tank was responsible for the rapid increase of radiation.

During the early campaign the slave crane experienced an electrical problem as it was traversing the craneway. The problem made it impossible for it to return back to the west CMP. The remote crane was moved to a position directly under the slave crane and the slave crane personnel were then evacuated by climbing off the slave onto the remote crane. As a result of this incident, a rope ladder was carried onboard the slave crane to be used in such an emergency. Safety suggested that the rope ladder was not safe and personnel should be evacuated from the slave by using the remote crane.

The slave crane is used as a moving platform for relamping the canyon. During relamping, electricians work on top of the slave crane trolley as well as in the cab. Dose rates during relamping are predominately gamma

and since the slave crane cab is closer in proximity to the canyon deck and the higher radiation source, than the trolley, dose rates to personnel in the slave crane cab will be higher than to the personnel atop the trolley.

CANYON

Routine entries to the Redox canyon deck became prohibitive shortly after start-up due to the excessive build-up of radiation/contamination levels. When the PUREX facility became operational in 1956, a decision was made to proceed with a dedicated effort to keep the PUREX canyon in such a radiological condition that would permit routine entries to the canyon deck for maintenance work on process equipment, as is done in the B-plant canyon.

PUREX operations devised a special crew of 6 to 10 operators and named them the "Bull Crew." This crew would make canyon deck entries and perform required decontamination after the crane had finished working in a process cell. Entries were also made prior to the work to lay paper down on the canyon deck if it was anticipated that the crane would be moving process equipment between cells. The "Bull Crew" concept was soon disbanded when the need for more operational personnel became a pressing issue and as new budget regulations became more restrictive. By 1959, all routine maintenance entries to the PUREX canyon deck were halted when radiation measurements in excess of 500 Rads/hr were detected on cell cover blocks.

On 3-28-58, a violent chemical "reaction" (explosion), occurred in A-dissolver cell involving the silver reactor. The reaction ruptured the vessel, damaged other equipment in the cell and discharged the ceramic packing, contained in the silver reactor, to the cell floor. The reaction was felt as a definite "thump", throughout the facility. The exact cause of the reaction remains unknown, but was presumed to be from ammonia gas that was generated from a reaction of ammonia with silver salts. No discernible release of radionuclides to the environment were detected.

In the middle 1960's, the canyon process cell cover block bails were determined not to be strong enough to support the 30 ton weight of the cell cover blocks. Fearing a bail failure might result in a block dropping from the crane and into an open cell and damaging equipment, the decision was made to completely replace all the cell cover lifting bails with a heavier type. The project was an extensive and arduous undertaking, resulting in removing all the old bails and core-drilling larger holes in the blocks for the new bails. A "jig" was specifically designed to be placed into M-cell for the sole purpose of turning the 30 ton cell blocks over, thereby permitting work to be performed on both sides. JAJ Construction forces got the contract and several sub-contractors were used. The project lasted several months and a large amount of man-rem exposure was expended. Some skin contaminations did occur, but all cases were minor in nature. As a result of the bail replacement and inspection it was discovered that several cell cover blocks were cracked and had to be replaced. The replacement was easy, but the disposal of the old blocks was more complicated. Each block was moved by the remote canyon crane into the RR tunnel and placed into a large plastic envelope that was draped on a flatcar. The sides of the plastic envelope were designed to be fastened to the RR tunnel walls by means of

pulleys and ropes. When the cell block was in position on the flatcar, the ropes were manually pulled, allowing the envelope to seal at the top. The damaged cover blocks were then transported to the burial ground where they were buried without incident.

A laundry hamper containing used protective clothing was located in the canyon at the west-end exit doorway, positioned directly beneath the west CMP drop-off. Sparks from a welding job that was in progress on the west CMP dropped over the CMP edge and fell into the laundry hamper causing it to ignite. The fire was extinguished and no contamination was spread outside of the canyon.

A near miss involving a potential radiation over-exposure occurred in 1957. It was decided to drain the water from the irradiated fuel storage basin, (located at the east end of the canyon) for inspection purposes. The near incident occurred during the time when personnel entries to the PUREX canyon were routine. An HP Tech. accompanied an engineer down the canyon to the edge of the fuel storage basin to witness the water drainage. Dose rates at the edge of the basin were 10 mR/hr. The two personnel left the canyon, then later in the shift the engineer wanted to return for another inspection. The HP supervisor suggested that the engineer proceed to the storage basin unaccompanied by the HP Tech., since the dose rates had already been established and were low. The HP Tech. decided that he would accompany the engineer, since he had no other tasks to perform at that time. As they approached the fuel storage area, dose rates were found to be 2 R/hr at 10 feet from the edge of the basin. Investigation revealed that when the water drained from the basin, several irradiated fuel elements that had fallen out of their containment buckets were left exposed on the basin floor. No over-exposure occurred.

In 1986, operations requested a radiation measurement on a failed E-2 centrifuge. An RPT was dispatched to the west canyon exit door to take the measurement. Since the canyon airlock was not lighted, the RPT could not see the meter on his detection instrument until he opened the door to the canyon, where the centrifuge had been positioned flush with the door opening. A radiation measurement taken at the position where the RPT was standing was later determined to be 60 Rads/hr. The centrifuge incident resulted in the employee exceeding his accumulated weekly exposure limit.

Beginning in the 1960's and lasting until 1972, periodic remote radiation traverses were made of the PUREX canyon deck. A high range radiation detection instrument (TPC) probe was attached to the west crane auxiliary hook and the cable was then run into the crane cab where it was attached to the instrument body. The probe was lowered to within one foot of the canyon deck as the crane made two up and back traverses of the entire length of the canyon. Radiation measurements were taken and recorded. Many areas of the canyon deck were found to measure in excess of 500 Rads/hr. This routine radiation trending was discontinued due to lack of interest and the information was not being utilized.

CANYON VIEWING ROOM:

The canyon viewing room was originally constructed of 1/4 inch clear plastic with dimensions approximately 6 by 8 foot. The viewiing room was located on the canyon deck, at F-cell, along the south wall, with an entry way on the side of the facility. The viewing room was used for close-up inspections (if radiation levels permitted) of process jumper connectors. It was also used to demonstrate to visitors, how the remote crane operate. The lucite viewing room was destroyed when it was inadvertently hit by a cell cover block, that was being moved from one location to another. The present canyon viewing room is at the same location and has been rebuilt nearly flush with the north canyon wall. It is constructed of concrete complete with a small lead glass viewing window. There is also an entry port, beneath the viewing window which can be used to insert an extended radiation detection instrument, into the canyon for obtaining academic radiation measurements on process equipment. The viewing room is seldom used, due to the limited visibility through the lead glass window.

A canyon deck entry door exists along the south wall of the canyon, at C-section. This door is sometimes used for personnel entries to the canyon deck, for special maintenance work on process jumpers when, for various reasons, the equipment cannot be worked on in M-cell. Skin contaminations and high exposure potentials are high for entries to the canyon deck at C-cell and special RWP's are required.

When the first bucket of irradiated fuel elements arrived at PUREX in 1956, it was lifted by the remote crane and slowly moved along the entire length of the canyon. HP Techs. followed its progress on the outside of the building looking for radiation beams through possible concrete faults or expansion joints. The only area where radiation was detected outside the building, besides the tunnel and canyon roof, was at the point where the outside, horizontal part of the tunnel roof is connected to the verticle wall of the building, on the south side. 120 mR/hr was measured at this point, as the fuel elements were lifted from the cask car.

LABORATORY VENT ROOM:

The Lab. vent room is located directly above the PUREX Labotatory and was involved in one major contamination spread in the 1960's. The Lab. vacuum system, located in the northwest corner of the vent room and consisting of a HEPA filter box, two vacuum pumps, vacuum holding tank and associated piping was internally contaminated as a result of a suck-back. Contaminated liquid filled the filter box and leaked, contaminating approximately 150 ft^2 of floor space. Radioactivity measurements on the liquid ranged from 5,000 d/m to 200,000 d/m beta. Alpha contamination was also detected, on the dry sections of the floor to 5,000 d/m. Radiation dose-rates to 20 mR/hr were detected through the piping and filter box. The leaks were repaired and the system was properly posted. A section of floor 10 ft. x 15 ft. in the vicinity of the vacuum pumps was decontaminated and remaining contamination

to 10,000 d/m beta, was painted over. The area remains posted as a surface contamination area and the piping is marked as being internally contaminated.

Both of the two Lab. ventilation systems located in the Lab. vent room, were internally contaminated with low level beta contamination during the early operational days at PUREX. The contamination originated from Trap Pit #2 steam leak, 151-A Diversion box spread and from numerous stack emissions.

The maximum radiation measurement ever obtained in the ventilation system was 50,000 d/m beta. The dust stops were changed out many times and decontamination was also performed. No contamination can be detected in the housings at present, but fixed contamination to 3,000 d/m beta was detected on the fan impellers during an entry in 1988. The fan housing is posted as being internally contaminated.

The Lab. hoods are exhausted through HEPA's contained in six large concrete containers located in the vent room. Extensive contamination control measures are set up for filter changes, though no major contamination spread has ever occurred during a filter replacement. Radiation dose rates in the filter boxes has never been detected in excess of 100 mrads/hr.

In the 1960's, frequent maintenance problems were occurring with the remote crane optics. A controlled area was set up in the northwest corner of the Lab vent room where the optics could be decontaminated and repaired. This area still exists and is still used on occasion. The floor is papered and posted as a surface contamination area.

LABORATORY

The PUREX Lab. has experienced many contamination spreads throughout its history. The majority of which, were insignificant and conditions were quickly rectified and returned to normal. Lab. contamination spreads usually originate from one of the following conditions: Dropping or spilling process samples, removing contaminated equipment from hoods, and from Lab. equipment that has failed and developed leaks. The following is a list of contamination spreads and occurrences that are typical to PUREX laboratory problems:

> A spot of contamination to 50 mrads/hr was found on the front of the semi-remote hood on 7-3-84. Further investigation revealed general contamination to 50,000 d/m beta on the face of the hood. The floor was also found contaminated. This area was decontaminated to acceptable levels.
>
> On 9-4-84, alpha contamination was detected in the Lab. counting room. An RPT was summoned and the counting room was placed on mask status. Further follow-up surveys revealed that a contamination spread had originated in the counting room and was then spread to Lab. 2 and 3. The hallway was also contaminated. The contamination was traced to L-3 sample discs which were found to be in excess of $1X10^6$ d/m alpha. Alpha contamination was also found on the ledges below the sample

counters measuring $2.5X10^5$ d/m. The contamination was eventually cleaned and all the affected areas were returned to normal conditions.

On 10-30-85, during a HEPA filter replacement, the Lab. hoods were shut down, in the event of an air reversal. When the hoods in Lab. #5 were sealed, the alpha cam alarmed. The room was evacuated and an RPT called. Contamination was detected on the floor in front of the cabinets to 21,000 d/m and 4 to 5,000 d/m alpha was also smeared from

the work tables. It was later determined that conditions generated from establishing ventilation control for the filter job had greatly increased the room negative. It was felt that the negative flow pulled contamination into the room from the pipechase between Lab. #4 and #5. The pipechase was later opened and decontaminated. The pipechase openings to Lab. #5, were also sealed.

On 4-13-85, a Lab. technologist found his shoe cover contaminated to 175,000 d/m. A contamination survey of the lab. revealed an area behind the ICP unit, in room 50, measuring greater than 750,000 d/m alpha. The source of the contamination was later determined to have originated from a loose plug in the hood vacuum system line located in the pipechase, separating room 50 from room 52 and was decontaminmated.

On 7-11-85, Lab. techs. discovered 1,000 d/m on their shoe covers when exiting the stockroom. Follow-up surveys revealed the source to be a spot on the floor in front of hood 16, in Lab. #2, measuring 150,000 d/m alpha. Seven other lab. personnel were found to have alpha contaminated shoecovers. It was thought that a flake or small speck of contamination had dropped to the floor from a package that had been recently removed from the hood.

On 7-8-87 an RPT was called to the Lab. to perform a follow-up survey of contaminated shoe covers. The survey revealed the instrument shop, Lab. hallway and the floor in Lab. #6 were smearing 50,000 d/m alpha. No actual source determination was ever made.

A contamination spread of a more serious nature occurred in Lab. #2 on 9-18-88. Lab. techs. were performing housekeeping duties which required removing all items from one of the hoods, so the hood floor paper could be replaced. Two one liter liquid waste trap bottles, (one containing 500 ml of liquid) that were loosely capped, double bagged and horsetailed shut, were placed on the sample cart outside of the hood. Upon returning from a break, the lab. technologist found both the alpha and beta cam's were alarming in lab. #2. It was noted that the tape used to horsetail the bag had come loose. Room air samples were measured at 60,000 d/m alpha and 40,000 d/m beta. The floor was generally contaminated to 50,000 d/m. Smears of horizontal surfaces were 1,500 d/m alpha. The contamination spread was determined to have been caused by a nitric/alcohol chemical reaction

A radiation incident occurred when a Lab. tech. detected 25 mR/hr on the side of a waste box. An RPT was called who determined the dose-rate on the side of the box was 5 Rads/hr not 25 mR/hr. No over exposure resulted.

In 1983, the semi-remote hood was constructed and installed in lab. #1. Its purpose was to analyze D-5 Pu samples. Highly radioactive samples were placed in this hood and high radiation dose rates were common behind the shielding. Personnel exposure trending revealed that the PUREX lab. extremity doses were increasing. One individual had received 75% of his yearly hand exposure by July. An intensive investigation, by lab. management was undertaken to reduce extremity exposures. Extremity exposures were significantly reduced by the use of extension tools, new techniques and employee education. Semi-remote hood work still remains the primary lab. function where radiation exposure problems are most likely to occur.

The Lab. pipechases are pipeways located between the walls separating one lab from another. Leakage of contaminated liquid from pipes in the pipechases has been an ongoing problem. Due to their inaccessible locations, repair of the leaks is difficult. Pipechase sink drain lines in lab. room #52 have a history of chronic leaking. Alpha contamination to $1X10^6$ d/m has been detected from liquid leaks in this area and high levels of alpha contamination has been painted over beneath the hoods in room #52. Fixed alpha contamination on the floors in lab. #1, #2, #3 and in the west end of the lab. hallway have been recovered with new tile.

The Lab. docks were contaminated from stack fallout. Decontamination of the docks was performed by washing the contamination from the docks with a water hose where it was picked up and appropriately disposed of. In some cases, low level residual contamination is still detectable in structure cracks and other inaccessible locations.

CANYON ROOF

The east half of the canyon roof has been contaminated several times. Roof contamination usually occurs as a result of emissions from the 291-Al stack. Other contributors to roof contamination have been from spreads at the 151-A diversion box and from a trap pit #2 steam leak. The maximum contamination detected on the roof ranged from 30,000 to 100,000 d/m beta, recorded in July 1957. No significant events leading to roof contamination have occurred since 1966. All but approximately 150 feet of the canyon roof is posted as a Surface Contamination Area. The last contamination survey of the canyon roof detected specks of contamination to 6,000 d/m beta on the metal expansion joint covers.

The above references to stack emissions, trap pit and diversion box spreads will be addressed later in this article.

Radiation dose rates through the canyon roof have been detected during two different operations. Dose rates of 120 mR/hr have been detected on the canyon roof directly over the R.R. tunnel when charging of irradiated fuel elements was in progress. Radiation dose rates through the canyon roof may

vary, depending upon the type of cell work being performed and the amount of cell covers off at one time, During an F-Cell concentrator burial prior to 1966, radiation dose rates measuring 70 mR/hr were recorded at the PUREX badge house resulting from radiation shine through the canyon roof. Alpha contamination has not been detected on the canyon roof.

Radon is frequently encountered at the Patrol security post located at the west end of the canyon roof. Patrol personnel have been made aware that there is no immediate hazard from Radon at this location.

202-A OFFICE ROOFS

The office roofs are located on the north side of the facility and next to the canyon wall. The roofs were all contaminated with low level beta on several different occasions as a result of stack emissions, trap pit and diversion box contamination incidents. The office roofs were posted as Surface Contamination Areas, but were resurfaced in 1984. Follow-up contamination surveys performed after the resurfacing revealed no contamination, and the roof areas were removed from surface contamination status.

RAILROAD CUT:

The PUREX railroad cut extends from the R.R. tunnel entrance door to the isolation area gate, approximately 800 feet. The railroad railings, ties and ballast in the R.R. Cut have been contaminated at various times from leaking burial boxes.

On 10-23-57, the PUREX railroad cut, as well as a large area of the right-of-way on the way to the industrial burial ground, was extensively contaminated.

The contamination spread occurred as a result of contaminated liquid leaking from a burial box which was loaded with tube bundles and other process equipment. Extensive decontamination efforts were required. Contamination from this incident is still evident in the PUREX R.R. Cut.

On 12-23-57, another extensive contamination spread occurred in the R.R. Cut when liquid leaked from burial boxes while in transit to the burial ground. Contamination levels were measured from 40 to 1700 mrads/hr. The burial boxes were 450 mR/hr at 150 feet.

Several other instances of burial box leakage occurred before the wood burial boxes were replaced with ones constructed of concrete.

A minor contamination spread occurred in the R.R Cut when a loaded burial box was parked in the cut, to be buried the following day. The box lid was slightly ajar, allowing winds to blow contamination from the burial box to the surrounding area, This contamination was cleaned up.

Another large contributor to R.R. Cut contamination was contaminated cask cars. Cask car external surfaces were decontaminated in the R.R. tunnel and moved out into the cut where they were allowed to drip dry.

The large ground area parallel and adjacent to the R.R. Cut was zoned as a Surface Contamination Area not because of contamination problems, but for the purpose of ensuring distance during "Hot" burials.

An instance can be recalled where the dose rate at 203-A was 40 mR/hr during an early burial of process equipment.

Academic dose rate measurements were taken at the R.R. Cut roll-up door during the charging of short-time cooled fuel. Radiation at this point was measured at 120 mR/hr.

The R.R. Cut car puller room was contaminated to 50,000 d/m beta as a result of contamination being tracked in from the tunnel and R.R. Cut. Low level contamination is still detectable on the floor of the car puller room.

Releasing railroad right-of-way from radiological controls must be given careful consideration. Although during the rail replacement job in the 1980's when the top layer of ballast was removed, contamination may still be detectable where it has been washed down deep from rain and snow melt.

An extensive spread of mixed fission products occurred in 200-E Area on 6-10-60. The incident developed when a wooden burial box containing failed PUREX tube bundles collapsed during backfill in the Industrial Burial Garden. The radiation level on the burial box was 5 R/hr at 100 feet. The collapse of the burial box was not noted by the Supervisor in charge of the burial operation and the decision was made to discontinue backfilling until monday, because of insufficient personnel exposure time. No communication was made that a portion of the box was still extending above the backfill. On sunday contamination to 800,000 d/m beta was detected on the shoes of an operator who had been working in the PUREX AMU area. The double doors on the north side of AMU had been left open for ventilation. Follow-up investigations revealed that wind had blown radioactive particles from the exposed portion of the burial box in a southeastern direction contaminating a large section of ground area and all structures enroute. Several private vehicles parked in the PUREX parking lot were contaminated, but were successfully decontaminated as well as the PUREX AMU. Contaminated particles were found on the shoulders of the road outside of 200 East Area as far as mile post 7 on highway 4-S. The primary decontamination effort was performed by the fire department using high pressure water to dilute the particle activity and the contaminated residue was later removed. No skin contamination or internal depositions resulted from this spread.

On 5-22-61, a PUREX wooden "non-collapsible" burial box containing 83 highly contaminated process jumpers collapsed as it was being covered in a burial trench. Contamination up to a maximum of 500 rads/hr. was spread over an area of 400,000 ft^2, generally within the burial garden.

On 11-20-59, during the burial of two tube bundles from PUREX, the burial box leaked contaminated liquid along the right-of-way from PUREX to the Industrial Burial Ground with readings to 3 rads/hr at 18 inches.

R.R. TUNNEL

The PUREX R.R. Tunnel consists of three separate sections: Main Tunnel, Burial Tunnel #1 and Burial Tunnel #2.

The Main Tunnel is posted as a Surface Contamination Area from the roll-up-door to the "yellow line". From the "yellow line" south is posted as an Airborne Area. Floor contamination levels from the roll-up door to the yellow line will usually measure from 5,000 to 10,000 d/m beta. During major contamination spreads beyond the yellow line, contamination levels have been detected in excess of 20 Rads/hr.

In the early 1960's, the main tunnel was grossly contaminated during the burial of an F-6 concentrator. Radiation levels south of the drop-off, from floor contamination were in excess of 20 Rads/hr. During this incident the foremost problem was how the tunnel could be decontaminated and expend the least personnel exposure. Operations management decided to bring an old automobile (1958 Chevrolet) into the R.R. Cut, remove the tires, place it on the R.R. track rails and drive it into the tunnel containing a two man decontamination crew equipped with water hoses. The purpose was to flush down the highly contaminated R.R. Tunnel floor from inside the automobile utilizing the chassis as shielding. This plan was abandoned when it was brought up that the engine may die while the car was in the tunnel, thereby trapping the crew in a highly radioactive area. The automobile was later removed from the R.R. Cut and buried in the dry waste burial ground. After an extensive decontamination effort, the Tunnel was eventually decontaminated using high pressure fire hoses and manual scrubbing under water.

As a result of the previously described tunnel contamination incident, certain sections of the tunnel gutters and floor drains still measure up to 3 Rads/hr at contact.

Approximately between the tunnel drop-off and the water filled door, a PUREX/Tank Farm process transfer line crosses beneath the tunnel floor. This transfer line is shielded with 4" of lead to reduce radiation exposure to personnel who might be in the general vicinity during a transfer. Dose rates of 2 R/hr have been detected at the edge of the lead shielded during transfers.

The R.R. Tunnel has one air sampling location. The pick-up point is located near the yellow-line, on the wall next to the doorway from the tunnel to the sample gallery. Due to the inadequacy of tunnel air sampling capabilities the entire tunnel area is placed on respiratory protection status whenever the roll-up door is closed.

At one time during the early campaign, the tunnel air sample (T-1) experienced a buildup of airborne radioactivity. For a short period, no source for the high air concentrations could be determined. The buildup continued until air sample results were approaching supplied air limits. It was eventually determined that the only source for this mystery would have to be from Burial Tunnel #1. At this time tunnel #1 was filled with highly

radioactive process equipment and the water filled door closed. It was determined that the process equipment in Tunnel #1 was generating high thermal temperatures, causing the burial tunnel to pressurize thereby forcing contaminated air out from around the water filled door into the tunnel proper. Sealing the water filled door by recaulking solved the airborne problem.

Early day fuel cask cars were equipped with lift-off lids. The lids were removed from the cask cars in the tunnel by the remote crane in preparation for charging fuel to the dissolvers. All three lids were removed from the cask cars and set down on the car decks. This procedure resulted in high levels of removable contamination on the cask car exteriors. Many long manhours of labor were expended decontaminating cars to the point where they could be safely shipped back to the reactor areas. In the late 1960's, cask cars were modified with roll-up lids which eliminated a major portion of cask car contamination.

There were many instances of fuel loaded cask cars arriving at PUREX with the drain valve on the water shielding section, leaking. Low level beta contamination was occasionally detected along the railroad right-of-way as a result of the leaking valves. Drain valves were later removed from cask cars.

In the late 1950's, a cask car arrived at PUREX with a dose rate of 1 R/hr emanating from the side of the car (normal dose rates at the side of the cask cars were 10 to 30 mR/hr). Investigation revealed that an irradiated fuel element had fallen from the bucket during loading and lodged between the inner cask and the outer wall. The fuel was charged to the dissolvers and the car sent back to the 100-Areas where the dropped fuel element was removed without incident.

Contaminated shielding water in the cask cars was also another major source of cask car contamination. When the fuel elements were transferred out of the casks to the dissolvers, contaminated water would drip from the canisters to the exterior surfaces of the cask car. The problem of cask car contamination was partially eliminated when cask car clean-out flushing frequencies were increased and crane operator procedures changed requiring the fuel canisters to hang and drip-dry over the open cask prior to moving them to the dissolvers.

During construction of the PUREX plant the #1 Burial Tunnel was incorporated as an integral part of the plant and was completed in 1956. Highly radioactive process equipment with high contamination spread potentials were placed on old railroad flatcars and pushed to the back of the burial tunnel for "permanent" storage. The first two cars were pushed into burial tunnel #1 in June 1960. Between that date and January 1965, six more cars were put into the tunnel, completely filling it. Burial Tunnel #2 construction was started and completed in 1964. The length of Burial Tunnel #1 is 358 feet and the length of #2 is 1688 feet. Burial Tunnel #2 has a capacity of 38 to 40 railroad cars and as of 4-6-89, contained 16 cars. The normal procedure for moving burial cars to the rear of the burial tunnel was by the use of a locomotive engine pushing a long string of spacer flatcars with the burial

car at the far end. The spacer cars were becoming contaminated on a regular basis using this method, requiring many man hours of decontamination effort. A small remotely controlled battery powered locomotive engine was special ordered. It was eventually nicknamed "Little-Toot". The engine could be covered with plastic for contamination control and be remotely operated to push the burial cars into the tunnel and return. A problem was experienced using this method when "little-Toot" returned from a mission into the burial tunnel. The wheels became contaminated resulting in the train tracks becoming contaminated in the main section of the tunnel. Some instances did occur when this situation was not realized immediately and contamination was subsequently transferred onto the main line railings by the locomotive engine. Many manhours were expended in summer and winter months decontaminating train rails.

Different types of detergents and cleaning agents were used for decontaminating rails. Surface contamination could be wiped from the rails to the point where they were non smearable. Then the following day smearable contamination would again be detected on the rails. It was determined that contaminated liquid would seep into the pours of the rails where oxidation would take place from a chemical reaction and then reappear on the rail surfaces. Several attempts at rail decontamination on subsequent days were needed before the rail surfaces could finally be released.

Burial Tunnel #3 location is adjacent to #2, but has not been constructed.

A skin contamination incident occurred during a movement into the burial tunnel in the late 1960's. An operations and a maintenance supervisor decided to try and determine for themselves when the burial box was positioned at the very back of the burial tunnel. They proceeded to remove the cap from a vertical 3 inch diameter riser that extended out of the top of the burial tunnel and by looking down through it, determine when the burial car passed beneath. As the car passed by the riser, contaminated air was forced up through the riser, resulting in gross skin contamination to the face of both employees. They were not wearing respiratory protection at the time. This incident resulted in both employees receiving 5 and 10% MPBB Ru^{106} fission product deposition.

VACUUM FRACTIONATOR (206-A)

The Vacuum Fractionator facility first came on line in 1957 and is used for the recovery and concentration of nitric acid during fuel reprocessing. Floor contamination varies depending upon process line leakage and the extent of decontamination effort expended. Smears of the Fractionator floor measuring 100,000 d/m beta are not uncommon. Radiation dose rates are usually highest on the side of the U-5 tank and the radiation dose rate at the two entry doors will average 5 to 15 mR/hr under normal operating conditions. The highest area of floor contamination is located between the U-5 and U-6 tanks where pump leakage has occurred on numerous occasions. During the contaminated recovered acid problem that occurred in December of 1986, dose rates in the fractionator building increased notably.

The lower level of the fractionator contains the U-8 condensate tank. Dose rates on the tank and contamination on the floor in this area are minimal.

On 4-21-70, an excessive amount of water was used to flush and decontaminate the interior of the 206-A building. The excess water flowed out from under the doorways and across the roadway contaminating it to 10,000 d/m to 50,000 d/m beta. Approximately 3,000 ft^2 were affected. The contaminated areas were decontaminated and returned to normal status.

In the early operating days 206-A had air sampling capabilities, but strong nitric acid atmosphere soon destroyed the air sample heads and vacuum lines. The facility has no permanent air sampling capability at this time and a high velocity air sample is taken prior to entries.

The 206-A facility has the capability for the replacement of tanks and equipment through the roof which is covered by four removable concrete cover blocks. This procedure has been performed twice without incident.

An instrument enclosure shack for 206-A is located on the north side of the building. In the past low level beta contamination has been detected when the instrument lines were opened at this location. The instrument enclosure is posted as a Surface Contamination Area.

The room air in 206-A is exhausted through U-Cell and out of the west sample gallery room exhaust stack.

U-CELL COVER BLOCKS

The cover blocks over U-Cell are posted as a Surface Contamination Area. The cover blocks have become contaminated with low level contamination to 10,000 d/m beta. The major portion of the cover block contamination occurred when pumps and other equipment were removed from U-cell and placed on top of the cover blocks for maintenance work.

A U-Cell entry manhole is located on the northeast corner of the U-Cell blocks and has been used for entries and exit to this area during equipment replacement.

CHEMICAL STORAGE AREA (211-A)

The roof of the 211-A pump house was contaminated as a result of a stack emission in the 1950's. The roof remained a Surface Contamination Area and was later resurfaced and removed from controlled status. Low level contamination was also once detected inside the pump house in the pump sump along the north wall. In 1987, during a routine contamination status survey of the 211-A area, contamination to 300,000 d/m beta was detected in the pipe trench leading to tank #40. This area has been designated as a Surface Contamination Area. The source of the contamination at tank #40 was never determined. No attempt has been made to decontaminate the pipe trench.

UNH LOADOUT FACILITY 203-A

Uranium solution has spilled to the loadout catwalk and loadout apron several times as a result of tanker overflows during loading and leaks in the loading system piping.

In the event of a UNH leak, it has been discovered that if decontamination is started immediately by flushing with water, the majority of the contamination can be removed. If UNH liquid is allowed to remain longer than 30 minutes, decontamination becomes much more difficult.

The loadout apron has been repainted numerous times, covering up fixed contamination to 50,000 d/m beta and 5,000 d/m alpha.

The large 203-A holding tanks P-1, P-2, P-3 and P-4 have been sources of high radiation due to process upsets and measurements as high as 2 R/hr have been recorded on the side of the tanks. A dose rate of 5 mR/hr was detected at the PUREX badgehouse during this period. When this problem occurred, releasing the UNH tankers was impossible due to the background radiation. Eventually the problem was rectified and the radiation background returned to normal.

The 203-A control room is normally maintained free of removable contamination except for the sump area. Contamination levels to 20,000 d/m beta and 10,000 d/m alpha can usually be detected in the sump. Process transfer lines in the control room have experienced leaks in the past which have resulted in the control room occasionally being posted as an airborne area.

The 203-A control room had air sampling capability from 1956 until 1972, but was not deemed necessary for the 1983 startup.

The pump room located adjacent to the control room contains two process pumps. These particular pumps have the reputation for leaking seals. Contaminated solution to 800,000 d/m beta is often detected in the pump drip trays. Floor contamination in the pump room is minimal and the pump room is not equipped for air sampling.

PR DOCK

The PR Dock is posted as a Surface Contamination Area. Several minor spreads of contamination have been detected on the PR Dock, usually due to radiation waste box leakage or from tracking contamination from other PUREX controlled areas. The PR Dock is not painted and contamination is decontaminated soon after it is detected. The north part of the PR Dock has been used as a product can storage area in the past, but no contamination spreads have occurred as a result of storing product at this location. In 1987, two conex trailers were attached to the PR dock for use as a radiation waste box storage area and the other for used SWP laundry storage.

In 1984, the PR Dock was contaminated with low level beta contamination as a result of a millwright fainting while working on the west crane. The employee was removed to the PR Dock while still wearing his outer pair of protective clothing. The contamination was immediately cleaned to non smearable status.

MISCELLANEOUS OUTSIDE AREAS

One section of the Security Isolation Area, surrounding the PUREX facility is contaminated with low level beta from patrol gate #3 to gate #4. Average spotty contamination levels range from 3,000 to 10,000 d/m beta on the ground surfaces. This section was contaminated as a result of a 291-A1 stack emission in 1984. The area is posted at both ends as a Surface Contamination Area.

A large section of ground area to the north and south of the east end of the PUREX facility is also posted as a Surface Contamination Area. Random specks of contamination in this area range from 3,000 d/m to 500,000 d/m beta. This area is downwind from the main stack and has been contaminated with radioactive particles from fallout since early 1957.

Ground surfaces and asphalt areas on the north side of PUREX including docks and roofs were contaminated with radioactive particles as a result of emissions from the 200 ft. stack. Spotty contamination to 500,000 d/m beta was first detected at this location in 1957. Water droplets from internal water flushes of the stack liner were also responsible for part of the contamination on the north side of the facility. The ground area north of the Laboratory dock extending out approximately 200 feet was the section where the highest concentration of particles were detected. The majority of the contaminated specks on the ground were removed when found, but when particulate contamination was dense, the areas were resurfaced. The road and walkway out from the Laboratory dock has been resurfaced twice, covering up spotty contamination.

Some cases of shoe contamination were recorded as a result of employees walking in contaminated outside areas before the contamination spreads were detected. The shoes were either cleaned or discarded to contaminated waste.

Removing contaminated specks from asphalt covered areas was always time consuming and difficult. Many different methods of decontamination were tried. Wiping with solvent or detergent merely diffused the contamination to a lower activity level, never completely removing all of it. Frustrated decontamination crews were once observed pouring acetone on contaminated asphalt and setting it afire. This practice was quickly discouraged. The most effective method found for removing attached radioactive particles from asphalt was to first soften the asphalt with solvent then remove a small portion of the contaminated asphalt with an implement such as a screwdriver, puttyknife, etc.

Decontamination crews often used fire hoses to water flush particles from PUREX roadways and occasionally the fire department was called in to flush a particle spread with "wetter" water. These methods were effective in removing particles from roadways if used immediately after a fallout, but residual contamination would still be detectable on the shoulders of the road which was picked up and appropriately disposed of.

On the south side of the PUREX facility, ground surface contamination incidents inside the posted Surface Contamination Areas were numerous during early PUREX operating days.

Southside contamination beyond the posted areas occurred occasionally during specific incidents. At column #15, two 6 inch "gooseneck" vent lines attached to the Process Distillate Discharge (PDD), transfer lines extend above ground next to the building. In 1987, an acid/caustic reaction took place in the underground PDD transfer line causing contaminated liquid to be emitted from the "gooseneck" to the ground directly below. Contamination levels to 600,000 d/m beta were detected over a 10 ft^2 section of ground. Decontamination crews removed the top 1 foot of soil, but contaminated soil remains below that level. The immediate ground area surrounding the "gooseneck" area is posted as a Surface Contamination Area.

Another "gooseneck" vent line that caused contamination problems is located due west of the "spud cellar". This particular vent pipe is connected to the 216-A2 catch tank and was a continuous source of ground contamination (directly beneath the vent opening) up to 300 mrads/hr from contaminated condensate. The contamination in this area has seeped into the ground as a result of past rain and snows to an unknown depth. At the 1983 startup, a vapor trap was installed on the vent line which eliminated the problem.

The major portion of ground south of PUREX encompassed by the Surface Contamination Area has been excavated numerous times and below ground level contamination has been detected, on occasion during the excavation work. Various levels of soil contamination have been discovered that were not anticipated during excavation for the repair of non process lines. When contaminated soil was detected it was sometimes removed, contained and sent to the rad. waste burial ground, but in many cases was left in the excavation, covered up with backfill and the area posted.

During an excavation to repair a leaking trap pit steam condensate line adjacent to trap #2, contaminated soil was detected in the vicinity of the line leak to 5 rads/hr. at a depth of approximately 20 feet. A patch was welded over the leaking pipe and the excavation backfilled.

PUREX ground area contamination will be further discussed in more detail under the sections of 291-A-1 Stack, Trap Pits and 151-A Diversion Box.

VENT BALANCE CAISSON

In the late 1960's, a shortage in product inventory was suspected. It was thought that the reason for the shortage was possibly due to a process line leak in a canyon cell, and liquid may be visible on the floor of the canyon wind tunnel if it were possible to view this area. An excavation/core drilling project was given to JAJ Construction forces to excavate a 12 ft. diameter hole, 40 feet deep next to the building on the south side at K-cell. When the excavation was completed a 24 inch hole was core drilled from the bottom of the caisson in through the concrete canyon wall directly into the wind tunnel for the purpose of determining if there was liquid on the floor of the wind tunnel. The dose rate for an engineer to climb into the core drill hole and look into the wind tunnel was 50 mR/hr. No liquid was observed on the floor of the wind tunnel. Negative air pressure at the core drill hole was very high and no contamination was transferred into the caisson proper. The core hole was eventually sealed except for a small opening presently in use by vent balance personnel to introduce DOP for the purpose of checking stack HEPA filter efficiencies. Hence the name "Vent Balance Caisson."

213-A LOAD-IN FACILITY

The 213-A Facility is located south of the 202-A building. It is a steel "Butler Building" and was once used for transporting liquid waste from shipping casks to PUREX cells. No process line flushing capability was incorporated into the load-out building and eventually all transfer lines became permanently plugged. The solution load-in/load-out function was moved to the 212-A Building. The 212-A Facility is currently used for temporary storage of low level contaminated dry waste.

During load-in operations occasional leaks in the tubing connectors did occur, resulting in radiation measurements to 5 Rads/hr and greater, on the liquid. No severe contamination spreads have occurred in the 213-A Building. All have been minor and were decontaminated as they occurred. Due to the lack of line flushing capability, high dose rates were sometimes encountered when process solution would not completely drain and would collect in the lower portion of the transfer lines.

Future decontamination and decommissioning of this facility will likely encounter high dose rates when the shielded transfer line pipe chase is dismantled.

The 213-A Facility is currently posted as a Surface Contamination Area and does not have air sampling capability.

212-A LOAD-OUT FACILITY

The 212-A Facility now inactive, was formerly used for delivering or withdrawing liquid radioactive waste to or from the 202-A Building. The 212-A Facility is located against the outside south wall of the 202-A building and is of sheet metal construction.

Process lines connect PUREX cell tanks with a shielded cubicle in the 212-A Facility, where connections were made to transfer the highly radioactive solutions into or out of a transport "Bowling Ball" cask.

On one occasion, an Operator was not wearing respiratory protection while disconnecting a cask. As the lines came loose, Sr^{90} solution sprayed into the face of the employee. The employee was immediately placed under a safety shower which partially removed the contamination and prevented serious acid burns. Final facial decontamination was difficult, but finally successful.

During load-out operations, dose rates were usually high and all personnel were required to evacuate the facility during this time. Dose rates were measured at 1 R/hr at the outside of the facility on one occasion, during load-out.

On May 15, 1968, a tubing connection on a Sr^{90} cask leaked, allowing highly radioactive solution to fill the cask cupola. The facility was evacuated and a team was set up to decide on the best way to remove the liquid from the cupola. The following day it was discovered that the liquid was gone from the cupola. A bucket filled with wiping rags was also found on the floor next to the cask measuring 750 Rads/hr (by use of a high range radiation detection instrument). An investigation into the incident revealed that an Operations crew had decontaminated the cupola without proper authority. The investigation also revealed that the decontamination crew apparently were not wearing their dosimeters, at the time. Complete investigation of the incident and corrective action were carried out.

Several maintenance entries were made into the 212-A valve pit. High dose rates were always encountered when the pit cover blocks removed, but no over exposures to personnel occurred as a result of the pit entries.

The floor of the 212-A Facility has been contaminated on occasion, but was decontaminated.

The 212-A Facility is presently posted as a High Radiation Area as a result of its use as a storage area for used filters and other radioactive waste.

291-A STEAM TURBINE BUILDING

On December 3, 1958, a Health Physics Tech. made a routine entry to the 291-A Steam Turbine Building and discovered liquid on the floor measuring 5 Rads/hr. to 20 Rads/hr. The fission product contamination leak resulted during the jetting of the 216-A-2 stack condensate catch tank to A-4 crib. The crib lines were plugged causing the waste liquid to back up via the floor drain into the 291-A Steam Turbine Building. The blacktop area outside the turbine building door was also contaminated to 8 Rads/hr. as a result of liquid running out from under the entrance door. The floor of the turbine building was eventually decontaminated, contaminated asphalt removed, the floor drain line to the A-4 crib disconnected and a new french drain constructed just south of the turbine building which is connected to the turbine building floor drain.

Low level alpha and beta contamination is detectable when fan ductwork is opened in the turbine building for inspection or maintenance. The Steam Turbine Building does not have air sampling capability.

293-A BACK-UP FACILITY

The Back-Up facility was designed to recover nitrogen oxides from dissolver off-gases, condense them to nitric acid which is then returned to the process.

The "Back-Up" facility consists of seven internal locations where physical entries are possible. Control Room, Lower Basement, Pipechase Basement, X-A, X-B, X-C and X-D cells. Dose rates and contamination levels in X-A and X-B cells are minimal. On occasion the floor in X-A cell has been contaminated to 500,000 d/m beta as a result of leaking acid lines.

X-C and X-D cells are located on the east side of the 293-A facility and are normally beneath concrete cover blocks. Several entries to X-C and X-D cells have been made for maintenance, and very low dose rate and contamination levels have ever been detected in these two cells. During the last entry into X-C cell in 1988, the concrete cover block was left off and is presently covered with a wooden cover. Dose rates through the wooden covers are less than 1 mR/hr.

No contamination spreads have been detected in the Control Room other than that which has been tracked in.

The Lower Basement is the most highly contaminated area in 293-A. Floor contamination ranges from 200,000 d/m to 100 mrads/hr removable. There are several stained areas on the floor resulting from leaks in the overhead DOG (Dissolver-Off-Gas) steam lines that measure up to 500 mrads/hr at contact. The bottom side of the overhead DOG line flanges are also highly smearable.

Contamination/dose rate measurements in the Pipechase Basement are less than in the Lower Basement. Contamination has been detected during maintenance work on open lines and steam systems in the Pipechase Basement, but the majority of contamination in this area has originated from the Lower Basement. In the late 1950's, field radiation measurements were detected in the Pipechase Basement to 50 mrads/hr originating from Kr^{85} gas. Follow up investigations revealed that Krypton was present during certain dissolver operations and was entering the basement of 293-A facility via the floor drains.

TRAP PITS

Trap pits are located exterior and next to the south side of the 202-A Building. They are concrete enclosures of varying depth. Trap pit #2 is approximately 35 feet deep. The trap pits are equipped with a single layer of concrete block covers. At one time the pits housed steam trap assemblies and associated piping which discharged effluent steam from concentrator tube bundles and heating coils to the crib. The trap pit exhaust is to atmosphere at the pit openings.

On July 1, 1961 a brief boilup of F-cell vessels took place primarily to check the effectiveness of an F-11 tower flush conducted earlier in the day. Three individuals who had been in the vicinity of trap pit #2 were found to have low-level skin, oral, nasal, and clothing contamination. Follow-up investigation for the source of the contamination revealed that a heavy plume of steam vapor was rising from trap pit #2. The boilup was discontinued immediately and water was routed to the tube bundles. The cover blocks were off of the trap pit at the time of the boilup test and dose rate measurements up to 500 R/hr were detected at the bottom of the trap pit and 600 mR/hr over the opening of the trap pit. Ground contamination was detected over large sections of the PUREX exclusion area and parking lot of varying intensities. Levels of 1,000,000 d/m beta to 100 mrads/hr were detected on the ground in the vicinity of the trap pit. Shoe covers were prescribed throughout the exclusion area and badgehouse until the walkways to the building entrances were cleaned and released on July 3rd. Large volumes of water were sprayed into tap pit #2 and on the immediate surrounding area. Irrigation rainbird sprinklers were laid out in the exclusion area and in sections of the railroad cut. Ground areas on the backside of PUREX in the vicinity of the trap pit were wet down and graded to remove the top few inches of soil. Asphalt road and walkways on the north side of the building were covered with a new layer of asphalt and vehicles in the parking lot were decontaminated and released.

JAJ Construction forces were given a contract to decontaminate the trap pit interior. HP Technicians were lowered into the trap pit in partially shielded cages by the stick crane for the purpose of dose rate determination for the upcoming tap pit decontamination. A plastic enclosure was then built over the trap pit and the walls and floor were cleaned by sand blasting.

Eventually the concentrator/tube bundle steam traps in trap pit #2 were removed and were replaced with "in-cell" DOV's.

No contamination spreads have occurred in the trap pits since the steam traps were removed. Dose rates taken at the trap pit #2 opening in 1987 were 150 mR/hr.

The effects of the 1961 trap pit contamination spread can still be felt throughout certain areas in the PUREX exclusion area. Trap pit cover blocks, inlet ventilation fan systems, north side docks, and canyon roof joints reveal low level residual beta contamination from the trap pit incident.

Trap pit #1 also experienced contamination problems from steam trap leaks though not as severe as trap pit #2. The steam traps in pit #1 were also replaced with "in cell" DOV's.

151-A DIVERSION BOX

The 151-A Diversion Box located on the south side of PUREX was a major source for high radiation and contamination spreads during the 1950's and 1960's.

The diversion box normally has 3 layers of concrete cover blocks for shielding purposes, but in the 1980's two layers were removed and transported to the dry waste burial ground where they were buried.

In the late 1960's a contamination spread occurred when the diversion box was opened for a jumper replacement job. The open box was not kept adequately wet down during the job and consequently contamination was blown from the open box by gusty winds, contaminating the immediate area surrounding the box and ground area on the north side of PUREX. Contaminated specks of 3,000 d/m beta were detected in the parking lot and cars were hosed down as a precautionary measure. The PUREX canyon roof, lab docks and asphalt areas on the north side were contaminated with particulate to 50,000 d/m beta. The majority of the contamination was picked up and a new layer of asphalt was applied over the roadway in front of the laboratory docks.

Radiation levels were always extremely high over the open 151-A diversion box and a remotely operated gantry crane (which straddled the box) was used to perform the in-box work. On occasion, with the help of a remote TV camera, the gantry crane operating console had to be operated from the "spud cellar" or 293-A basement in order to keep radiation exposures low. Gamma dose rates from sky shine were often detected on the north side of the PUREX facility during the time when the cover blocks were off of the diversion box. Contamination spreads were common when working in 151-A, but usually the extent of the spread could not be determined until after the completion of the job, due to the radiation background. In 1970 the gantry crane was removed from the 151-A diversion box area and the stick crane was used for in-box work. The use of the stick crane and mirrors to see into the box decreased the length of time that the box was open, but man rem exposures were consequently higher due to the need for personnel to be in closer proximity of the open box.

Several contamination control methods were discovered from experience when working in the open box with the stick crane:

1. Cover the horizontal surfaces of the crane with plastic.
2. Wash down cover blocks with water prior to removing blocks.
3. Set cover blocks on plastic.
4. Lay plastic on the ground area surrounding the pit opening prior to opening the box.
5. Intermittently spray water into the pit during the job.
6. Never leak check jumpers with cover blocks off.
7. Place fallout collection plots or air samplers downwind of the open diversion box.

On September 30, 1960 PUREX personnel were involved with testing a new jumper which had been installed in the 151-A diversion box on September 27, 1960. The jumper test consisted of a visual inspection of the jumper connections for possible leaks during jetting. A gross leak was observed and the test was stopped while the jumper wall connector was loosened and reimpacted. The test was resumed, the connections were again observed to be leaking and the observers requested the jetting to be stopped. Before the jetting was stopped, a cloud of steam was observed for about 20 seconds, emanating from the faulty jumper connection in the pit.

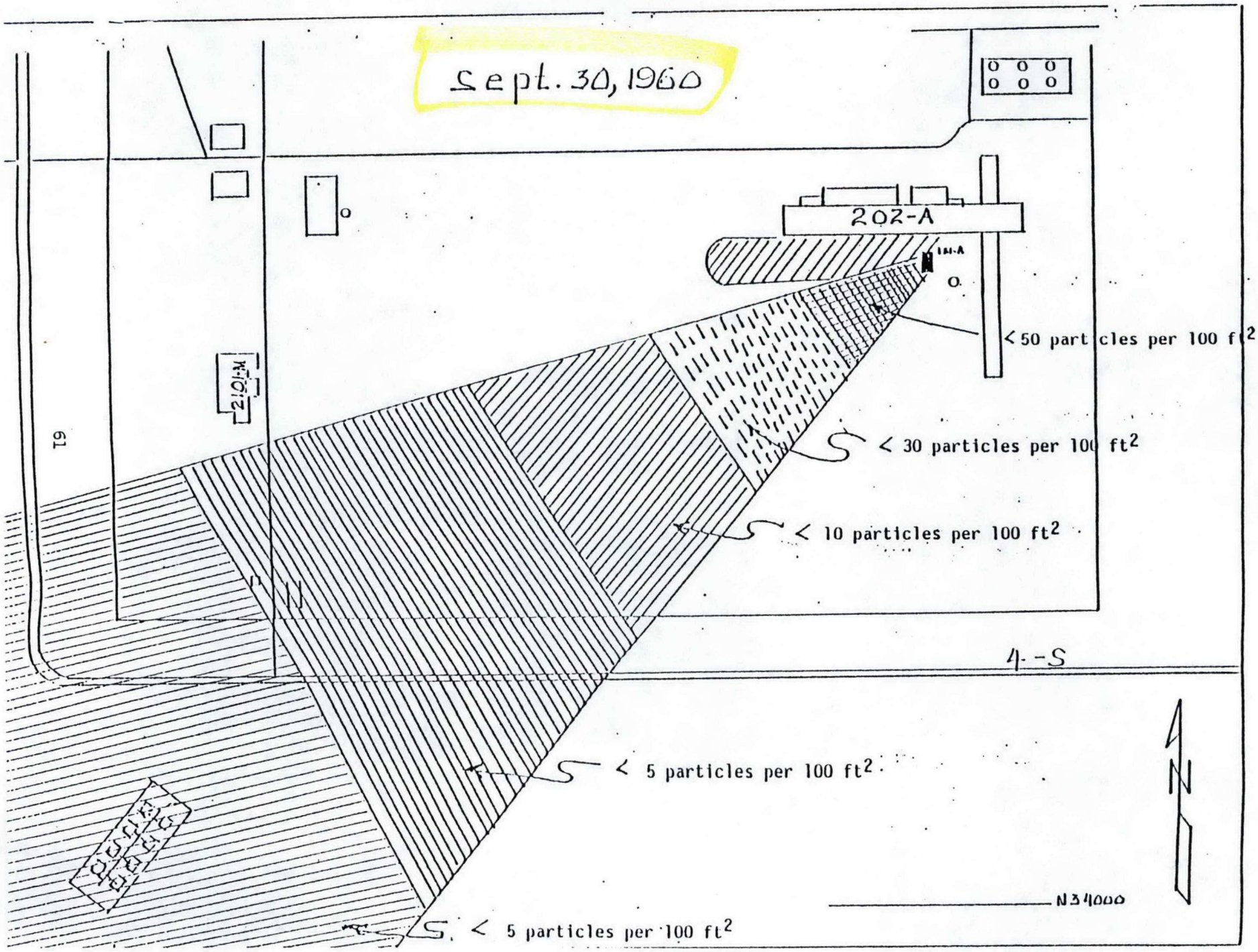
Follow up surveys revealed that contaminated particulate was spread south from the diversion box across highway 4-S. Radiation levels varied from 1 to 3 Rad/hr. on the ground near the diversion box and spots to 30,000 d/m beta outside the PUREX exclusion area. The plot plan on the following page shows more detailed information concerning the contamination spread.

Contamination of protective clothing, skin, and personal effects were detected on eleven employees. All employees were successfully decontaminated and released within a few hours. All personnel were surveyed at the whole body monitor and no internal deposition was detected. Bioassay samples were also taken and were negative. Three government vehicles that were down-wind of the contamination spread were also contaminated and one suburban was eventually buried in the dry waste trench. All personnel leaving the 200 east area were surveyed and were found to be clean. All traffic to and beyond 200 west area was rerouted from highway 4-S to 11-A. All road areas were eventually released from controlled status.

All roads and the highway involved in the contamination spread were flushed with water and finally released.

291-A-1 STACK FILTERS

The PUREX facility was designed and constructed with one underground fiber glass filter bed. On May 22, 1964 the process was shut down to investigate the cause of decreased air flow and increased dp across the main canyon ventilation filter. Holes were bored through the concrete covering and the filter bed was found to be depressed from 12" to 24". The filter media was found to be coated with a material--primarily ammonium nitrate. The dose rate through the core drill hole was 400 mrads/hr. The stack flow had also dropped from 120,000 cf to 72,000 cfm. A new underground updraft fiberglass filter was designed and constructed in 1965. During this period a temporary above-ground emergency bi-pass filter was designed to provide adequate control in the event of complete failure. The new by-pass filter was a 8 X 8 X 12 ft. sheet metal box held together by vise grip pliers (to make dismantling easier in the event of high radiation) and contained 48 HEPA filters. The by-pass filter box was placed above ground on the north side of filter #1 and was never extensively used as the new #2 glass bed filter was completed on time. The temporary by-pass filter box was eventually dismantled and discarded to underground radioactive waste.


Sept. 30, 1960
202-A
< 50 particles per 100 ft2
< 30 particles per 100 ft2
< 10 particles per 100 ft2
< 5 particles per 100 ft2
< 5 particles per 100 ft2
61
4-S
N34000
N

A third underground stack filter utilizing HEPA filtration in place of fiber glass was designed and completed in 1982. The third filter was never used due to a warping problem that occurred with the HEPA frames when they were welded. Contamination can be detected inside filter #3 pit near the proposed tie-in site to 500,000 d/m beta, originating from condensate leakage from the #2 filter bed ventilation tunnel.

In 1983, PUREX stack releases were found not to be acceptable and a fourth above ground filter was constructed. The fourth filter building was constructed above ground containing ten HEPA filter containment boxes. The filter boxes were designed to be removed and replaced through the building roof if necessary. The HEPA filters may also be changed out through bag-out ports located on the side of the containment boxes. A filter change out through the bag-out ports in 1988 revealed that contamination and radiation levels were low.

Laboratory analysis of the 291-A-1 stack air samples revealed that the total alpha concentration in 1986 was less than one percent of the 1985 value. The reduction was due to the operation of the new 4th. filter, installed in 1985.

SAMPLE GALLERY HOOD EXHAUST STACK FILTERS

The west sample gallery hood exhaust stack located at the southwest corner of the PUREX facility exhausts west end sample gallery sample hoods. The west sample gallery hood exhaust filters are HEPA and are located in an underground concrete box at the base of the 296-A-2 stack. These filters have been changed out twice during the PUREX campaign and no radiation or contamination incidents have resulted. High level alpha contamination does exist in the filter box and appropriate greenhouse containment must be used. The greenhouse must be constructed in such a way as to permit crane access through the top for cover block removal.

The east sample gallery hood exhaust stack located at the northeast corner of the PUREX facility exhausts the east sample gallery sample hoods. The filters are HEPA and are located in an underground concrete box at the base of the 296-A-3 stack. These filters have been replaced three times since PUREX startup. High level beta contamination exists in the filter pit and greenhouse containment must be utilized. During the last filter change the maximum dose rate encountered in the filter pit was 150 mrad/hr.

PR STACK FILTERS

The PR stack filters are HEPA and are located in a metal bag-out box on top of R-cell cover blocks next to the 296-A-1 stack. The original PR filters were located in the same location, but were contained in a concrete box such as the sample gallery hood exhaust filters. During the latter campaign the concrete box was discontinued and the present stainless steel bag-out box was put into use. The PR stack filters have been changed out many times, but seldom without contamination problems. During the early days prior to the use of the bag-out method a cardboard box containing a used filter was inadvertently cut open and alpha contamination in excess of 40,000 d/m

contaminated a 20 ft. section of R-cell cover blocks. During present day PR filter replacements, contamination problems occur because of the difficulty in using the bag-out method. Negative air pressure in the filter boxes makes it nearly impossible to maneuver the filters into the bags. Consequently the filters are removed from their containment manually and placed into plastic bags. This procedure usually succeeds in contaminating the interior of the greenhouse.

CRIBS AND RETENTION BASINS

At the time of this writing there are only three PUREX cribs that can be classified as active. All of the other 30 to 40 PUREX cribs have been abandoned due to failures, lack of demand or environmental restrictions.

The following information will deal with a select few of the cribs associated with the PUREX facility since original startup.

On 4-20-61 a large spill of 1,335 pounds of depleted uranium was lost to the ground when a UNH tank trailer overflowed on the loading apron at 203-A. The solution drained through an open plug valve in the sump and then into 216-A22 crib.

On August 28, 1961 an incident occurred at the A-31 crib site resulting in a radiation exposure to two individuals in excess of Hanford Operating control limits. The circumstances leading to the exposure of the two employees started on August 25, 1961. Work was nearing completion on the tie-in for a new crib (A-31) located south of the PUREX plant. An excavation at the site uncovered two stubbed off lines from the facility. Construction forces had just finished welding one line to the crib distributor line and the other line was left stubbed off. Radiation dose rates at the bottom of the excavation were 30 to 40 mR/hr. A lack of clear communication between all functional organizations involved: PUREX Operations, facilities Engineering, and Research and Engineering led an operations supervisor to believe the crib was ready for use and an attempt was made to jet a small amount of solvent from the F-13 tank to the new A-31 crib. Later investigation proved that an error had occurred in connecting to the stubbed line rather than to the crib entry line and consequently the solution lay trapped in the stubbed portion of the line in the excavation. On August 28, two welding inspectors asked the PUREX Health Physics supervisor for permission to visually inspect the welds on the new crib line. The HP supervisor unaware that material had been jetted to this area, instructed them in the proper clothing to wear and advised them that no time limit was necessary. No apparent warning was given to stay out of the trench. The two welding inspectors entered into the trench and spent about five minutes in close proximity to the pipe lines. Later radiation surveys of the excavation revealed dose rates to 500 R/hr at contact on the stubbed line. Evaluation of their film dosimeters revealed that the employees had received a maximum whole body dose of 2.4 and 2.8 Rem. The cause of the incident was deemed to be "premature and unauthorized use of the new crib line" and "failure to determine existing conditions in the radiation area and therefore, to provide proper control of personnel exposure."

On 4-19-62 a clay distributor pipe to the 216-A10 crib collapsed creating a depression in the ground surface. This problem was corrected by installing a second distributor line in the crib paralleling the original line. The replacement line also failed in 1966.

Crib 216-A45 is presently awaiting approval to be the A10 replacement.

Gable mountain swamp (now deactivated) was located one mile north of the 200 east Area. The area of open water in this swamp was approximately 71 acres. PUREX cooling water was once discharged to this swamp and up through 1967, 85.0×10^9 liters of cooling water and had been discharged there.

On 6-12-64, a leak in the cooling coil of the waste sampling tank (F-15) allowed mixed fission products to escape to the B-Swamp and gable Mountain swamp. The general land area surrounding the swamps was not contaminated during or after the incident. Radiation dose rates at the east area perimeter roadway opposite the B-ditch, at the time of the cooling coil incident were 30 mR/hr. Low level radiation readings that are still evident in the CWL pump pit are as a result of this leak.

During the winter of 1972, an alkaline deposit was observed to be forming on the ground surface over the entire length of the 216-A30 crib. It appeared to be a salt residue that was condensing out from vapors being emitted through the porous ground surface of the crib. Generally, the deposit read 4,000 to 6,000 d/m beta. A few tumble weeds were found in the immediate vicinity measuring 12,000 d/m beta. An exploratory excavation was made into the crib and dose rates up to 800 mrads/hr were encountered at a depth of 4 ft. The crib was stabilized and no salt residues or radioactivity have been observed on the crib surface since that time.

291-A-1 STACK

The following is a compilation of not all, but some significant radiological events emanating from the PUREX 200 foot stack.

Deposition of radioactive particulate on the ground from the PUREX 200 ft stack were first observed in March 1956, one month after startup. The particles were detected by audio-radiograph on particle fall-out collection plates, but were of such low magnitude of radioactivity that they could not be detected by direct survey with portable GM instruments.

The major portion of the contamination reaching the stack was found to be coming from the canyon exhaust filters, but it was also determined that as much as 30 percent of the stack contamination could be attributed to the dissolvers. At this time it was determined that the vessel vent system was the major contributor of contamination to the canyon exhaust filters.

On September 4, 1956, particles were detected on the ground in the immediate stack area at levels up to 30,000 d/m beta. A sustained deposition of radioactive particles continued after that date at an average rate of 240 particles per square foot per week at a 200 foot radius around the stack. The most intense single fall-out occurred on July 4, 1957, when a stack

emission contaminated an area of 50 feet by 150 feet to the west-northwest of the stack, contaminating the ground surfaces to levels of 100 to 600 mrads/hr.

By March, 1957, the ground contamination covered an area of about 1,000 feet by 2,000 feet surrounding the PUREX 200 ft. stack.

As of September 10, 1957, radioactive fission product particles discharged from the 291-A-1 stack had contaminated about 46 acres around the stack. Levels of the ground activity varied from a few thousand d/m beta to mrads/hr. Fall-out through 1957 was continuous at variable rates.

In 1957, the first build-up of contamination on the interior of the stack liner was noticed. Weekly stack flushes were initiated and were successful in reducing the build-up of scale in the stack liner. Problems occurred while flushing the stack at the 200 foot level. Contaminated water droplets deposited low level contamination in the immediate area of the stack and on one occasion during a stack flush when the wind was blowing from the southeast, several cars in the PUREX parking lot were contaminated up to 4,000 d/m beta, but were readily decontaminated.

The stack liner was traversed in September, 1956, with a Geiger counter for a build-up of activity. A level of 8,000 d/m beta was noted in the upper section. An earlier traverse had showed 200,000 to 300,000 d/m beta. 12 rads/hr was also found on contamination which had leaked from a weld seam at the base of the stack liner.

In 1957, an alarm was connected to the strip sampler on the 200 foot stack, which activated an alarm light in the dispatcher's office in case of a particle emission rate of greater than 4.5 u/ci in a 30 minute time period.

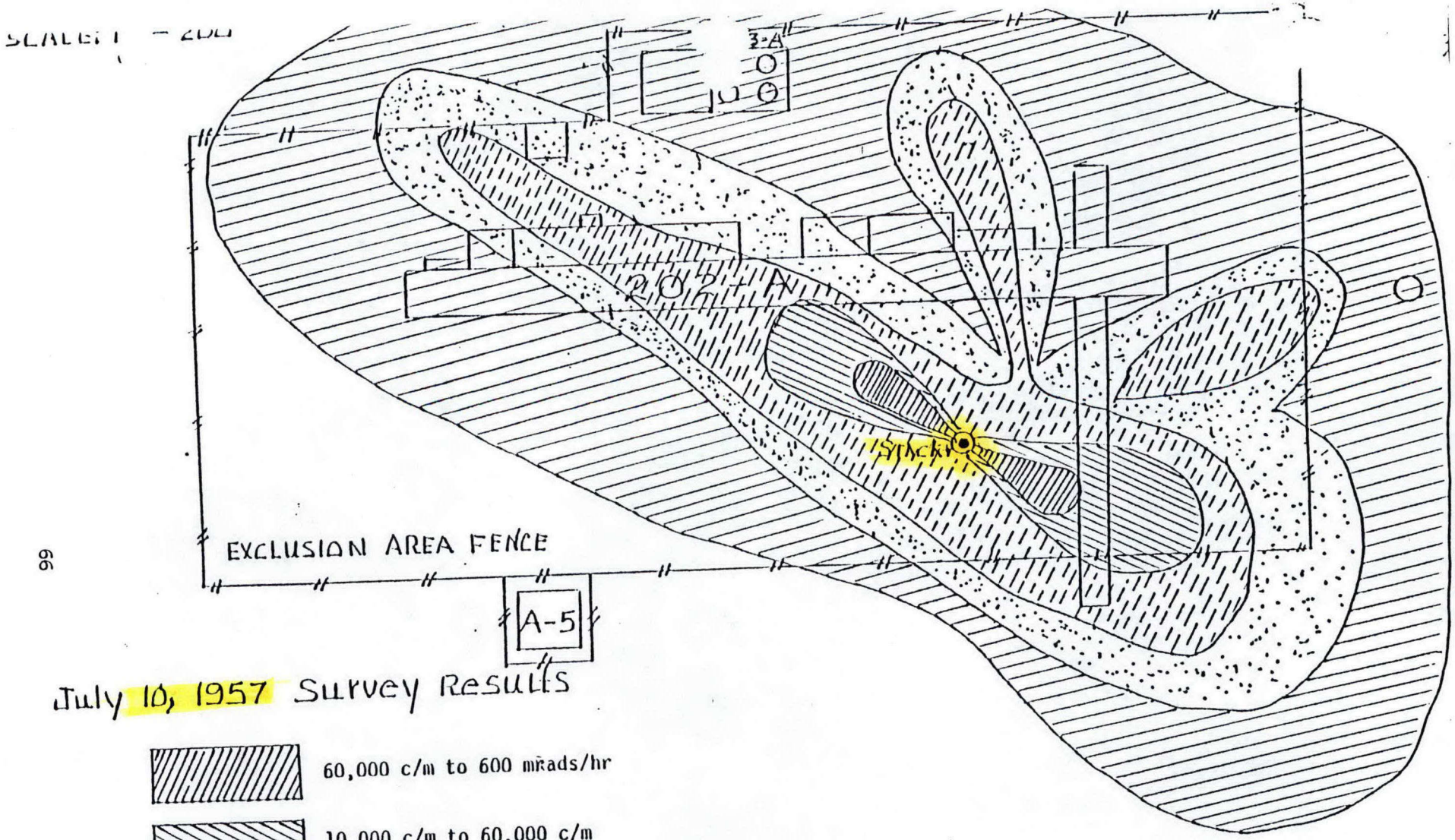
A plot plan of the July 4, stack emission on the following page gives more detailed information as to the extent of ground contamination.

Stack emissions continued through the 1960's and were mostly attributed to the build-up of ammonia nitrate in the stack liner. In the early 1960's ammonia nitrate flakes were discovered on the ground surrounding the 200 foot stack that measured 1 inch in diameter.

In 1987 Construction forces installed a mechanism inside the 200 foot stack that succeeded in diffusing the stack flow so that it was more evenly distributed throughout the liner, thus preventing ammonia nitrate build-up on one particular section of the stack liner.

Iodine emissions were a concern in the 1960's. On 5-21-62, short-cooled metal was received and charged at PUREX. Operating control limits were exceeded during transfer of metal solution from the dissolver.

On 10-21-63, an I^{131} emission occurred from the PUREX stack as a result of an error in shipment of three buckets of short-cooled metal.



July 10, 1957 Survey Results

- 60,000 c/m to 600 mrads/hr
- 10,000 c/m to 60,000 c/m
- 3,000 c/m to 10,000 c/m
- 800 c/m to 3,000 c/m
- Less than 800 c/m

These plotted survey results were determined by background readings with the GM probe 1" off the ground. Area surveyed was one square foot approximately every fifty feet.

On September 3, 1964 radioiodine was released into the atmosphere from the PUREX stack when "green" (short-cooled) reactor fuel was unknowingly charged into a dissolver. The process was stopped as quickly as possible, and steps were taken to retain as much of the radioiodine in the plant as possible.

September 21, 1964 a bucket of "green" metal was detected by crane operator observation and confirmed by the tunnel monitor. The bucket was returned to IPD prior to being charged.

In 1956, when stack emissions occurred, an attempt was made to pick up the radioactive particles from the ground, but as the fall-out problem continued, this proved to be a fruitless task. After 1957 loads of gravel were hauled in on several different occasions and distributed over the immediate contaminated ground areas surrounding the stack. It is estimated that the ground area within 150 foot radius of the stack is contaminated with varying degrees of radioactive particles down to a depth of 18 inches. This will need to be considered if the area is to be released from radiological control.

More efficient gaseous effluent filtration could have been achieved earlier had the future need been foreseen and steps taken to meet it.

At the 1983 PUREX start-up a dire need for state of the art gaseous stack sampling equipment was realized. A stack gaseous sampling system nicknamed the PING (Particulate Iodine Noble Gasses) was installed on the main stack, but suffered numerous problems with plugging, internal contamination, detector corrosion and instrumentation failures. In 1987, the MFRAM (moveable filter radioactive aerosol monitor) was installed. This unit is expected to eventually be the primary gaseous sampler for the PUREX stack when training and instrumentation problems have been worked out...

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