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HEALTH PHYSICS REPORT 236

Historical Report of Radiation Protection at GEND

Introduction:

The information presented in this report was collected in response to a request by the GEND Plant Manager in November 1989. Included are a basic description of early operations, significant HP activities, unusual events, and a summary of environmental releases of radioactivity since plant start up in 1957. The bulk of this information was taken from microfilm records and personal recollection by John Holliday, GEND Health Physicist 1957 - 1985, under contract # R-00162-X.

Discussion:

The core business of the Pinellas Plant was the same in 1957 as it is today, that is, production of neutron generator tubes for use in nuclear weapons. This process involves the loading of various metal films with deuterium and tritium under vacuum conditions, to form metal hydrides. Over the 30 year period since plant start up significant improvements have been made both in the product itself, and in the production methods. The original loading systems were made largely of glass and were much more delicate than the metal systems in use today.

During the first decade of operations, monthly reports to GE Management and the AEC indicate frequent personnel exposures, loss of contamination control, and releases of tritium to the environment. From the first Health Physics report, dated April 1957, it is apparent that GEND Health and Safety personnel had much to learn about methods to monitor and control tritium exposures and releases. At that time, very little published material was available concerning tritium safety. The overall attitude of the scientific (and regulatory) community was that tritium presented little hazard due to the very low energy associated with its decay. However, should these same events occur in today's regulatory environment, detailed investigations and reports would be required in many instances.

DISCLAIMER

To better understand the early problems faced by radiation protection specialists at the Pinellas Plant, a brief description of the glass loading systems and their operation is needed. As shown in figure 1, the system consisted primarily of 2 vacuum pumps and a glass manifold to which quartz "beds" and glass "tubes" were attached. The system was roughed down using the Welch pump and taken to fine vacuums by the mercury diffusion pump. System pressure was originally measured with a U-tube mercury manometer mounted on a meter stick. Tritium and deuterium were introduced to the system by applying heat to the beds which contained either titanium deuteride or titanium tritide. Following the required exposure time, gas take back was accomplished by removing heat from the bed. When the system pressure reached zero, as indicated by the mercury manometer, the operator would age (functionally test) the tubes right on the system, using pulse tanks. Then, following bake out and pump down, the operator would seal off the tubes. Attaching and removing system components (such as beds and tubes) was accomplished using a torch. Variations in the quantity of tritium released to the environment following tube loading were attributed to: (1) Operators of various heights trying to determine that two legs of a U-tube manometer located inside a dimly lit hood were of equal height and, (2) Intentional opening of the #1 stopcock when the time for gas take-back was too lengthy.

Glass breakage was a frequent occurrence. Systems occasionally exploded or imploded causing gas release, loss of contamination control, and personnel exposure. To limit this breakage the glass systems were periodically "flamed" by "lead" glass men who would apply heat to the system using a torch to relieve stress in the glass. During this procedure the #1 stopcock would be open, maintaining the system at a rough vacuum with the pump exhaust vented to the stack.

The major causes of area contamination were the change and maintenance of the Welch vacuum pumps, and the cleaning of glass systems and component parts. Each of the hood rooms contained four glass loading systems resulting in a total of approximately 80 (contaminated) Welch vacuum pumps. Tritium gas and oxide, as well as vapors from the mercury diffusion pumps would build up in the pump oil until either saturated or flushed with air. Periodically, the pumps were removed from the systems and taken to a hood room where their oil was changed and any other necessary maintenance was performed. System cleaning involved cleaning all system stopcocks using a solvent material for removing greases. On occasion, breakage of a titanium hydride bed would cause high levels of floor contamination due to the high specific activity of the tritide that existed as extremely fine powder (similar to talc or activated charcoal.) Increased experience of manufacturing personnel in loading operations and education of area personnel in radiological safety, resulted in fewer losses of contamination control over time.

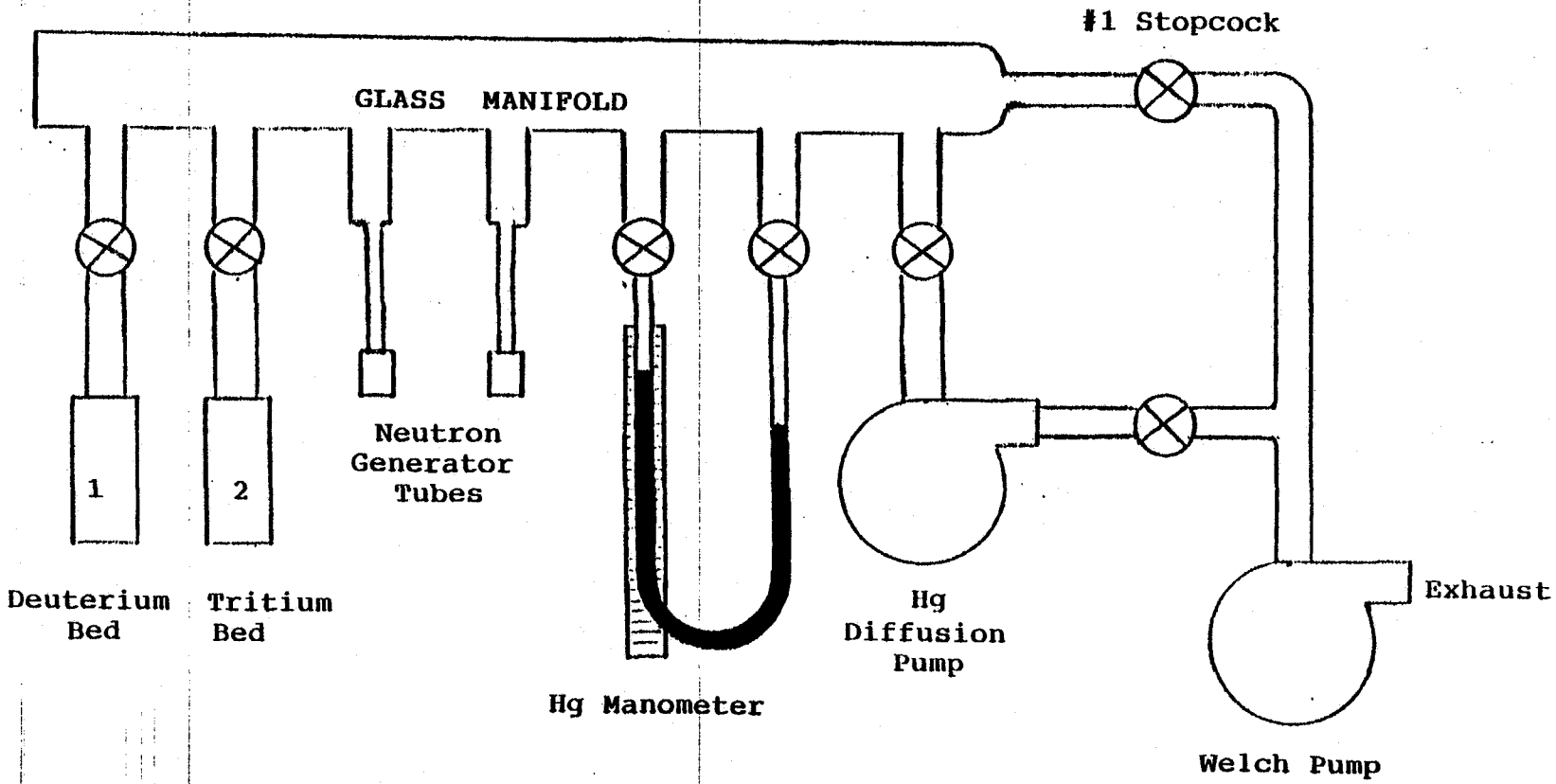


FIGURE 1: Glass Loading System

Three specific actions were responsible for major reductions in the quantities of tritium released to the environment. First, manufacturing management approved a 15 minute wait prior to opening the #1 stopcock after a tritium load*. This significantly reduced the quantity of tritium remaining in the system, and resulted in a reduction in total environmental discharges from 42,600 Ci in 1959 to 6,700 Ci in 1960.

Second, Health Physics personnel developed a method to convert gaseous tritium to water vapor and then remove the water molecules from an air stream using a desiccant. This concept was presented to the General Engineering Laboratory in Schnectady who then designed and installed the first Stack Effluent Control System (SECS) ever to be used anywhere. This system became operational in October 1960. The effect of the installation of the SEC System on releases is easily observable on Figure 2.

Third, the main tube exhaust area (108) was rearranged by removing most of the hood rooms and replacing the glass loading systems with metal systems similar to those in use today. With the switch to metal systems the gas storage unit was switched from titanium hydride in a glass cylinder to uranium hydride in a stainless steel cylinder. This provided better protection against breakage and allowed lower temperatures to be used when driving off the gas for each use.

Tritium releases to the environment rose with the startup of the metal loading systems because these systems were not initially connected to the SEC System. However, once all tritium loading systems were connected to the SECS in 1972, routine releases were reduced to a level approximately 100 times lower than those experienced in the 1950's.

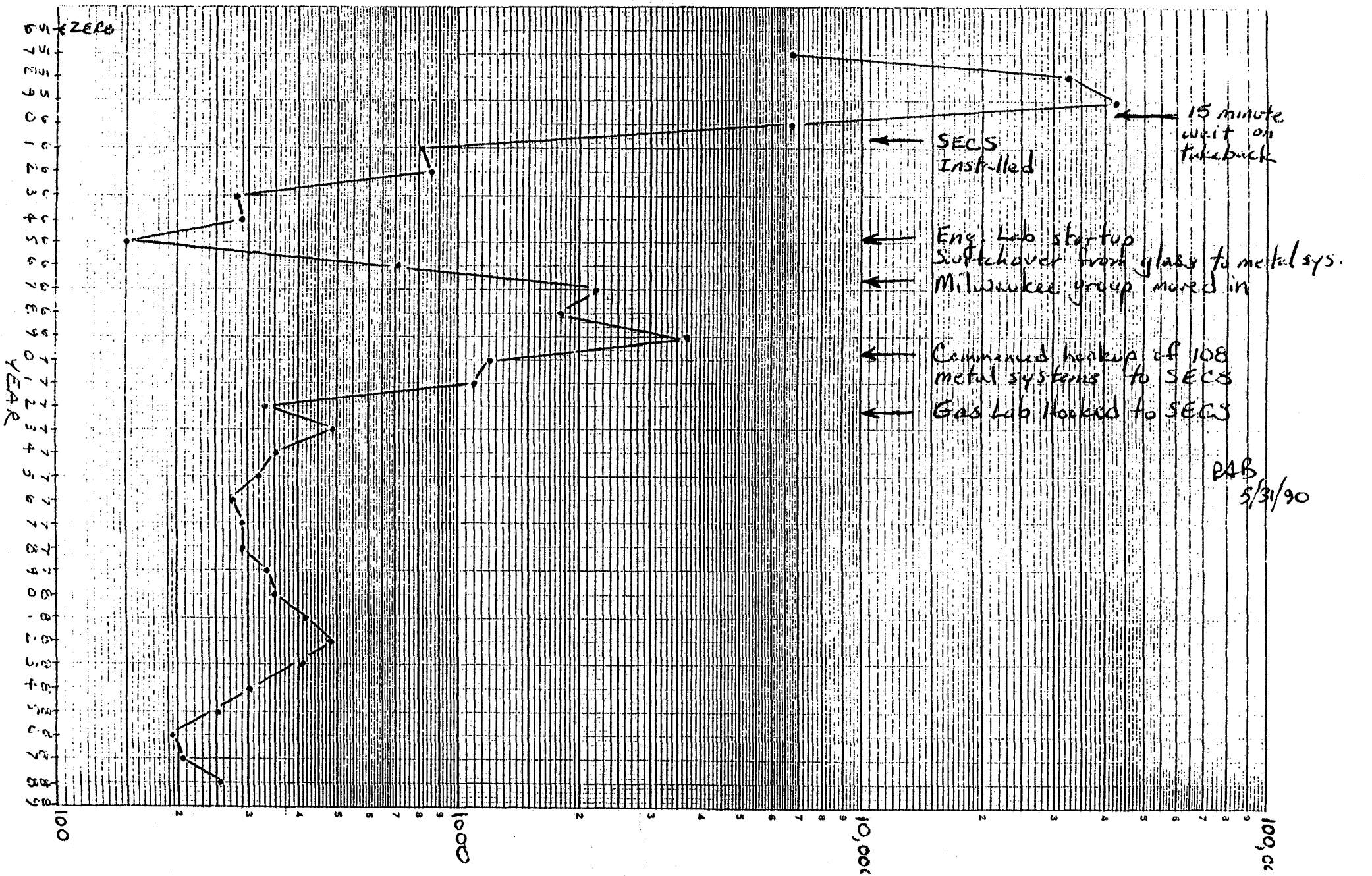
Over the last 15 years environmental releases have roughly paralleled tube production volumes. The major contributors to current routine releases are believed to be permeation of small amounts of T_2 gas through the metal walls of the uranium storage beds during heating, and minor HTO releases during normal system maintenance.

Much of the history of the Health Physics Program at GEND is documented on microfilm. Interested individuals may view the films at the record retention office. An index to this information is included as attachment C. For convenience a tabulation of events of historical significance involving radiation protection (attachment A) and a list of unusual events involving environmental releases or personnel or area contamination (attachment B), are included here.

*Note: The "wait period" was replaced by a specific vacuum limit once vacuum gages were installed on the systems around 1960.

FN-265-A (8-50) GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., U.S.A. 3 cyc. x 170 1mm Divisions

FIGURE 2: TRITIUM CURIES RELEASED PER YEAR



Attachment A:

Date	Activity
4/57	Glass wool filters installed on Kanne inlets
	Need for calibration of Kanne chambers recognized
	New employee orientation in rad safety offered
9/57	Request for prior-employment exposure records initiated
	Pu-Be source received
	Written instructions provided for response to tube damage
	Washing machine purchased
10/57	Measured n dose rates at all test positions
	Reduced LLD for HTO in water by X2
	Pre and post employment bio program instituted
11/57	Measured n-output of n.g's (10 mrem/pulse @ 1 inch)
	Stack oxide levels first monitored
	SWP program initiated
12/57	Raytheon Tubes found to contain 10 nci Co-60
	GOP E.10.06 "Review of Operations" was issued
	Sandia asked to provide film badges
	Foot monitor installed in Area 108.
	Telephone booth whole body T monitor installed in Area 108.
1/58	Received 5, 50-micro ci Cs-137 sources
2/58	Monitored shipments of Co-60 needles
1/60	HP representative assigned to area 108 full time
3/60	Monitored workers urine for Hg exposure (max 0.052 mg/l)
	Installed stopcock interlocks on all systems in 108
6/60	Began milk sampling
	HP procedures prepared for GEXF Recovery System
8/60	Shoe covers reinstituted in 108. Area shoes still used
	Requested funds to purchase EM & RAT truck
	Visited by Florida State Board of Health on Environmental Monitoring

Date	Activity
9/10/60	Secured area 108 in preparation for Hurricane Donna. Provided continuous HP coverage during storm. Requirement for full anti-c's in 108 reduced to lab coats for normal production operations.
11/14/60	Visited by FSBH to review EM data. Began using NBS Handbook 69 for MPC's Pu Alpha sources shipped to Sandia for calibration
2/61	Evaluated and rejected use of Kr-85 for leak testing - doses too high.
3/61	Full-time HP Support provided to 3rd shift.
7/61	100 m ci Co-60 Source found leaking was corrected.
8/61	Semi-annual AEC Health & Safety Inspection.
11/61	The Cottingham School was advised on protection from fallout. We calibrated survey instruments for the Pinellas County Health & Fire Departments.
2/62	Fallout monitoring station set up
3/62	An HP representative spoke to the 8th grade at Maderia Jr. High on "Radiation" FSBH and ALO reviewed our HP programs.
9/62	HP personnel participated in Operation Spade Fork.
10/62	A modified personnel monitor was installed in Area 108.
3/63	HP darkroom installed
9/63	HP representative attended radiflo training course 9/24/63 Kr-85 first put in radiflo unit - lost 2 curies due to leaks Employees found falsely identifying urine samples
11/63	Dichromate coating found to hold Kr-85 in radiflo fixtures - removed X-rays found penetrating E-beam evaporator ports. Began use of wrist badges

Date	Activity
2/64	E-beam evaporator found reading 250 mr/hr at start up - shielded to 4 mr/hr Semi-annual AEC inspection.
6/64	0.2 Ci HTO in waste was burned as a test
10/64	ALO approved on-site incineration of rad waste Inspected by AEC (Semi-annual)
11/64	PAO approved reduction in env. Sampling frequency
12/7/64	Eng lab's first exhaust unit approved for use
11/65	HP representative visited Milwaukee We participated in a presentation on "the peaceful uses of atomic energy" at Azalea Jr. High. RAT team exercise
12/65	X-ray diffraction unit found leaking was shielded Gas powered air sampler obtained for RAT
4/66	In place testing of freshly loaded tubes in 108 discontinued.
9/66	Move from Milwaukee in progress
12/66	Glovebox line installed in A182C
4/67	HP got 1.6 Rads surveying a new x-ray machine. The unit was then shielded
7/69	X-ray survey found wiring problem resulting in 2X higher energy output at start up
9/69	Semi-annual survey found leaking Ba-bolt 10 ug Ra-226 source found at warehouse X-ray emission unit in area 155 found leaking to 1.6 R/hr Shallow wells near holding tanks found to have measurable HTO indicating leakage.

Date	Activity
* 10/69	10.74 Ci of HTO measured in acid dip tank Commenced connection of metal systems to SECS
11/69	Building 400 Cell #3 contaminated with TiH_2 from used flask storage - all flasks removed to burning pad West of building 400. Eng working on new bed processing system to eliminate need for storage.
2/72	4 HP personnel served on RAT teams for an incident involving a leaking Delta Airlines shipment.
2/72	Gas lab hooked to SECS completing the SECS extension project. Preloaders identified as a major point of stack emissions of HTO, along with the bed processing system.
8/72	Identified need to bake out sorb pumps to SECS immediately after use or keep chilled until so baked.
11/72	Sniffer pumps installed on 182 Mezzanine
11/72	Audited by ALO
11/72	Gel column env monitoring system being evaluated
2/73	Order placed for 120 Ci Cs-137 irradiator
5/73	PSAR Submitted to ALO for RTG project
8/73	Made arrangements to ship getter discs to Mound for T_2 recovery Ion pump cleaning put 41 curies HTO in acid soln. AR for waste drum storage bldg submitted Env monitoring stations being installed RTG PSAR returned - disapproved - modified Shepherd calibrator installed.
9/73 - 1/86	Activity logs not available.
1/86 - Present	See Health Physics files

ATTACHMENT B

Unusual Events involving radiological protection at GEND

Date	Description	Curies Released
12/10/57	Operator error in manometer use Rm 18	458
2/11/58	Error in estimating the amount of T_2 Rm 18 remaining in the system	1253
7/8/58	Glass system breakage Rm 22	280
3/7/58	Glass system breakage Rm 18	567
8/16/58	Operator error in loader valve position Rm 21	780
8/18/58	Glass Breakage (bed) Rm 21	1180
2/10/59	Operator error in stopcock use Rm 8	286
2/20/59	Hand Contamination - Operator not wearing gloves (Ed Perrino)	—
2/21/59	Area Contamination - Operator broke glass system Rm 18	—
3/12/59	Operator contaminated during system cleaning by another worker Rm 14	—
6/4/59	GEL personnel error working on SECS test Rm 21	753
6/5/59	Area Contamination - Diffusion pump exploded in hood 14	—
6/18/59	Near miss explosion on glass system - operator error	—
6/18/59	Air in loading system (explanation questioned) Rm 20	423
9/11/59	Tritium in holding tank H_2O possibly from drum washing	6.5
10/5/59	Stopcock blew out of glass system Rm 15	

Date	Description	Curies Released
1/60	Operator left stopcock open	40
2/5/60	Glass bed broke from strain	72
2/11/60	Operator left stopcock open	308
3/25/60	Operator error caused 3 workers exposure Rm 13	—
5/14/60	Broken flask caused area contamination Rm 10	—
6/21/60	Ion Gage Exploded Rm 18	—
7/8/60	Sample bulb dropped Rm 23	6.8
7/13/60	Manifold shattered exposing worker Rm 23	—
8/12/60	Contamination spread (TiH_2) in 108 from broken flask	—
4/61	Area contamination from system breakage	—
12/62	Breathing Air supply line connected to A108 exhaust duct	
2/4/65*	Explosion during cold trapping	38 Kr
3/10/65	Worker exposed when x-ray interlock failed (Tom Wineman) XRE shutter	
3/30/65	Broken flask Rm 9	—
5/20/65	Flask explosion Rm 12	—
5/66	SECS Col Water removal problem	252
1/27/67	Glove box pump oil degassed A182C	32
10/12/67	Personnel Contamination - O-ring mishandled Rm 18 Gerald Breier	—
1/17/68*	Faulty relay in auto mode of Radiflow #1 - Unit vented when placed in manual.	129 Kr

Date	Description	Curies Released
6/18/68*	Acid cleaning explosion - Area 181	0
2/69	Leaking Flange @ sorb pump 108	8
2/69	Area Contamination when pump exh lines cut during hood removal Rm 2	0
2/3/69	Equipment failure - valve did not seat properly -	20 Kr
8/11/69	Holding Tank Overflow after pump failure	—
11/5/69*	Area contamination Bldg 400 assoc with D-bed	?
1/70	Area contamination/personnel exposure from flaking tube part in Gas lab	—
2/70	Area Contamination from pressurized sorb pump (air expansion) Rm 2	—
11/20/70	Area Contaminated when operator used vacuum cleaner on ScH_2 dust - A182D	0
12/28/70*	SECS Col saturated from an air leak in A108	117
3/12/71*	Copper gasket uncovered in Rm 18 hood - High internal dose	7.3
6/14/71*	Area 108 Wallace Tiernan Gage repair, high internal	
10/9/71*	Radiflo #1 Storage tank leak	6.1
10/21/71	Tritium release from improperly baked evaporator system A182D	129
11/10/71*	Area contamination from T-loaded disc - A154 Auger spectrometer sample	0
12/1/71*	High internal exposure - Room 18 hood work	1

Date	Description	Curies Released
4/72	Area contamination/liq discharge from flaking fixture in A182D	1.5
5/72	Hand exposure from XRE unit (7R) during cleaning Dan Sgro	—
8/3/72	Leaking sorb pump	12
1/4/73*	Water leak in area 182D	0
5/73*	Area Contamination from ErH_2 film in A157, 8, 6	—
5/11/73*	Fire in boom box - Bldg 200	0
3/17/74*	Water leak in area 108	0
4/4/74*	RGA installed on exhaust unit in 182D	0.85
1/31/75*	Improper valve closure on Uranium bed	< 150
1/30/76*	Contaminated 6" valve shipped	0
6/76*	Loss of 7100 Ci of T_2 gas to SECS	0
2/77	Packaging of fixtures in 182D glove box	28
5/23/77*	Radiflow valve failure during cold trapping	16 Kr
9/11/79*	Work in Rm 18 Hood - High internal dose	5.7
8/80*	Contaminated Electron Microscope excessed	0
2/25/82*	TRS valve left in wrong position during maintenance in 108 (M/S)	8.6
4/20/82*	Operator left TRS valve in wrong position during maintenance in 108 (M/S)	48
5/24/82*	TRS valve left in wrong position during maintenance in 108 (exhaust unit 513)	9.5
9/1/82*	Leaking sample bulb (gas in pinch off)	3.0

Date	Description	Curies Released
1/5/83*	Bed Oxidation System room 21, design problem	130
1/19/83*	Work on Sorb pump in 208, overpressure relief	9
4/5/83*	Bed heater control failure area 108	0
7/25/84*	Sorb pumb Sieve dumped into drum in 108 - UOR 84-07	67
4/3/84*	SECS blockage when Trichlor was introducted in Area 182D	0
12/9/85*	Sorb pump overheat - Area contamination - UOR 86-01	0
6/5/86*	Waste Drum removed from Area 108 without survey	0
6/24/86*	Mass Spec Oil Change workers exposed to T_2 gas UOR 86-04	1.5
11/24/86	Tracerflow maintenance	3.6 Kr
2/5/87	270 Ci pumped from Rm 18 to SECS	0
6/16/87	SECS pressurization by Ar purge in 108	0
8/87	Cold Trapping	26 Kr
9/8/87	ELDS #6 Sorb pump leakage (bad weld at neck)	0.7
11/4/87	Test of O_2 regeneration need by SEC system	12
2/11/88	Leaking sample bulb from 182 in 108	8
3/7/88*	E-beam welder shield failure - workers exposed UOR 88-03	0
5/5/88	Purge left on over 3rd Shift in 108 - SECS overpressure	2.7
5/27/88	Leakage from Radiflo system #2	0.4 Kr
9/88	Lab area release over 2 week period	16.2

Date	Description	Curies Released
1/6/89*	Water in SECS line area 182D - UOR 89-02	1
9/7/89*	Loss of control of Radioactive Material - UOR 89-08	0
12/15/89*	Work performed in area 108 without permit - UOR 89-12	0