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Spill Exercise 1980: An LLNL Emergency Training Exercise

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Lawrence Livermore National Laboratory

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SPILL EXERCISE 1980:
AN LLNL EMERGENCY TRAINING EXERCISE

ABSTRACT

An emergency training exercise at Lawrence Livermore National Laboratory (LLNL) demonstrated that off-hours emergency personnel can respond promptly and effectively to an emergency situation involving radiation, hazardous chemicals, and injured persons. The exercise simulated an explosion in a chemistry laboratory and a subsequent toxic-gas release.

INTRODUCTION

Periodic training exercises are conducted to ensure that the emergency response personnel of Lawrence Livermore National Laboratory are properly trained to handle emergency situations. The first of a new series of emergency training exercises was conducted in February 1980. This exercise, entitled "Spill Exercise 1980," was planned, conducted, and controlled by a multidepartmental committee (Appendix A).

The exercise simulated an explosion and radiation spill in a chemistry laboratory, followed by a toxic-gas leak several hours later. It was initiated at 5 a.m. on Tuesday, February 26, and was completed by noon. The exercise was designed to be as realistic as possible and to test the general emergency response capability for off-hours emergencies; activities were limited to the LLNL facilities in Livermore and to the immediate off-site environment. Several departments and divisions participated, including Hazards Control, Security, Medical, and G-Division (Atmospheric Release Advisory Capability, ARAC). The non-Hazards Control organizations were included because they would be involved in any real emergency of this type. The participants are listed in Appendix B.

OBJECTIVES

The objectives of the exercise were to:

- Train and evaluate the performance of specific LLNL emergency response groups in a simulated off-hours emergency.
- Test the effectiveness of the LLNL Security Communications Center and the LLNL emergency dispatcher (Fire Safety Division) in initiating proper communications and procedures to activate the following LLNL emergency response organizations: Fire Safety Division; Emergency Assistance Team; Medical Department; Hazards Control Department's Operational Safety Division, General Safety Division, and Environmental Evaluations Group Off-Site Sampling Team; and the Administration Office.
- Train and exercise Health and Safety Technicians and other personnel in the proper measurement, assessment, and cleanup of a radioactive nuclide spill.
- Test the emergency evacuation of an adjacent building (B-253).

EXERCISE CONTROL AND LIMITATIONS

An important part of any emergency exercise is maintaining control of the sequence of events, so that participants are not injured and outside agencies are not notified needlessly. Control of Spill Exercise 1980 was provided by using a detailed scenario (Appendices C-G) and umpire observation of all activities. A knowledgeable umpire was selected from each group involved in the exercise to evaluate and control that group's performance. Umpires were assigned to locations from which they could observe the exercise activities and interact with participants if problems arose. Their primary responsibility was to prevent injury or unacceptable exposure of any participant, umpire, or non-involved person. Since actual radioactive materials were used in the exercise, the umpires' second concern was to prevent the spread of radioactive material outside of the immediate exercise area. Umpires were not permitted to interject guidance to the participants without first conferring with the Exercise Director unless injury, exposure, or unnecessary contamination would occur without timely action.

EXERCISE SITUATION

The exercise was held in the Material and Equipment Yard immediately east of B-251 at the Livermore site. Two surplus transport containers were placed in the center of the yard and staged to resemble a chemistry laboratory. This simulated chemistry laboratory was the focal point of the emergency exercise. The simulated accident was initiated by setting up the laboratory as though a hydrogen explosion had occurred within the laboratory and caused the damage. The result of this explosion was:

- Physical damage to the laboratory.
- Spillage of several chemical reagent bottles from their storage shelf onto the laboratory floor. The chemicals were of low toxicity and cleanup presented little hazard.
- Dispersion of radioactive material. Actual low-level ^{223}Ra was used within the laboratory, as was a multi-curie ^{60}Co source (see Appendices H and I). Airborne activity was simulated.
- Minor injuries to two experimenters.

A toxic-gas leak was simulated about 4 hours after the start of the exercise, to test the effectiveness of the evacuation procedures for a nearby building. The leak was simulated using an unlabeled cylinder of carbon dioxide mounted in a locked cabinet outside the laboratory. (To prevent discovery and removal of the cylinder before the exercise, a sign was mounted inside the cabinet stating that the cylinder was to be used later in the exercise and should not be disturbed.) At the prescribed time, the cabinet was unlocked and a label, "Danger: Rhenium/Tungsten Hexafluoride," was attached to the cylinder. The cylinder valve was opened, resulting in a white plume of CO_2 and water droplets. The Disaster Coordinator was immediately handed the message:

> "This is an exercise. A cylinder of the toxic material Rhenium/Tungsten Hexafluoride has begun leaking. The valve stem is broken between the valve and the cylinder. The white smoke is the reaction product of the material and air. It is blowing directly toward the air-conditioning intakes of B-253. This is an exercise."

If the Disaster Coordinator had not ordered evacuation of B-253, he would have been given a prepared message requesting evacuation.

The actual sequence of events at the simulated accident area during the exercise was as follows:

Time	Event
05:05	Exercise was initiated by phone call from B-251 Maintenance Machinist to the Emergency Dispatcher.
05:07	Firefighters and off-shift Health and Safety Technician arrived at the scene of the exercise (Fig. 1).
05:15	Radiation field was detected and the two victims were removed from the radiation area (Figs. 2 and 3).
05:22	Area control was established and "hot zone" set up.
05:28	ARAC printout was requested by Disaster Coordinator.
05:32	Environmental survey was requested.
05:42	Field first aid of victims was completed.
05:43	Emergency Assistance (EA) Team callout was initiated.
05:49	Victims were transported to LLNL Medical (Fig. 4).
06:11	EA Team began arriving at scene and preparing plan for entry.
06:31	EA Team members began to dress out for area entry (Fig. 5).
06:53	First survey team entered the spill area.
07:17	Second survey team entered the spill area.
07:27	Gamma source was located.
07:32	Alpha radiation was detected on bootie (Fig. 6).

FIG. 1. LLNL Fire Department arrives at the simulated accident scene 2 minutes after initial call, with one engine company, one ambulance, and the command-and-control vehicle.

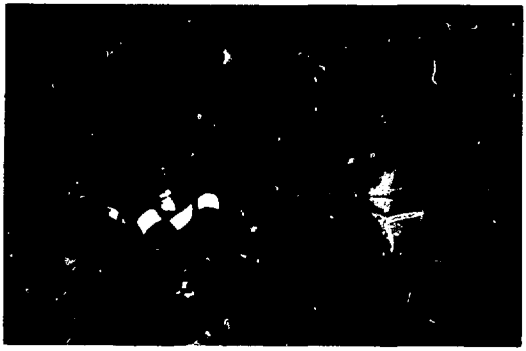

FIG. 2. Casualties are examined for injuries and surveyed for radioactive contamination by off-shift Health and Safety Technician and firemen.

FIG. 3. Unconscious casualty is removed from the accident scene.

FIG. 4. Casualty in ambulance before transportation to Medical Department.

FIG. 5. Emergency Assistance Team prepares to enter the accident area.

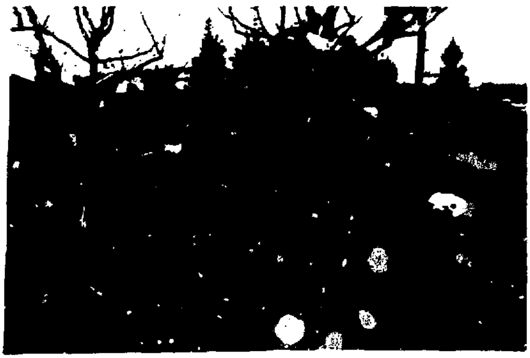

FIG. 6. Individuals exiting the accident area are monitored at the "hot-line portal."

07:46	First reports on off-site samples were received.
08:00	Gamma source was secured (Fig. 7).
08:26	Third survey team entered to bag up gas bottles of rhenium/tungsten hexafluoride. "Spilled" 60,000-cpm alpha source was on floor of shed. Industrial Hygienists and Health and Safety Technician examined spill area for hazards other than ionizing radiation (Figs. 8 and 9).
08:55	Team entered in chemical suits to isolate bottles of rhenium/tungsten hexafluoride.
09:05	Simulated hexafluoride leak was initiated (Fig. 10).
09:14	Evacuation of B-251, B-261, and Travel Dept. trailers was simulated. Evacuation of B-253 was initiated (Fig. 11).
09:26	Evacuation was completed and employees were allowed back into B-253.
09:38	Emergency operations of Spill Exercise 1980 were completed. Remainder of operation was routine radiation spill cleanup and was used to train new Health and Safety Technicians.

FIG. 7. ^{60}Co source is removed from the accident area with a remote manipulator, for placement in a lead pig.

FIG. 8. Industrial Hygienists and Health and Safety Technicians prepare to enter the accident area.

FIG. 9. The accident scene is examined for hazards other than ionization radiation.

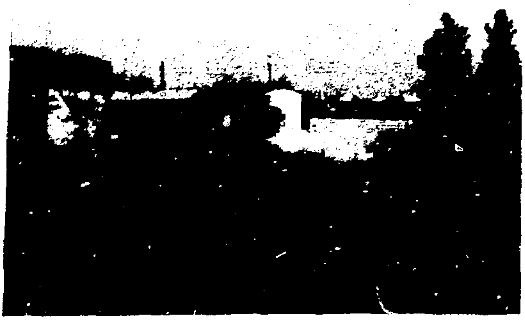

FIG. 10. Simulated release of rhenium/tungsten hexafluoride (actually CO_2). Building 253 is in background.

FIG. 11. Building 253 is evacuated when the simulated rhenium/tungsten hexafluoride drifts toward its air-conditioning intakes.

CONCLUSIONS AND RECOMMENDATIONS

Spill Exercise 1980 followed the planned scenario closely. A critique session was held for all participants on February 27. The exercise demonstrated that the Hazards Control Department, as supported by ARAC and Security, can respond promptly and effectively to an emergency situation involving radiation, hazardous chemicals, and injured personnel during off-hours. The especially favorable aspects of the exercise included:

- Initial size-up by the off-shift Health and Safety Technician and Fire Department.
- Safety Team and Fire Department coordination.
- ARAC functions.
- Off-site environmental sampling.
- EA Team response and demeanor.

The exercise also pointed out several areas of needed improvement which should be addressed:

- Improve callout procedures and methods to speed notification of essential personnel. In the exercise, there was unnecessary delay in Safety Team Leader, EA Team, and Health and Safety discipline callout. The dispatcher seems to be extremely overloaded during the early stage of an emergency, real or otherwise.

- Improve skill and technique in using portable radiation-detection instruments in emergency situations. There was difficulty in locating the exact position of the gamma source and delay in determining the extent of the alpha contamination. In addition, small natural thorium sources attached to the victims were not detected because of failure to use the proper instrument.

- Improve evacuation procedures for B-253 to include persons outside of the building. During the exercise, an outside contractor with escort was working on the roof and was not evacuated from the area.

- Improve visitor control at the on-scene command post to eliminate crowding in the area. Spectators without an emergency function should be kept clear of the command post to prevent unnecessary interference.

CJT/cc

APPENDIX A

DISASTER EXERCISE PLANNING COMMITTEE

Chairman: J. L. Morse, Hazards Control Department

Members: A. L. Buerer, Hazards Control Department
T. A. Gibson, Hazards Control Department
G. D. Greenly, G-Division
M. J. Kotowski, Hazards Control Department
J. M. Loverin, Hazards Control Department
Z. E. MacBain, Hazards Control Department
R. T. Trolan, Hazards Control Department
W. F. Vance, Hazards Control Department
G. Y. Liu, Medical Department
J. B. Garberson, Public Information Office*

*Committee involvement for possible or actual press contacts.

APPENDIX B

PARTICIPANTS

Players:

J. S. Dittig	Deputy Disaster Director
J. F. Becker	Safety Team Leader
C. W. Mickel	Safety Team Leader
L. A. Chandler	Fire Safety, Disaster Coordinator
J. F. Corey	Fire Safety
G. D. Dakin	Fire Safety
J. W. Linhart	Fire Safety
T. D. Baird	Fire Services
R. W. Blendow	Fire Services
K. G. Butts	Fire Services
M. P. Lowas	Fire Services
J. C. McKenzie	Fire Services
M. L. White	Fire Services
D. E. Hankins	Health Physics
K. M. Laudermilch	Health Physics
R. L. Morris	Health Physics
D. S. Myers	Health Physics
J. T. Powell	Health Physics
R. L. Wilson	Health Physics
J. E. Bardecker	Health & Safety Technician
J. R. Foster	Health & Safety Technician
J. D. Lum	Health & Safety Technician
F. M. McMillen	Health & Safety Technician
A. S. Micolosi	Health & Safety Technician
R. H. Quast	Health & Safety Technician
J. F. Robinson	Health & Safety Technician
J. R. Shingleton	Health & Safety Technician
W. M. Shea	Health & Safety Technician
S. B. Willhoite	Health & Safety Technician

K. C. Young	Health & Safety Technician, Owl Shift
B. A. Bettencourt	Industrial Hygiene
J. S. Johnson	Industrial Hygiene
J. Lipera	Industrial Hygiene
R. E. Johnson	Respirators
K. P. Ellis	Off-site Health & Safety Technician
M. S. Alton	ARAC, G-Division
E. S. Cassaro	ARAC, G-Division
R. Lange	ARAC, G-Division
L. A. Lawson	ARAC, G-Division
K. R. Peterson	ARAC, G-Division
D. J. Rodriguez	ARAC, G-Division
C. R. Veith	ARAC, G-Division
C. L. Lindeken	Environmental Evaluations
H. E. Pfeifer	Environmental Evaluations
W. J. Silver	Environmental Evaluations
A. J. Toy	Environmental Evaluations
J. H. White	Environmental Evaluations
L. M. Barber	Off-site Sampling Team
K. J. Davidson	Off-site Sampling Team
C. W. Sunbeck	Off-site Sampling Team
R. D. Taylor	Off-site Sampling Team
D. W. Homer	Nuclear Chemistry

Umpires:

J. L. Morse	Hazards Control, Exercise Director
T. A. Gibson	Health Physics, Deputy Exercise Director
W. F. Vance	Control Room Operations
J. M. Loverin	Fire Services Operations
R. G. Purington	Fire Services Operations
A. L. Buerer	Industrial Hygiene
C. D. Burgin	Industrial Safety
M. J. Kotowski	Industrial Safety
R. T. Trolan	EA Team Operations
H. W. Patterson	Hazards Control
M. H. Dickerson	ARAC, G-Division
G. D. Greenly	ARAC, G-Division
C. B. Ozaki	Health Physics
C. E. Byrne	Health & Safety Technician
D. J. Kvam	Environmental Evaluations

APPENDIX C

PLANNING SCENARIO

Event No.	Time (approx.)	Operation/Event	Player action/Requirements	Umpire action, if needed (real time)
1	0500	Call to FD*; explosion in Radiochem Equip yard (south of B-253), injuries, cloud seen moving downwind	FD dispatcher initiates FD and offshift H&S Tech response (+ Security, MM, and Medical)	Give message card to Dispatcher if action incomplete Make initial call in to FD
2	0505	Initial size-up	1. Verify telephone report • Injuries • Fire • Radiation 2. Begin gathering info for action • Witnesses • H&S Tech • Experimenter • Air samples	Give message card(s) to responding fire officer if size-up not acceptable

*Abbreviations are listed at the end of this table.

Event No.	Time (approx.)	Operation/Event	Player action/Requirements	Umpire action, if needed (real time)
3	0515	Prioritize initial actions	1. Treat injured while controlling activity	Ensure activity not spread/ingested
			2. Survey for radiation and other hazardous material	
			3. No fire risk	
			4. Consider: EAT, Respirator Van (18-84), EE, STL, ARAC	
4	0530	Expanded notification/ request for assistance	1. Request: EAT, STL, EE, ARAC, Van 18-84 thru Dispatcher	1. Require EAT, STL, Van 18-84 only.
			2. Notify: Emergency Operations Group Leader Fire Protection Engineering Group Leader Fire Safety Division Leader DDD	2. Simulate notification of management above DDD
5	0545	HP surveys	1. Air sampling	Preclude actual exposures or activity spread outside B-251 fence
			2. Instrument surveys	
			3. Visual reconnaissance (with suitable garb & instruments)	

Event No.	Time (approx.)	Operation/Event	Player action/Requirements	Umpire Action, if needed (real time)
6	0600	On- and off-site concern	1. Evaluate airborne and off-site concern 2. Area control by Security	1. Require EE & ARAC participation 2. Require area control (before normal workday)
7	0630-0830	DDD briefs Mgr. of Plant Services on status	DDD prepares status report from ● EE ● ARAC ● STL/EAT ● Medical	Call Mgr. of Plant Services to call DDD (0830 hrs)
8	0800	Recovery operations	1. Secure gamma sources 2. Activate Counting Lab for alpha ID 3. Detection of alpha contamination Recovery technique--One of following is acceptable: ● Hot asphalt ● Cover with plastic ● Hose down into sump	Preclude actual exposure or contamination spread out of area

Event No.	Time (approx.)	Operation/Event	Player action/Requirements	Umpire action, if needed (real time)
9	Before 1000	Change Team Leaders (before simulated hexafluoride release)	Briefing of new STL by departing STL and others at Field CP	Present message card requiring backup STL
10	1000	Simulated hexafluoride release	1. Evacuate B-253 2. Simulate others 3. FD sweep of B-253 for casualties 4. Area control by Security (additional)	Require evacuation of B-253
11	1100	Continue spill recovery	See Step 8	See Step 8
12	1300	Close out briefing of Mgr. of Plant Services	DDD briefs, based on current info from STL, FD, EE, EAT, etc.	Call Mgr. of Plant Services
13	NLT 1500	Terminate Exercise		Present message card to DDD
14	0900 (day following exercise)	Debriefing of Umpires and Players		

CP = Command Post
DDD = Deputy Disaster Director
EAT = Emergency Assistance Team
EE = Environmental Evaluations
FD = Fire Department

HP = Health Physicist
H&S = Health & Safety
MM = Maintenance Machinist
NLT = Not later than
STL = Safety Team Leader

APPENDIX D

RADIATION SAFETY AND HEALTH PHYSICS SUBSCENARIO AND CHECKLIST

1. Control and Umpire Group will properly post, by signs, area as a radioactive area on the day before the Exercise.

2. Control and Umpire Group will emplace ^{60}Co source and contaminate exercise location by spraying ^{223}Ra solution on the day before the Exercise.

3. Control and Umpire Group will assure that players do the following, if they do not do same on their own initiative:

   a. Establish manned checkpoint for entry to and exit from area.
   b. Provide person manning Checkpoint with Radiation Incident Log form.
   c. Establish a list of personnel in the area at the time of the incident. (Make sure that all persons are accounted for.)
   d. Establish manned holding area for persons involved in incident.
   e. Get briefing on incident from Health and Safety Technician.
   f. Does the incident involve potentially
      (1) High radiation fields
      (2) High airborne radioactivity levels
      (3) High levels of contamination
   g. If any answer to f is yes, send for additional Health Physics support.
   h. Prepare to enter area for evaluation.
   i. Instruct person manning holding area to monitor personnel who were in the vicinity of the accident:
      (1) Check for external contamination and contaminated wounds
      (2) Pull dosimeters and send to Personnel Dosimetry
      (3) Take nose swabs, as appropriate
   j. Segregate exposed personnel and
      (1) Send to Medical (high radiation dose)
      (2) Send to Medical (bioassay)

(3) Send to Medical (contaminated wound)

(4) Send to Whole Body Counter

(5) Send to Decon

k. Establish communication between health physicist at checkpoint and health physicist in area for evaluation.

l. Incident Evaluation

(1) Size-up

(2) Start air sampler (inside and outside area)

(3) Monitor dose rates at specified locations

(4) Evaluate probability of release of radioactive material to environment

(5) Evaluate requirement for additional air sampling or monitoring

(6) Mark contaminated and high-radiation areas

(7) Brief Radiation Safety Division Leader

m. Inform Health and Safety Technician or Emergency Coordinator of requirement for:

(1) Spill Team

(2) Environmental Survey Team

(3) Meteorologist

n. Establish:

(1) Contamination control requirement

(2) Protective clothing requirements

(3) Respirator requirements

(4) Dosimeter requirements

(5) Limitations on work time in area

(6) Additional ventilation requirement

APPENDIX E

ARAC SUBSCENARIO AND CHECKLIST

Time	Action by participants	Action by umpires, as required
H + 0:30	Fire Dispatcher alerts ARAC Central Facility via ARAC site system and/or emergency call list.	Umpire gives instructions to alert ARAC (Attachment 1).
H + 0:45	ARAC Central Facility alerts ARAC staff and begins preparation of regional model input files. Fire Dispatcher communicates to ARAC Central Facility info on emergency.	Umpire provides details of accident for communication to ARAC Central Facility (Attachment 2).
H + 1:00	Fire Dispatcher or Off-Site Sampling (OSS) Team Captain uses ARAC site system to calculate Gaussian (10-m and 40-m winds).	Umpire provides meteorological data if needed (Attachment 3).
H + 1:30	ARAC Team Leader alerts Computer Center of "super priority" need and contacts disaster response force leader/OSS Team Captain.	

Time	Action by participants	Action by umpires, as required
H + 2:40	Regional model calculations made and contour files sent to LLNL site for use of disaster response force and/or OSS.	
	Fire Dispatcher informs ARAC Central Facility of new emergency (leaking cylinder).	Umpire provides winds if needed and details of leak (Attachment 4). Surface winds are from 195 degrees at 2 m/s.
H + 10:00	Secure from Exercise.	

Attachment No. 1: ARAC Alert N[illegible]ation

THIS IS AN EXERCISE

YOU ARE TO USE THE ARAC SITE SYSTEM AND ALERT THE ARAC CENTRAL FACILITY TO THE FACT THAT THERE IS AN EMERGENCY EXERCISE IN PROGRESS BY PROVIDING THEM WITH THE FOLLOWING INFORMATION:

"THIS IS AN EXERCISE.

ACF THIS IS LLNL WE HAVE AN EMERGENCY IN PROGRESS. AT 1300Z(0500L) AN EXPLOSION AND FIRE IN THE STORAGE YARD OF BLDG. 251 CAUSED A POSSIBLE RELEASE OF TOXIC MATERIAL TO THE ATMOSPHERE. DETAILS UNKNOWN AT THIS TIME.

THIS IS AN EXERCISE."

THIS IS AN EXERCISE

Attachment No. 2: Information about Exercise Accident

THIS IS AN EXERCISE

YOU ARE TO USE THE ARAC SITE SYSTEM AND RELAY THE FOLLOWING INFORMATION ABOUT THIS EXERCISE ACCIDENT:

"THIS IS AN EXERCISE.

TOXIC CHEMICAL FIRE STARTED 1300Z, IN STORAGE YARD OF BLDG. 251, FIRE EXTINGUISHED AT 1301Z. ALPHA EMISSIONS DETECTED. POSSIBLE HEAVY METAL INVOLVED...POSSIBLY RA-222 AND/OR PU-238."

THIS IS AN EXERCISE

Attachment No. 3: Directive to Use Meteorological Information in Exercise

THIS IS AN EXERCISE

YOU ARE TO USE THE ATTACHED METEOROLOGICAL INFORMATION FOR ANY CALCULATIONS THAT YOU MAY NEED TO MAKE DURING THIS EXERCISE UNLESS DIRECTED OTHERWISE.

THIS IS AN EXERCISE

Meteorological Information

1 UTMX = 613.824 UTMY = 4172.139 Z = 10.000

TIME (Z)	DATA TYPE	WIND SPEED (M/SEC)	WIND DIRECTION (FROM)	SIGMA THETA (DEG)	TEMP (C)	SOURCE HEIGHT (M)
23:45	SA	4.5	237	14.9	9.7	10
23:30	SA	4.2	243	14.7	9.4	10
23:15	SA	4.9	262	13.8	9.0	10
23:00	SA	4.7	260	15.9	9.2	10
22:45	SA	4.9	250	15.4	9.5	10
22:30	SA	4.1	235	14.4	9.8	10
22:15	SA	4.6	239	16.9	9.7	10
22:00	SA	3.3	204	19.3	9.2	10
21:45	SA	3.4	181	11.9	8.3	10
21:30	SA	3.4	216	12.9	7.7	10
21:15	SA	4.1	215	12.6	7.8	10
21:00	SA	6.0	212	11.2	7.5	10
20:45	SA	7.2	209	12.4	8.0	10
20:30	SA	6.9	206	14.1	7.9	10
20:15	SA	4.6	181	12.5	7.3	10
20:00	SA	3.3	198	12.7	7.0	10
19:45	SA	4.1	212	10.0	7.0	10
19:30	SA	5.8	203	11.2	7.1	10
19:15	SA	6.4	204	12.8	7.7	10
19:00	SA	6.1	201	11.9	8.7	10
18:45	SA	6.2	195	11.7	8.5	10
18:30	SA	5.2	195	10.4	7.9	10
18:15	SA	4.9	189	10.9	7.1	10
18:00	SA	2.2	201	250.4	-15.3	10
17:45	SA	3.2	207	80.2	-2.4	10
17:30	SA	5.0	207	13.0	7.6	10
17:15	SA	6.0	207	10.2	8.4	10
17:00	SA	3.7	211	16.5	8.2	10
16:45	SA	5.1	192	11.5	7.7	10
16:30	SA	4.7	213	13.6	7.2	10
16:15	SA	5.9	214	10.0	7.6	10
16:00	SA	4.5	216	10.8	7.8	10
15:45	SA	4.3	215	10.2	7.7	10
15:30	SA	4.1	210	12.9	7.5	10
15:15	SA	2.6	204	13.7	7.1	10
15:00	SA	2.7	186	12.4	7.1	10
14:45	SA	2.5	192	10.0	7.1	10
14:30	SA	2.4	180	9.0	7.1	10
14:15	SA	2.4	176	7.6	7.1	10
14:00	SA	2.0	189	14.1	7.1	10
13:45	SA	2.2	203	11.7	7.0	10
13:30	SA	2.9	194	8.9	7.1	10
13:15	SA	3.1	206	8.3	6.9	10
13:00	SA	2.6	214	10.7	6.9	10
12:45	SA	3.0	208	9.1	7.0	10
12:30	SA	3.7	214	10.4	7.1	10
12:15	SA	3.9	211	9.7	6.9	10
12:00	SA	2.9	211	8.7	6.8	10
11:45	SA	2.8	204	9.8	6.9	10
11:30	SA	3.4	213	9.1	6.7	10
11:15	SA	2.9	228	12.2	6.7	10

Attachment No. 4: Hexafluoride Release Notification

THIS IS AN EXERCISE

THERE HAS BEEN A RELEASE OF "HEXAFLUORIDE" FROM A STORAGE SHED NEAR BLDG. 253 ... SURFACE WINDS ARE FROM 195° AT 2.0 METERS PER SECOND.

THIS IS AN EXERCISE

APPENDIX F

PUBLIC INFORMATION OFFICE SUBSCENARIO AND CHECKLIST

About 1330 hours, Day 1, Garberson phones Public Information Office (PIO) playing TV reporter who hears about serious accident on site. Wants to film accident site, bodies, extent of radiation spread, etc.

At about same time, Judy Bryer (red-badge PIO employee) appears at South Gate playing newspaper reporter. She insists on coming on site for interviews at accident scene.

Both Garberson and Bryer will try to get information out of non-PIO channels—e.g., from Hazards Control, Plant Management, Chemistry, etc.

Tests:

- PIO ability to get and communicate accurate, balanced information quickly.
- Cooperation of Hazards Control, Pass Office personnel, etc., with PIO.
- PIO notification of other communication outlets (e.g., Visitors Center, DOE-SAN PIO).

APPENDIX G

CONTROL ROOM FUNCTIONS

The control room will serve as headquarters for the Control and Umpire Group. It will be staffed by the Exercise Director and his staff and will be open to all Control and Umpire Group personnel.

OPERATIONS

A. Players will not be allowed into the control room unless cleared by the Exercise Director.

B. A log will be kept in written form indicating the following:

1. Description of operation
2. Time of initiation
3. Method of initiation (e.g., Umpire, Fire Chief, etc.)
4. Players involved
5. Time of completion
6. Preliminary grade (1 = outstanding, 5 = dreadful)

A tape recorder will be used for verbal backup of the log.

C. A status chart will be kept in brief form on the blackboard. This can be used for group briefings.

PHOTOGRAPHIC RECORD

A. Photographs will be taken by a roving TID photographer. The photographer will have to be briefed prior to the Exercise.

B. Additional photographs may be taken by Control and Umpire Group personnel.

EQUIPMENT REQUIRED

A. Two radios, one for player net and one for control/umpire net.

B. One telephone and phone book (also Hazards Control phone list).

C. Two tape recorders and extra tapes.

D. Log book, clipboards, pens, pencils, and notepads.

E. Camera and film.

APPENDIX H

RADIOLOGICAL SAFETY EVALUATION FOR SPILL EXERCISE 1980

William C. King

INTRODUCTION

During the first quarter of 1980, an accident exercise will be conducted at LLNL, Livermore site, to train participants and to test the response to a serious accident that results in the spill of radioactive materials and the release of chemically toxic fumes. But the released fumes will not be toxic. A short-lived radioactive material will be used.

The simulated accident will occur in two joined transport containers containing chemical laboratory equipment, such as a glove box and work tables, located outside Building 251 on the east asphalt apron. A liquid containing ^{223}Ra and its daughters will be sprayed into the transport containers and on the asphalt apron near the door to provide realistic radiation-contamination levels. In addition, a multicurie ^{60}Co sealed source will be located inside the transport containers to provide a high-level gamma field. When the response team arrives at the accident scene, it must give the ^{60}Co source immediate attention.

It is desirable to stage this accident exercise as realistically as practicable. However, to minimize the radiation risk to participants and observers and keep the off-site effects negligible, the quantities of radioactive materials used will make it practically impossible for any one individual to receive an annual radiation internal exposure greater than 0.1% of that permitted under the Federal Radiation Protection Guides.* Thus, the administrative limit of exposure for this exercise, lasting approximately 8 to 10 h during a single day, will be established as follows:

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*For LLNL employees, control group, and players, a limit of 100 mrem external gamma radiation will be set for the exercise. This limit is well below the guide line of 3000 mrem per quarter set by DOE regulations and will allow us to use the multicurie ^{60}Co source.

	Participant	Off-site person
Internal exposure (bone)	30 mrem	3 mrem
External exposure (whole body)	100 mrem	0.5 mrem

This report is an evaluation of the radiological hazards associated with staging and executing the accident-training Spill Exercise 1980.

PREPARATION OF THE ^{223}Ra CONTAMINANT

The Nuclear Chemistry Division of LLNL will supply 0.1 mCi ^{223}Ra in solution. The ^{223}Ra is prepared from its parent isotopes, ^{227}Th and ^{227}Ac, by chemical separation. The purity of the ^{223}Ra solution will be assured to contain less than 10^{-4} Ci ^{226}Ra, ^{227}Th, and ^{227}Ac before it will be used in the exercise.

The ^{223}Ra solution will be moved from the nuclear chemistry laboratory in Building 251 to the accident site in a leak-tight shielded container. After arriving at the site, it will be diluted with water to approximately 2.5 gal in a garden-type sprayer. The sprayer will be used to dispense the solution in the areas to be contaminated; about half the solution (50 µCi) will be used to contaminate the asphalt surface near the door of the transport containers and the remainder to contaminate equipment inside them.

HEALTH PHYSICS ASPECTS OF ^{223}Ra DAUGHTERS AND ^{60}Co

^{223}Ra is an alpha emitter with a half-life of 11.43 d. The decay chain of ^{223}Ra passes through five daughters to reach stable ^{207}Pb. All the daughters have short half-lives ranging from 1 ms for ^{215}Po to 36 min for ^{211}Pb. Alpha, beta, and gamma radiations are emitted in the decay of the ^{223}Ra chain. The ^{223}Ra decay chain with the type, energy, and fraction of each radiation emitted is shown in Fig. H-1. The gamma radiation from a 1-Ci point source of ^{223}Ra in equilibrium with its daughters is 0.12 R/h at 1 m (Ref. 1).

After dispersal of the 0.1 mCi of ^{223}Ra and its daughters, the direct radiation hazard is minimal; potential internal contamination of the body is a greater risk.

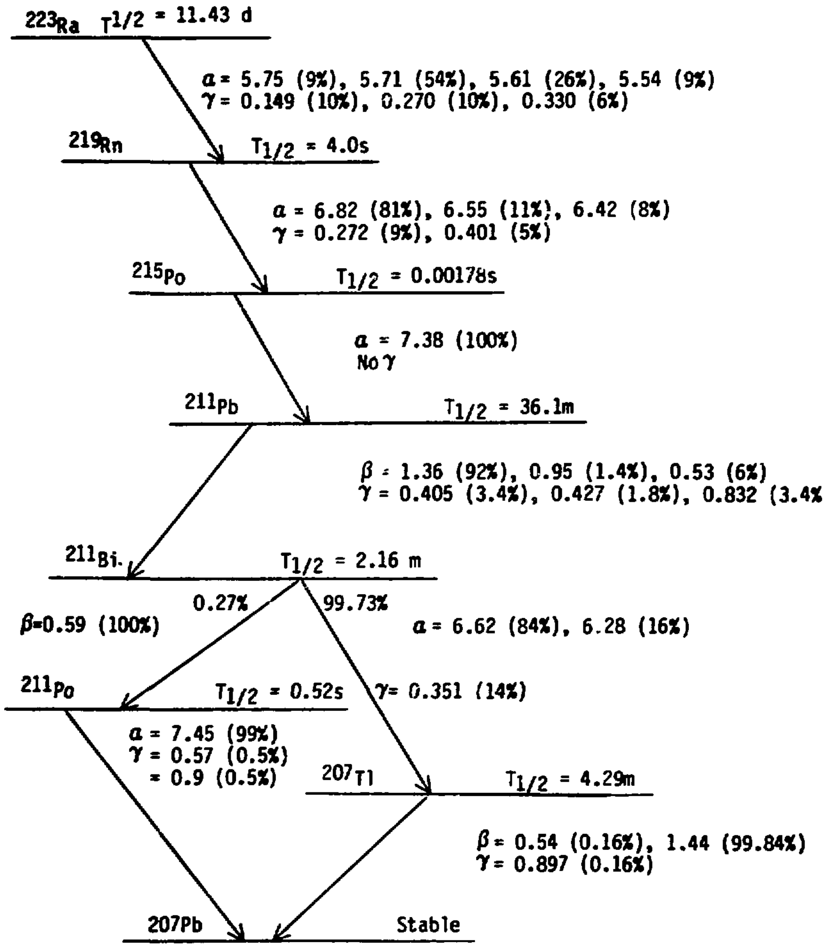

FIG. B-1. The decay chain of ^{223}Ra, showing the types of energy and the fraction of each radiation emitted. For example, in "α = 5.75 (9%)," the maximum α energy is 5.75 MeV and 9% of the disintegrations decay by this mode.

If ^{223}Ra is taken into the body either through inhalation, ingestion, or through a wound, a fraction of the material will translocate from the initial site of deposit to the bone, where it will reside until it decays. This will take several months. The annual exposure to the bone permitted under current Federal Radiation Protection Guides should be no more than 30 rem/y.

In ICRP Publication 2,[2] one finds the following biological data for ^{223}Ra:

- Fraction passing from GI tract to blood = 0.3
- Fraction passing from blood to bone = 0.5
- Effective half-life of isotope in bone = 11.4 d
- Total effective energy for the ^{223}Ra decay chain = 28.0 MeV/disintegration
- Quality Factor (QF) = 10
- Non-uniform distribution factor (n) = 1

Excretion of ^{223}Ra in the urine is given by the equation[3]

$$U = 0.0056(QBD)t^{-1.52} ,$$

where QBD represents the quantity in the blood on day one and time (t) is in days. These data are used in the AERIN Code[4] to follow the transport of ^{223}Ra to the bone, to determine the dose to the bone, and to predict the quantity of activity in the urine at any time after intake.

Because of the short residence time of ^{223}Ra in the bone, the total integrated dose from a single intake is reached within 90 d. That is, the total annual dose to a single intake is accumulated in the first quarter-year after intake.

The multicurie ^{60}Co source used to give a high γ-field will be sealed, so this will present no internal dose hazard. The health physics aspect of using this source is the external whole body gamma radiation exposure it could produce in the exercise participants. Two high-energy gamma rays are emitted per disintegration of ^{60}Co (1.17 MeV and 1.33 MeV). The dose rate at 1 m from 1 Ci of ^{60}Co is 1.2 R/h. The source used will not exceed 10 Ci.

According to the AERIN Code, a single intake by radiation of 2.5 nCi of ^{223}Ra would result in a total integrated dose to the bone of 30 mrem. This is assuming that ^{223}Ra is in a readily soluble form and that the particle size is 1 µm Activity Mean Aerodynamic Diameter (AMAD). A single intake by ingestion of 4.1 nCi would result in a total integrated dose to the bone of 30 mrem. To limit the inhalation intake to 2.5 nCi, no personnel will be exposed to an integrated air concentration of greater than 0.12 $\mu Ci/min \cdot m^{-3}$ without respiratory protection. The integrated air concentration outside the Laboratory fence should not exceed one-tenth this value. From the CPS Code[5] for LLNL, we find that the reduction in the integrated air concentration between the accident site and 412 m downwind (the nearest fence boundary) is 1.4×10^{-3} of the source air concentration.

A very small amount of air activity will be generated during the spraying operation in preparing for the exercise. The nozzles of the sprayer are designed so that aerosol generation is kept to a very small percentage of the liquid being laid down. The total area initially contaminated on the apron will be less than 20 m^2, and the surface contamination will be limited to 2.5 $\mu Ci/m^2$. Therefore, the total amount of surface contamination outside the transport container will be 50 µCi of ^{223}Ra. In the NUWAX-79 operation conducted in April 1979, where these same sprayers were used to spread the contamination, the amount of aerosol generated was less than 0.01% of the material laid down. When this value for aerosol generation is used, the integrated air concentration a few meters downwind from the operation is estimated to be less than 8.3×10^{-5} $\mu Ci/min \cdot m^{-3}$. At the nearest fence line, the integrated concentration will be less than 1.2×10^{-7} $\mu Ci/min \cdot m^{-3}$.

Once the radium solution has dried on the asphalt, some activity in the air could be produced by resuspension of the contaminant. Many factors influence the fraction of material resuspended; e.g., wind velocity over the surface, the amount of traffic disturbance, the length of time the contaminant has been on the surface, the surface material, and the chemical form of the contaminant. No data exist on resuspension factors for radium contamination on asphalt pavements. Resuspension of plutonium contamination on soils has been extensively studied, however.[6] Values have been reported to range from

10^{-7} to 10^{-3} m^{-1}. If we take the most conservative value as applying to paved asphalt (10^{-3} m^{-1}) then the air concentration observable from an infinite surface at 2.5 $\mu Ci/m^2$ would be 2.5×10^{-3} $\mu Ci/m^3$. A working person exposed to this concentration for 8 h would inhale about 2.5 nCi, or the administrative limit established for the exercise.

Air concentrations at the fence line will be 3.5×10^{-6} $\mu Ci/m^3$ at the centerline of the plume. These concentrations integrated over 8 h give 0.12 $\mu Ci/min \cdot m^{-3}$ at the site and 1.7×10^{-6} $\mu Ci/min \cdot m^{-3}$ total integrated exposure concentration.

Part of the practice will be for the accident-response team to control the spread of contamination. The team will be required to decontaminate or to fix the contamination; therefore, no significant resuspension will occur.

The support staff for the exercise will ensure that air samples are taken on the perimeter of the accident site during the spraying operation and again during the actual exercise. This will document the actual air activity generated, and provide data helpful for other exercise planning and for real accidental spills.

Table H-1 summarizes the maximum integrated air activity that might be generated during the exercise. No person should exceed the administrative limits for inhalation of ^{223}Ra during the exercise. However, for added precaution, personnel who are spraying the contaminant and all participants who enter the contaminated area will wear full-face respiratory equipment and full anti-contamination clothing.

The ^{223}Ra could be carried outside the boundaries of the accident site through another possible route. If it should rain after the radioactive contamination has been placed on the asphalt apron, the radioactive material will be carried away with the runoff. One reason Building 251 was selected as the accident site is that runoff is to a 60-m^3 sump, which will prevent the contamination from running into the storm sewer. The surface area draining to this sump is 5810 m^2 and includes the asphalt aprons and the roof area of the building. Therefore, it will take a rainfall of 1.03 cm (0.41 inches) to fill the sump. This much rainfall is not uncommon for the area during the rainy season. However, should the sump fill, a tank truck from Hazards Control Department Waste Disposal will be ordered in to pump out the water and store it until decay of ^{223}Ra is sufficiently low to render the liquid harmless.

TABLE H-1. Maximum integrated air activity that might be generated during the exercise.

Location	During spraying ($\mu Ci/min \cdot m^{-3}$)	Resuspension, conservative ($\mu Ci/min \cdot m^{-3}$)	Administrative limit ($\mu Ci/min \cdot m^{-3}$)
Accident site (apron of Bldg. 251)	8.3×10^{-5}	0.12	0.12
Nearest fence line (412 m west)	1.2×10^{-7}	1.7×10^{-4}	1.2×10^{-2}

If all 50 µCi of ^{223}Ra should drain into the sump and it fills to 60 m^3, the concentration of ^{223}Ra will be 8.3×10^{-7} µCi/ml. A person drinks about 1400 ml of water a day. If the sole source of drinking water for a person was the sump supply, he would ingest 1.2×10^{-3} µCi on the first day. This would result in a total integrated exposure to the bone of 8.5 mrem.

During the exercise and thereafter, the support staff will periodically check the sump. If it approaches the full level, a tank truck will empty the sump and transport the contaminated liquid to the liquid-waste tanks at the decontamination and disposal building on the LLNL site.

The liquid effluent will be held in the sump and in the auxiliary waste tanks (if they are needed) until radioactive decay has reduced the concentration to the level permitted for discharge.

Even if by oversight the sump did pump out to the storm sewer during a heavy rain, the radioactivity will be diluted by other runoff so that the concentration would be less than 7×10^{-7} µCi/ml, the Federal Radiation Protection Guide concentration for discharge of ^{223}Ra to an unrestricted area.

If the ^{60}Co source is used, it will pose a potential risk of external exposure to the players but will have no off-site impact. The exposure rates at various distances from a 10-Ci ^{60}Co source are given in Table H-2.

TABLE H-2. Exposure rates at various distances from a 10-Ci ^{60}Co source.

Distance (m)	Exposure (R/h)
0.48	127
1	11.8
2	2.95
5	0.47
10	0.12

To assure that no player will be exposed above the administrative limit from this source, umpires will closely monitor the exercise and stop the play if the players do not use proper procedures.

CONCLUSIONS

The administrative exposure limit for this exercise is set at 0.1% of the maximum annual exposure limit permitted under current radiation protection guides. By limiting the quantity of ^{223}Ra used in the exercise, the calculations made in this paper show that no person should exceed the administrative limit for internal exposure even if his respiratory equipment fails. Cleanup and fixing of the contamination will occur on the day of the exercise so that no residual effects will be present following the exercise. Umpires will observe closely the manner in which the players take care of the ^{60}Co source and will stop the play unless the players properly store the source in its shielded container.

This exercise can be conducted safely and will provide sufficient realism to give the accident-response crew excellent training and experience.

REFERENCES

1. W. C. King, *Radiological Safety Evaluation Report for NUWAX-79 Exercise*, Lawrence Livermore National Laboratory, Livermore, CA, UCID-18173 (1979).
2. International Commission on Radiological Protection, "Report of ICRP Committee II on Permissible Dose for Internal Radiation (1959) with Bibliography for Biological, Mathematical and Physical Data," *Health Phys.* 3 (1960).
3. International Commission on Radiological Protection, *Report of Committee IV on Evaluation of Radiation Doses to Body Tissues from Internal Contamination Due to Occupational Exposure*, ICRP Publ. 10 (1968).
4. T. J. Powell et al., *AERIN--A Computational Version of the ICRP Lung Model*, Lawrence Livermore National Laboratory, Livermore, CA, UCID-17000 (1976).
5. R. R. Peteson, T. U. Crawford, and L. A. Lawson, *CPS: A Continuous-Point-Source Computer Code for Plume Disperson and Deposition Calculations*, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-52049 (1976).
6. L. R. Anspaugh et al., "Resuspension and Redistribution of Plutonium in Soils," *Health Phys.* 29 (1975).

CJT/cc

APPENDIX I

MEMORANDA

383/114

25171/28794

October 30, 1979

TO: H. W. Patterson

FROM: T. A. Gibson/J. L. Morse

SUBJECT: Briefing Notes and Facts to Support the Use of Radium-223 (half-life 12 days) for the Spring 1980 "Radiation Spill Exercise"

The Hazards Control Department Spring 1980 exercise has as its principal objective to test and train the emergency response organizations of LLL* when they respond to a major spill of radioactive material. The more realistic the exercise: then the better the training, the more interest shown by participants, and the greater the learning and benefit for all personnel involved.

It is proposed to use the radioactive nuclide ^{223}Ra as the contaminant for this exercise. The radiological safety aspects of this alpha emitting nuclide are exhaustively discussed in UCID 18173, "Radiological Safety Evaluation Report for NUWAX-79 Exercise," William C. King (a copy of which is attached).

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*Organizations that will participate are:

Fire Department
Emergency Assistance Team
Field Team Leader and his field team
Police Department
Off-site Sampling Team
ARAC
Public Information Office
Deputy Disaster Control Director (or alternate)
Emergency Control Coordinator (or alternate)

It is proposed to use the fenced-in area adjacent to Bldg. 251. This area lies to the east of Bldg. 251, and the fenced area is accessible only through Bldg. 251 and through a gate near the southwest corner of the fenced area. During the exercise, we propose not to enter Bldg. 251, but rather to use only the gate. The water drainage from this area flows north and then west through a grating covered concrete-lined ditch to a retention tank. The total capacity of the tank can be approximately 50,000 liters (see attached Facility Safety Procedure 251 (Revised June 1, 1979) pages F-1 and F-2).

We propose to place one or two surplus transportainer boxes in the center of the "fenced in area," and then stage these boxes to resemble a chemistry laboratory. The interior of the boxes will be contaminated with ^{223}Ra and this will be the focal point for the exercise. Even if some of the exercise contaminant should get outside of the transportainer boxes and on the blacktop area, the drainage for the area is such that all of the liquid flow will go to the retention sump at the northwest corner of Bldg. 251. The radioactive contaminant will be dispersed in the same fashion as it was for the NUWAX-79 Exercise. No radioactive material will be airborne. This will be achieved by keeping the area suitably damp. Even if it rains during or after the exercise, radiological safety will not be jeopardized because all the surface liquid flow will go to the retention sump. Total quantities and concentrations of ^{223}Ra used in this exercise will not exceed those used in UCID-18173 to assess potential hazards during NUWAX-79.

The undersigned believe that this radionuclide can be used safely, and that its use will help, in a vital and necessary way, to achieve a good exercise. We might add that a spill exercise without a radioactive nuclide would be marginal at best.

T. A. Gibson

J. L. Morse

TAG:JLM:gw

Attachments: UCID-18173
Facility Safety Procedure 251

382

25129

November 12, 1979

TO: V. A. Mode

FROM: H. Wade Patterson

SUBJECT: Preparation of ^{223}Ra Sample

Recent contacts with Mel Coops and Dave Sisson (by Tom Gibson of Hazards Control) indicate that a small amount of ^{223}Ra solution could be made up by Nuclear Chemistry to be used in a spill exercise in the spring of 1980. I would appreciate your approval to go ahead with the preparation at the proper time. An estimate of your people's FTE requirements is also needed. The exact quantity of ^{223}Ra will be determined at a later time. I would also appreciate your maintaining this preparation in strict confidence.

Thank you for your assistance.

H. Wade Patterson, Department Head
Hazards Control Department

HWP:gw

December 14, 1979

TO: All Hazards Control Department Personnel

FROM: H. Wade Patterson

SUBJECT: Exercise - 1980

During the first quarter of 1980, there will be a major scale disaster exercise at the Livermore site. This exercise will require the participation of all elements of the Hazards Control Department as well as the participation of other groups at LLL-Livermore.

This memorandum will be the only announcement concerning the forthcoming exercise.

H. Wade Patterson, Head
Hazards Control Department

HWP:TAG:gw

Distribution:

All Hazards Control Department Personnel
Hazards Control Support
Security Department - Operations Division
J. B. Garberson, Public Information Office
J. B. Knox, G-Division, for ARAC
D. E. Nielsen
J. L. Olsen

383

25141/28795

January 29, 1980

TO: H. Wade Patterson

FROM: T. A. Gibson, Jr./J. L. Morse

SUBJECT: Update on Planning for Spill Exercise 1980

Following your instructions, a ten-man committee has been planning the Hazards Control Department's major exercise for 1980. The undersigned are concerned that the exercise might be cancelled or postponed because of the recent earthquakes. We believe that a cancellation or postponement (postponement is tantamount to cancellation) of Spill Exercise 1980 would not be in the best interests of the Hazards Control Department for the following reasons:

- The January 24 and January 26 earthquakes did not produce radioactive spills of consequence; thus, no experience or training in response to a major radioactive spill has occurred. The exercise being planned is strongly oriented toward a spill of radioactive material. Our Health and Safety Technicians and other Hazards Control Department personnel still need training in this type of emergency response.

- The Nuclear Chemistry Division has granted your Department permission to use their fenced in area to the east of Bldg. 251 for the exercise. This area is available for use only prior to March 1, 1980. After then, the area will not be available until after the upgrade of Bldg. 251 or about June 1981. The fenced in area east of Bldg. 251 is the only truly suitable area on site for the planned exercise.

- The exercise, unlike response to the recent earthquakes, will be observed and monitored by the Hazards Control Department Head and his exercise control and umpire group. Correct as well as incorrect actions will be observed. Thus, the Hazards Control Department will materially benefit from the learning experience and ensuing critique.

- The exercise command and control group extends no higher than the acting head of Hazards Control Department on the day of the exercise. Other LLL groups are participating on a voluntary basis. Their participation is not central to a successful exercise. Some, such as PIO and Medical, will probably not participate.

The undersigned recommend that the exercise planning continue and that the exercise be conducted on one of the planned time window days; i.e., February 19, 20, 21 or 26, 27, 28.

T. A. Gibson, Jr.

J. L. Morse

TAG:JLM:gw

THIS IS AN EXERCISE

LAWRENCE LIVERMORE LABORATORY

Operational Safety Procedure
Effective: 2/19/80
No. 251 Sp Ex-80
Expires: 3/19/80

TITLE: Hazards Control Department Spill Exercise - 1980

INTRODUCTION:
Reason for Issue: To control in a safe manner an exercise involving and emitting radioactive materials and other materials.

RESPONSIBILITIES:
James L. Morse is responsible for implementing the controls set forth in this safety procedure and observance of applicable Laboratory safety standards in order to provide for the safety of this operation. His alternate is Thomas A. Gibson, Jr.

GENERAL DESCRIPTION:
Location: Between Bldg. 255 and Bldg. 251
Operations Authorized: All Hazards Control Department work and clean up procedures necessary to render the area free from radioactive material and/or other hazardous material.

HAZARDS ANALYSIS: High level gamma fields will be present and alpha emitting radioactive nuclides will be spilled (intentionally) at the exercise location.

MATERIAL CONTROLS:

One or more of the following radioactive materials will be present:

Co-60, Sr-90, Ir-192, Cm-244, Pu-239, Ra-223, Pb-212, Ra-228

Criticality Safety: Not applicable

OPERATING & PERSONNEL CONTROLS:

1. All LLL Health and Safety Manual and DOE Manual Chapters and orders will apply and be observed. LLL Disaster Control Plan Supplement No. 6, "Emergency Assistance Team" will be followed by Exercise players.

2. "Radiological Safety Evaluation for Spillex-1980" by William C. King, February 1980, will apply (this document not available to Exercise players).

3. If necessary, phone the following:

   a. Wesley W. Hayes, Jr. Ext. 2-7862

   [illegible] [illegible]47-6427

   b. William H. Hutchin Ext. 2-0451

   Home 582-3646

Distribution:

____
RESPONSIBLE INDIVIDUAL:

____
HAZARDS CONTROL:

____
AUTHORIZING INDIVIDUAL:

THIS IS AN EXERCISE

THIS IS AN EXERCISE

N O T I C E

THIS LABORATORY IS UNDER THE CONTROL OF:

WESLEY N. HAYES, JR.

PHONE: OFFICE 2-7862

HOME 447-6427

AND

WILLIAM H. HUTCHIN

PHONE: OFFICE 2-0451

HOME 582-3646

IF YOU NEED HELP OR ASSISTANCE, OR IN EVENT OF AN EMERGENCY, PHONE ONE OR BOTH OF THE ABOVE.

OTHERWISE, KEEP OUT!

THIS IS AN EXERCISE