PNL-3935
UC-11

An Increment of Analysis

Estimated Airborne Release of Plutonium from Atomics International's Nuclear Materials Development Facility in the Santa Susana Site, California, as a Result of Postulated Damage from Severe Wind and Earthquake Hazard

September 1981

Prepared for
Division of Environmental Impact Studies
Argonne National Laboratory
under Contract DE-AC06-76-RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute

Battelle

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PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
Under Contract DE-AC06-76RLO 1830

Printed in the United States of America
Available from
National Technical Information Service
United States Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151

Price: Printed Copy $______*; Microfiche $3.00

*Pages	NTIS Selling Price
001-025	$4.00
026-050	$4.50
051-075	$5.25
076-100	$6.00
101-125	$6.50
126-150	$7.25
151-175	$8.00
176-200	$9.00
201-225	$9.25
226-250	$9.50
251-275	$10.75
276-300	$11.00

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ESTIMATED AIRBORNE RELEASE OF PLUTONIUM FROM ATOMICS INTERNATIONAL'S NUCLEAR MATERIALS DEVELOPMENT FACILITY IN THE SANTA SUSANA SITE, CALIFORNIA, AS A RESULT OF POSTULATED DAMAGE FROM SEVERE WIND AND EARTHQUAKE HAZARD

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September 1981

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Argonne National Laboratory
under Contract DE-AC06-76-RLO 1830

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(a) Advanced Fuel and Spent Fuel Licensing Branch
Division of Fuel Cycle and Material Safety
U.S. Nuclear Regulatory Commission

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SUMMARY AND CONCLUSIONS

The potential mass of airborne releases of plutonium (source term) that could result from wind and seismic damage is estimated for the Atomics International Company's Nuclear Materials Development Facility (NMDF) at the Santa Susana site in California. The postulated source terms will be useful as the basis for estimating the potential dose to the "maximum" exposed individual by inhalation and to the total population living within a prescribed radius of the site. The respirable fraction of airborne particles is thus the principal concern.

The estimated source terms (Table 1) are based on the damage ratio, i.e., the fraction of enclosures crushed or punctured during events of varying severity, and the potential airborne releases if all enclosures suffer particular levels of damage. In an attempt to provide a realistic range of potential source terms that include most of the normal processing conditions, a "best estimate" bounded by upper and lower limits is provided. The range of source terms is calculated by combining a high best estimate and a low damage ratio, based on a fraction of enclosures suffering crush or perforation, with the airborne release from enclosures based upon an upper limit, average, and lower limit inventory of dispersible materials at risk. Two throughput levels are considered. The factors used to evaluate the fractional airborne release of materials and the exchange rates between enclosed and exterior atmospheres are discussed.

The postulated damage and source terms are discussed for wind and earthquake hazard scenarios in order of their increasing severity.

The largest postulated airborne releases from the NMDF are for the maximum wind hazard (nominal windspeed 170 mph) and for linear acceleration exceeding 0.55 g. Both scenarios postulate virtual complete loss of the structure excluding the vault. Wind and earthquake hazards using higher windspeeds or linear accelerations should not result in substantially greater source terms. The source terms are expressed as mass of plutonium particles, 10 μm aerodynamic equivalent diameter or less, released up to 4 days after the events.

Because of the small inventories routinely found in the facility and the use of a batch process, the instantaneous airborne release for the maximum wind and earthquake scenarios is dominated by the postulated release from crushing of the glovebox exhaust filters.

TABLE 1. Source Term Estimates for AI's Nuclear Materials Development Facility Due to Wind and Earthquake Hazard

EVENT	MASS RELEASE OF PLUTONIUM IN THE RESPIRABLE SIZE RANGE[(a)], g		
	UPPER BOUND	AVERAGE	LOWER BOUND
WIND HAZARD			
NOMINAL WINDSPEED 110 mph (49.2 m/sec), $3x10^{-6}$ PER YEAR PROBABILITY OF OCCURRENCE			
INSTANTANEOUS	-	-	-
ADDITIONAL MASS RELEASED IN NEXT 2 HOURS	0.003	-	-
ADDITIONAL MASS RELEASED IN NEXT 6 HOURS	0.009	-	-
ADDITIONAL MASS RELEASED IN NEXT 16 HOURS	-	-	-
ADDITIONAL MASS RELEASED IN NEXT 3 DAYS	-	-	-
NOMINAL WINDSPEED 130 mph (58.1 m/sec), $8x10^{-7}$ PER YEAR PROBABILITY OF OCCURRENCE			
INSTANTANEOUS	0.01	0.005	0.003
ADDITIONAL MASS RELEASED IN NEXT 2 HOURS	0.003	$1x10^{-5}$	$1x10^{-5}$
ADDITIONAL MASS RELEASED IN NEXT 6 HOURS	0.009	$3x10^{-5}$	$3x10^{-5}$
ADDITIONAL MASS RELEASED IN NEXT 16 HOURS	$8x10^{-5}$	$8x10^{-5}$	$8x10^{-5}$
ADDITIONAL MASS RELEASED IN NEXT 3 DAYS	$4x10^{-4}$	$4x10^{-4}$	$4x10^{-4}$
NOMINAL WINDSPEED 150 mph (67.1 m/sec), $4x10^{-7}$ PER YEAR PROBABILITY OF OCCURRENCE			
INSTANTANEOUS	0.03	0.02	0.02
ADDITIONAL MASS RELEASED IN NEXT 2 HOURS	0.003	$4x10^{-4}$	$4x10^{-4}$
ADDITIONAL MASS RELEASED IN NEXT 6 HOURS	0.009	0.001	0.001
ADDITIONAL MASS RELEASED IN NEXT 16 HOURS	———	0.001	———
ADDITIONAL MASS RELEASED IN NEXT 3 DAYS	———	0.02	———
NOMINAL WINDSPEED 170 mph (76 m/sec), $1x10^{-7}$ PER YEAR PROBABILITY OF OCCURRENCE			
INSTANTANEOUS	4.	4.	4.
ADDITIONAL MASS RELEASED IN NEXT 2 HOURS	0.02	0.004	0.003
ADDITIONAL MASS RELEASED IN NEXT 6 HOURS	0.06	0.01	0.01
ADDITIONAL MASS RELEASED IN NEXT 16 HOURS	0.02	0.03	0.03
ADDITIONAL MASS RELEASED IN NEXT 3 DAYS	0.7	0.2	0.2
EARTHQUAKE HAZARD			
LINEAR ACCELERATION LESS THAN 0.55g, GREATER THAN $2x10^{-3}$ PER YEAR PROBABILITY OF OCCURRENCE	NO SIGNIFICANT DAMAGE RESULTING IN AIRBORNE RELEASE		
LINEAR ACCELERATION EXCEEDING 0.55g, 0.6 g HAS A 1.3×10^{-3} PER YEAR PROBABILITY OF OCCURRENCE			
INSTANTANEOUS	4.	4.	4.
ADDITIONAL MASS RELEASED IN NEXT 2 HOURS	0.02	$4x10^{-5}$	$4x10^{-5}$
ADDITIONAL MASS RELEASED IN NEXT 6 HOURS	0.06	$1x10^{-4}$	$1x10^{-4}$
ADDITIONAL MASS RELEASED IN NEXT 16 HOURS	0.2	$3x10^{-4}$	$3x10^{-4}$
ADDITIONAL MASS RELEASED IN NEXT 3 DAYS	0.7	0.002	0.001

(a) PARTICLES 10 μm AND LESS AERODYNAMIC EQUIVALENT DIAMETER

\- LESS THAN 10^{-7}g PLUTONIUM

INTRODUCTION

If the structure and equipment that contain radioactive materials fail because of the stresses imposed by the impact of a natural phenomenon, the downwind population can be subjected to a radiological hazard from the airborne material. The estimated airborne releases of contained radioactive material form the basis for calculating the radiation dose, which is one component of an overall risk analysis.

This report is a part of an interdisciplinary study sponsored by the United States Nuclear Regulatory Commission (NRC) and coordinated by the Division of Environmental Impact Studies of the Argonne National Laboratory (ANL). It is one increment in a series dealing with the potential airborne releases of plutonium from licensed plutonium fuel-fabrication facilities. The study estimates the potential release from the Atomics International NMDF at Santa Susana, California, as the result of a severe wind and earthquake hazard.

The estimates of airborne plutonium releases were developed by identifying the damage sustained by the structure and equipment at varying severities of wind and earthquake. The Pacific Northwest Laboratory (PNL)[a] staff used data developed by other specialists. The description of the facility was provided by the Engineering Decision Analysis Company (EDAC 1978a) as was data on the potential responses of the structure and equipment to various severities of earthquake hazard (EDAC 1978b). The Disaster Research Institute at Texas Tech provided similar information for wind hazard (Mehta, McDonald and Alikhanlow 1980).

The primary concern in the calculation of downwind dose for this study is inhalation (McPherson and Watson 1978, p. 3). In this increment of the series the primary emphasis is the release of plutonium particulate material of a size range that can be carried downwind and inhaled. Particles of 10-μm

(a) Pacific Northwest Laboratory is operated for the U.S. Department of Energy by Battelle Memorial Institute.

aerodynamic equivalent diameter (AED)[a] or less are conservatively assumed to be the respirable fraction. Such an assumption overstates the potential effect by a factor of 1.5 to greater than an order of magnitude, depending upon the lung deposition model chosen (Mercer 1977, Figure 1). The behavior of the structure and equipment in accident situations is not precisely understood. With such uncertainties, the estimates of airborne releases tend to be conservative, that is, estimates are probably greater than the releases that would actually be experienced.

(a) Aerodynamic equivalent diameter: Particles exhibiting the aerodynamic behavior of a unit density sphere of the stated size.

BUILDING AND PROCESS DESCRIPTION

The first step in estimating the potential airborne releases of plutonium is to find out what materials and equipment are present and to identify those features and operations that could influence the material released. The information was gathered from documents issued by Engineering Decision Analysis Company (EDAC), the NRC, and PNL. This information includes descriptions of the structure and of the process (which influences the types and locations of equipment). The amounts and forms of materials present and information on engineered safety systems are also included.

BUILDING DESCRIPTION (EDAC 1978a)

The NMDF (055 Building) is a one story, windowless, tilt up, concrete building located in the Atomics International Nuclear Development Field Laboratory, which is in the southeastern portion of Ventura county, 29 miles northwest of downtown Los Angeles (AI 1976). The site is in a pocket in the Simi Hills, 800 ft to 1000 ft above the populated valley floor (AI 1976) and is in a relatively remote mountain site (NRC 1980).

The building is rectangular, 202 ft long (north-south direction) by 60 ft wide (east-west direction) by 17 ft high. Figure 1 is a plan of the building. The floor is a concrete slab on grade. Steel "I" beams, 20 ft between centers, support the concrete tilt-up panels (20 ft x 17 ft) that are tied together by concrete inserts welded to the main building columns. The panels are also supported by the column footings. Lightweight concrete-filled roof panels (20 ft x 2 ft) are welded to roof beams running in an east-west direction (60 ft), which are supported by the main building column. The interior partitions are of metal-stud construction with gypsum-board faces. There are several doors in the exterior walls of the facility. The two standard size doors in the east and west exterior walls of the glovebox room are protected by concrete enclosures from wind-generated missiles.

The vault is attached to the southern corner of the west exterior wall of the Glovebox Room and is an 11-ft-square, cast-in-place concrete box.

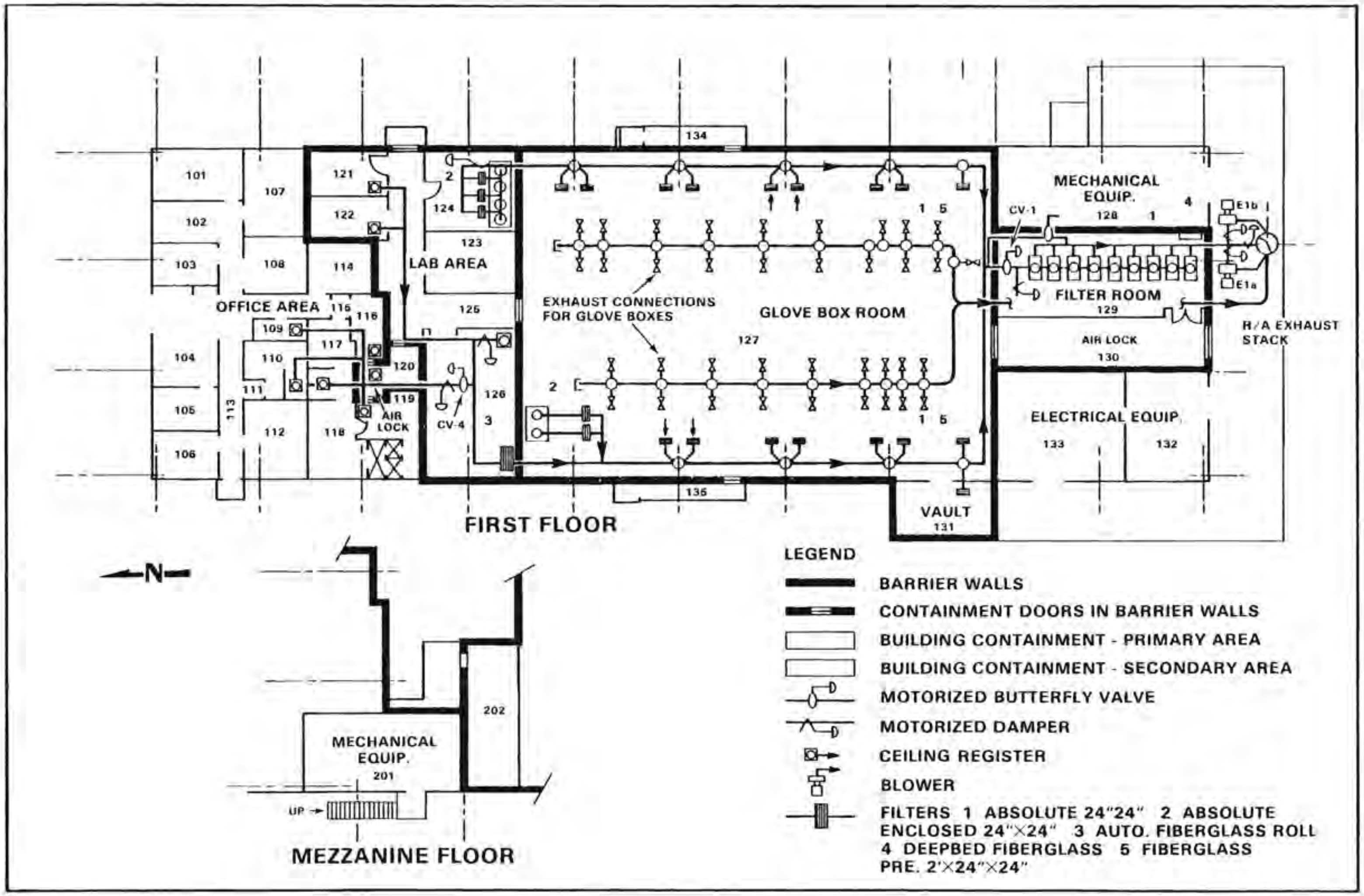

FIGURE 1. Plan View of NMDF and Schematic of Exhaust System

GLOVEBOX ROOM

The glovebox room occupies the central portion of the NMDF and is rectangular. Its plan dimensions are 60 ft x 90 ft. Part of the mezzanine (Rm 202) is open to the glovebox room. Figure 2 shows the arrangement of the two glovebox lines that, along with the process and argon-purification equipment, are the principal items in the room. The gloveboxes are constructed of 3/16-in. stainless steel with 3/8-in. plexiglas windows. The designation and dimensions are given in Table 2.

PROCESS DESCRIPTION

The NMDF is an experimental facility for the development of mixed-carbide fuel. The batch process used in the facility is shown in Figure 3. Only 10 to 12 batches were processed during the last year of operation (see Attachment A) and, for the purposes of this analysis, each batch is assumed to need 1 week of 8-h/day operation to be processed. The quantity of radionuclides at risk is shown in Table 3. Due to the differences in toxicities, only the plutonium is considered (10 CFR 20 APP B). The quantity of flammable materials that can be located in the facility are shown in Table 4.

ENGINEERED SAFEGUARDS

Ventilation and Exhaust (Mishima 1980)

Room air is supplied via diffusers set near the ceiling of the Glovebox Room. Room air is exhausted via 2 ft x 2 ft HEPA filters in the risers near floor level along the east and west walls. The exhaust is carried by sheet metal ducts at ceiling levels. Most of the inert gas (glovebox atmosphere) recycles through a purification system. Only enough gas is exhausted to maintain a preset negative pressure. The few gloveboxes having an air atmosphere extract room air via HEPA filters and exhaust into the stainless steel exhaust ducts running over each glovebox line. The room glovebox exhausts are joined in Room 130 (Filter Room). The system is shown in Figure 1.

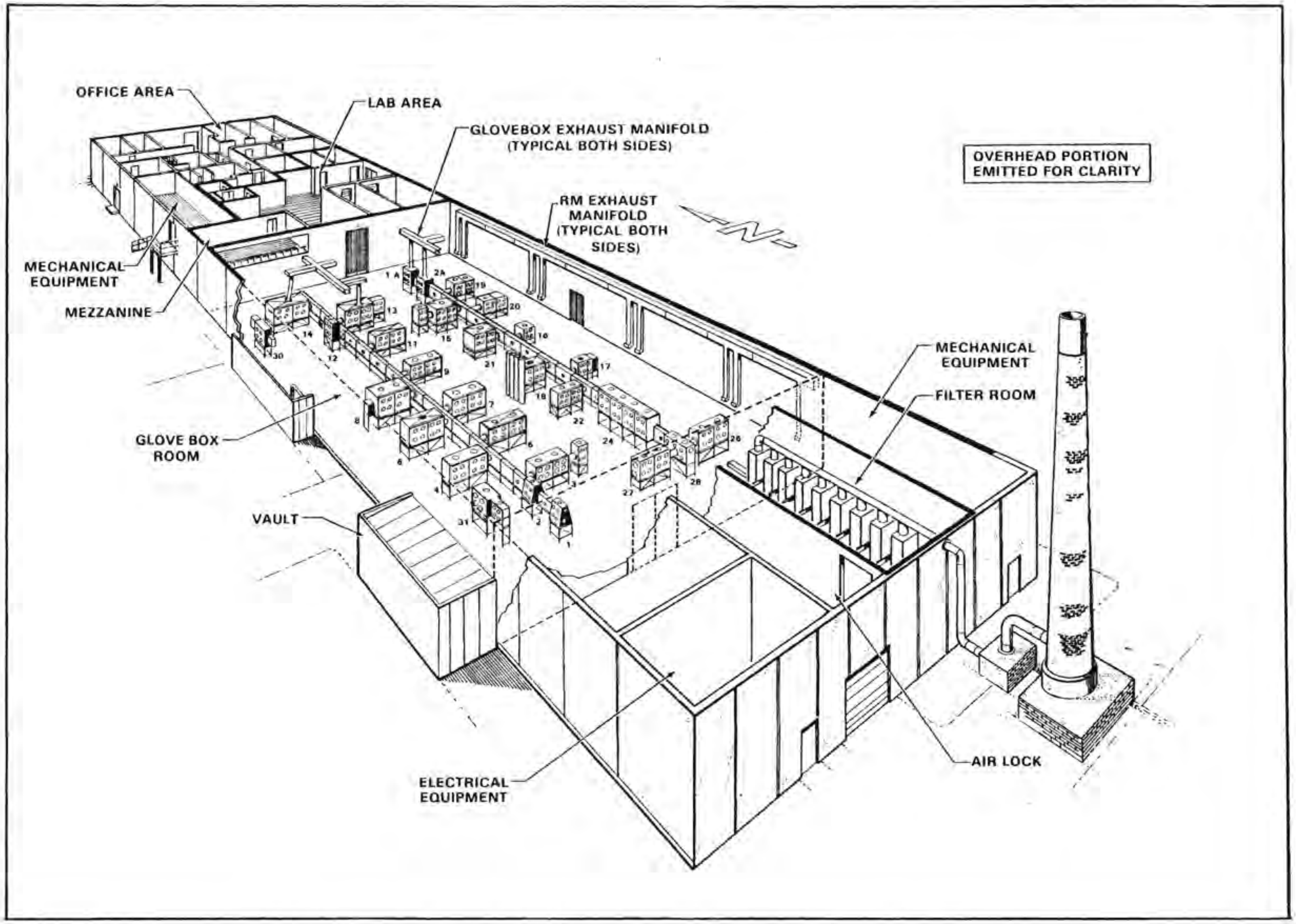

FIGURE 2. Isometric Drawing of NMDF with Glovebox Arrangement

TABLE 2. Summary of Data for Glove Boxes

Glove Box Name	Station No.	Box No.	Box Size (in. x in. x in.)	Comment
Air entrance	1	K-1	36 x 30/23 x 33	Trapezoid side
Air entrance	1A	K-1A	36 x 30/23 x 33	23 in.--upper dimension
Inert gas entrance	2	K-2	36 x 30/23 x 33	30 in.--lower dimension
Inert gas entrance	2A	K-2A	36 x 30/23 x 33	
Blend box	3[a]	K-3	84 x 42 x 42	
Weight box	3A	K-3A	42 x 42 x 48	
Unload box--sinter furnace	4[b]	B-1	84 x 30 x 42	
Dry and mill box	5[b]	K-11	84 x 42 x 42	
Load box--sinter furnace	6[b]	B-2	84 x 30 x 42	
Press box	7[b]	K-7	84 x 42 x 48	2-in.-thick steel plate installed in the box
O.D. grind box	8[b]	K-8	84 x 42 x 48	2-in.-thick steel plate installed in the box
Granulator and screening box	9	K-6	84 x 42 x 42	
Transfer box	10	B-3	42 x 24 x 42	
Inspection box	11	B-8	84 x 42 x 48	
Weigh box	12	K-12A	42 x 24 x 42	
Pin-loading box	13	K-12	84 x 42 x 42	
Waste-packaging box	14	K-14	84 x 42 x 42	
Dissolution and sample preparation	15[b]	K-15	84 x 42 x 42	

TABLE 2. (contd)

Glove Box Name	Station No.	Box No.	Box Size (in. x in. x in.)	Comment
Balance box	15A	K-15A	42 x 24 x 42	
X-ray fluorescence box	16(b)	K-16	42 x 42 x 42	
Emission spectrograph half box	17(b)	K-17	42 x 42 x 42	
Arc spark box	17A	K-17A	42 x 24 x 42	
Inert gas fusion box	18(b)	K-18	84 x 42 x 42	
Metallography preparation	19(b)	K-19	84 x 42 x 42	
Metallography observation	20(b)	K-20	84 x 42 x 42	
Wet-chemistry box	21(b)	K-21	84 x 42 x 42	
TGA equipment box	22(b) 23	K-5	84 x 42 x 42	
Power-processing box	24	K-13	142 x 45 x 48	
Sintering-furnace box	26	K-4	84 x 42 x 48	
Pellet pressing and granulator	27	K-9	84 x 42 x 42	
Transfer box	28	B-4	69 x 24 x 42	
Arc-casting box	29	K-5	72 x 42 x 42	
Fuel pin-weld box	30	B-7	48 x 32 x 33	
Glovebox (AEC)	31(a)		84 x 42 x 42	

(a) Boxes of primary concern.
(b) Boxes of secondary concern.

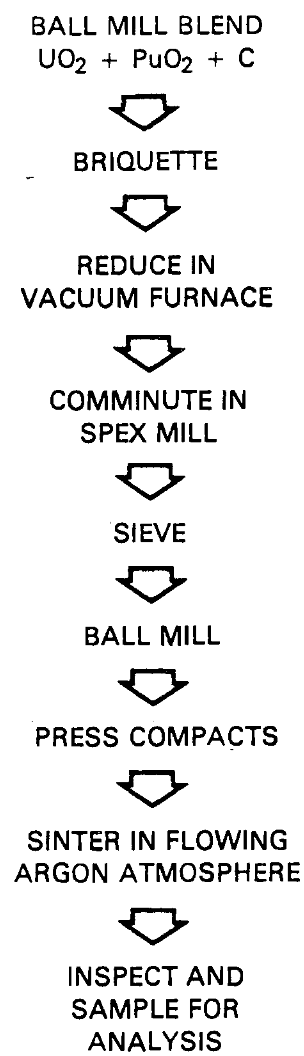

FIGURE 3. Mixed-Carbide-Process Flow Diagram

TABLE 3. Inventory-at-Risk

Glove Box No.	Process Operations	Amount of Radionuclide Normal Processing Pu, g	U-235, g	Physical Form	Chemical Compounds[(a)]	% of Time in Process Step
3	Batching, Slugging	225	540	Powder	A, B	20
4	Carbothermic reduction	0 to 120	0 to 350	Slugs	A, B, C	10
5	Size reduction	0 to 120	0 to 350	Powder	C	20
6	Sintering	0 to 120	0 to 350	Pellets	C	10
8	Pressing and inspection	0 to 120	0 to 350	Powder and pellets	C	40
7	None	0	0	---	---	---
15	Coulometry	10	40	Dissolved in solutions	A, B, C	
16	None	---	---	---	---	---
17	Emission Spectroscopy	1	1	Crushed pellets	A, B, C	---
18	Carbon analysis	20	80	Powder	A, B, C	---
19	Metallography	2	8	Pellets	C	---
20	Metallography	20	80	Pellets	C	---
21	Oxygen analysis	2	5	U-Pu-Pt	C	---
22	Thermogravimetric	100	400	Solidified waste	Analytical solutions solidified in bentonite clay--stored until disposed of	---
13	Storage of Fuel Pellets	0 to 360	0 to 1050	Pellets	C	

(a) A = PuO_2, B = UO_2, C = Mixed (Pu - U) Carbide as ____ U--20% Pu.

TABLE 4. Amounts of Combustible Materials in Room 127

Material	Normal Amount	Maximum Amount
Methanol	500 ml	1000 ml
Benzene	0	0
Vacuum oil	20 gal	20 gal
Lapping oil	500 ml	1000 ml
Carbowa	0	0
Epoxy	1 qt	2 qt
Kimwipes		
Kim towels	10 lb	15 lb
Cardboard		
Paper sacks		
PVC sheet	100 lb	224 lb
PVC bags	30 lb	40 lb
Spray paint	30 oz	40 oz
Film	0.5 lb	1.0 lb
Sodium	50 g	200 g

Exhaust air passes through three banks of HEPA filters held in nine sheet metal enclosures. The volume of the glovebox room is approximately 2.06 x 10^5 ft^3 and, at a rated flow of 9,000 cfm, the system produces five air changes per hour in that room. The exhaust fans and stack are not attached to the building.

Fire Protection System

Fire protection is provided by thermal detectors (rate-of-rise detectors) in each glovebox and smoke detectors in the NMDF at the ceiling level. Dry extinguishers are located throughout the NMDF. The pipe for a sprinkler system has been installed. Both thermal and smoke detectors are provided in the vault.

AREAS OF CONCERN

The handling of (Pu + U)-C presents some additional potential hazards. Small quantities of plutonium can become volatile during high-temperature operations (Burnham, Skardahl and Chikalla 1964; Paffreyman and Potter 1964) and may accumulate in equipment. Plutonium carbide oxidizes slowly in air at 200° to 300°C and burns brightly at 400°C (Cleveland 1967). Plutonium carbide has remained in air at ambient temperature for 2 months with no reaction (Cleveland 1967). The ignition temperature of uranium carbide decreases with increased surface (Snowdon et al. 1964) and the plutonium carbide is more reactive than the uranium (Cleveland 1967). Oxidation, with or without ignition, can convert large pieces such as pellets to loose powder.

The quantities and forms of plutonium and uranium as well as the processing activities in each glovebox in the NMDF are shown in Table 1. The greatest quantity of plutonium in the most dispersible form present in the NMDF (loose powder) is listed for glovebox #3, batching and slugging. Glovebox #5 holds a lesser quantity of plutonium but in the form of a (Pu + U)-C powder. Glovebox #8 likewise may contain (Pu + U)-C powder before being pressed into pellets. Gloveboxes #4 and #6 hold comparable amounts of (Pu + U)-C but as bulk solids (slugs and pellets). Thus, the gloveboxes are rated in order of decreasing concern:

- Glovebox #3--Batching and Slugging
- Glovebox #5--Size Reduction
- Glovebox #8--Pressing and Inspection
- Glovebox #4--Carbothermic Reduction
- Glovebox #6--Sintering

The remaining boxes in the system are analytical boxes holding lesser quantities of plutonium and uranium.

DAMAGE SCENARIOS

Once the significant features of the facility are defined, the damage leading to loss of containment and the stresses on the contained material that can make them airborne must be described. The damage to the structure and equipment from the impact of increasing levels of wind and earthquake hazard has been assessed. The wind damage response developed by Mehta, McDonald and Alikhanlou (1980) ranged from minimal damage to a glovebox to failure of the entire building. The only earthquake building damage leading to a significant airborne release of Pu was a failure of the entire building (EDAC 1978b).

WIND DAMAGE (Mehta, McDonald and Alikhanlou 1980, pp. 32-34)

Nominal Windspeed of 110 (49.2 m/sec); 3 x 10^{-6}/yr Probability of Occurrence

One of the two standard doors in the exterior walls of the glovebox room fails due to a change in air pressure. The enclosure around the outside of the door prevents the entry of wind-generated missiles, but wind could circulate through the room resulting in minimal damage to gloveboxes and filters.

There is no significant damage to the filter room or vault.

Nominal Windspeed of 130 mph (58.1 m/sec); 8 x 10^{-7}/yr Probability of Occurrence

Failure of the exterior doors could cause the collapse of interior partitions in the Filter Room. Debris from the wall could strike the filter enclosures. No significant damage to the vault is found.

Nominal Windspeed of 150 mph (67.1 m/sec); 4 x 10^{-7}/yr Probability of Occurrence

One or two gloveboxes could be crushed by the failure of the interior partitions in the north or south end of the glovebox room. The roof and exterior walls in this area remain intact.

Collapsing beams could strike enclosures. Small portions of the roof deck may collapse along with the beams. No damage to the vault is found.

Nominal Windspeed of 170 mps (76 m/sec); 1 x 10^{-7}/yr Probability of Occurrence

Collapse of roof causes collapse of exterior walls. All gloveboxes, filters and filter enclosures are crushed. No significant damage to the vault occurs.

EARTHQUAKE DAMAGE (EDAC 1978b, pp. 52-53)

Linear Acceleration of 0.2 to 0.35 g; 1 x 10^{-2}/yr Probability of Occurrence

No significant damage leading to airborne release occurs.

Linear Acceleration of 0.35 to 0.55 g; 2 x 10^{-3}/yr Probability of Occurrence

No significant damage leading to airborne release occurs.

Linear Acceleration in Excess of 0.55 g; 0.6 g has 1.3 x 10^{-3}/yr Probability of Occurrence

Exterior walls fail at 0.6 g causing the roof to collapse. Gloveboxes (filters and filter enclosures) are crushed. The vault remains intact at levels exceeding 2 g.

APPROACH AND FACTORS USED IN ESTIMATING SOURCE TERMS

Once the damage to the facility and equipment is assessed, source terms are estimated to provide data for the calculation of potential radiation dose to the general population. A principal concern is the quantity of particulate material in the size range that can be transported downwind, inhaled by humans and deposited in the lungs. The quantity of material made airborne by an event depends on the quantity of hazardous material placed in jeopardy by the event and the type and level of stress imposed. The fraction of material made airborne that is released from the facility depends on the number of barriers between the airborne material and the outdoors and the transmission of airborne material through the barriers. The factors used in estimating the source terms are discussed below.

INVENTORY AT RISK

The quantity of plutonium placed in jeopardy by the impact of severe winds and earthquakes comes from two sources--process materials and process materials that have been relocated and accumulated at other locations. Plutonium is placed in jeopardy only if the primary barrier (i.e., glovebox, filter enclosure, etc.) loses its integrity. The inventory is considered according to three assumptions--presence of the maximum, the average and no process materials. Relocated process materials are assumed to always be present. The fraction of time the process material will be found at the locations is also a consideration.

Process Inventories of Plutonium

The quantity of plutonium that could be located in the various gloveboxes in the glovebox room of the NMDF is shown in Table 2. Since the carbide-fuels operation is a batch process, the plutonium used can only be in one location at a time. (The percent of processing time that quantity would be present at that location is also shown.) Only 10 to 12 batches of fuel were processed during the final year of operation (see Attachment A). A 1-shift, 5-d/wk operation is assumed and a 1-wk period is required to process a batch. Thus, the process materials are only in jeopardy 40 h/168 h week x 12 wk/52 wk per year, or about 5.5% of the time.

Relocated Process Materials Inventories

Surface Contamination

The level of surface contamination estimated for the principal process gloveboxes (#3, 5, 7 and 9) based upon the quantity of Pu + U^{235} picked up by wiping the surfaces is 5×10^{-9} g Pu/cm^2 (5×10^{-5} g Pu/m^2) and 2×10^{-8} g U^{235}/cm^2 (2×10^{-4} g U^{235}/m^2) (see Attachment A). The level of contamination in other gloveboxes is estimated to be a factor of 10 lower and the level of uncertainty was estimated to be up to several hundred percent. A surface contamination level based upon the visibility of deposited powders, 7.5 g powder/m^2, has been assumed for previous studies of mixed-oxide fuel-fabrication facilities (Mishima, Schwendiman and Ayer 1978, Mishima et al. 1980, and Mishima and Ayer 1980). A conservative value, 200 times the estimated value, of 1×10^{-4} g Pu/m^2 was applied for this study.

Filters

A maximum "average" loading of 1 g Pu for glovebox exhaust filters, with a maximum loading of 4 g Pu at change out, has been reported (Westinghouse 1974, pp. 5.1-5.13). This value will be applied for all glovebox exhaust filters for this study.

The potential accumulation of Pu in downstream filters are estimated using the assumption that the transmission through the initial filter is 5×10^{-4} and that filters in the final filter banks are not changed as frequently as upstream filters. If 5×10^{-4} g Pu accumulate in the second filter for each 1 g accumulated on the initial filter, and the second filter remains in the place for 100 filter changes, its loading would be 0.05 g Pu. A value of 0.1 g Pu is applied for the loading of the initial HEPA filters of the final bank, 0.05 g for the second filter, and 0.01 g Pu for the third filter.

In two of the situations above, glovebox surface contamination and exhaust filter, most of the material accumulated would be in the form of carbides. Because of the fine size of the materials deposited due to the low, intermittent exhaust flow and the presence of trace quantities of oxygen in the inerting gas, conversion to PuO_2 appears to be virtually certain with time. The airborne contamination released to the exhaust system is a fine particle in an air atmosphere and is probably rapidly converted to oxide. Thus, both surface contamination and material accumulated on filters are considered oxides.

DAMAGE RATIO

Damage ratio is a term used to denote the fraction of enclosures damaged to the two levels of loss of integrity used in this study--perforation and crush. Perforation is defined as:

> "Perforation of the glove box: Pieces of timber, concrete blocks, loose pieces of pipe or equipment could strike a glove box, causing an opening in the glove box window. Plutonium stored in canisters is not likely to be released in this case, but loose material in powder form could possibly escape the confines of the glove box. Failure of an exterior wall could allow the wind to circulate throughout the building, causing loose objects to be thrown against the glove boxes. Windborne debris could cause missile impact on the glove box and may cause perforation of the glove box." (Mehta, McDonald and Alikhanlou 1980, p. 25)

Crush is defined as:

> "Crushing of glove box: If a heavy object falls on the glove box, structural members of the box may collapse resulting in the glove box being crushed. This event could occur if a load-bearing wall or building frame should collapse, thus allowing the roof structure to fall downward. In this case, the roof integrity of the glove box would be violated. The material inside the glove box would be exposed to the atmosphere." (Mehta, McDonald and Alikhanlou 1980, p. 24)

FRACTIONAL AIRBORNE RELEASE OF PARTICULATE MATERIAL

The various factors applied to estimate the airborne release of plutonium as a result of the postulated damage scenarios are listed in Table 5. Some

TABLE 5. Fractional Airborne Release Factors

Event	Factor
• Crushing of glovebox	
- containing powder	Volume of glove box x 300 mg powder/m^3
- containing surface contamination only	10^{-2}/m
• Perforation of glovebox	
- containing powder	Fraction of volume of glove box affected x 100 mg powder/m^3
- with surface contamination only	10^{-4}/m
• Damaged to filters	
- crushing	10^{-1} of accumulated material airborne
- perforation	10^{-2} of accumulated material airborne
• Aerodynamic entrainment	
- powder, less than 5 mph	10^{-10}/sec of exposed material
- powder, greater than 5 mph	10^{-8}/sec of exposed material

considerations that influence the applicability of these factors for the damage scenarios described are noted in the following paragraphs.

Crushing of Glovebox

Crushing is defined as a complete loss of containment such as rupture of the steel shell or loss of one or more of the large viewing windows. The event is assumed to generate sufficient excess force to inject uncontained powders into the air and to break glass or thin-wall rigid-plastic containers.

1. Glovebox containing powder--Vibrating powder resting on a surface does not appear to provide as much dispersion of the powder as tumbling. The mass airborne concentration is indicated by experimental

data measuring the value within seconds after tumbling of a powder with a density and size distribution similar to the PuO_2 assumed for this study (Mishima, Schwendiman and Ayer 1978, p. 30).

2. Glovebox containing surface contamination only--Surface contamination can range from particles settled on the surface to material mixed into the surface. The resuspension factor applied is a value measured for a combination of mechanical and aerodynamic stresses (Mishima, Schwendiman and Ayer 1979, p. 44).

Perforation of Glovebox

Perforation is defined as a partial loss of containment (loss of one or more glove ports, loss of a portion of a viewing window, etc.) that allows air to circulate through the glove box. The rate of release from the break will depend upon the size of the opening, whether the exhaust system continues to function, and the velocity of air entering the opening. The particulate materials airborne within the volume are released from the glove box with time. If the exhaust flow is zero, the release is exponential with time. Release of greater than 99% of the airborne material within 30 min is considered instantaneous.

1. Glovebox containing powders--The force transmitted to the glove box during perforation is assumed to be considerably less than during crushing. Since a finite period of time is required to release the airborne particulate material, a mass concentration measured approximately 1 minute after tumbling a fine powder and considered quasi-stable, was selected. Furthermore, the disturbance due to perforation can be more localized than in crushing and it was judged that the powder only occupied a fraction of the volume of the glovebox (Mishima, Schewendiman and Ayer 1979, p. 39).

2 Glovebox containing surface contamination only--A reduced resuspension factor of 10^{-10}/m was selected to reflect the reduced force and area involved in perforation (Mishima, Schwendiman and Ayer 1980, p. 18).

Damage to Exhaust HEPA Filters

Unless otherwise stated, the filters attached to glove boxes are assumed to suffer the same damage as the glove box to which they are attached. Secondary filters within the building will also suffer the same type of damage.

1. Crushing of HEPA filters--Although the filter material (glass-fiber mats) is fragile, the plutonium particulate material accumulated can be embedded in the filter and associated with other materials such as dust, condensed organic vapors, etc. These materials may not be readily dispersed in a respirable, transportable size-range. A conservative airborne fractional value of 10% of the accumulated materials released are assumed in the absence of experimental data (Mishima, Schwendiman and Ayer 1979, p. 46).
2. Perforation of HEPA filters--A reduced fractional-airborne-release factor of 1% is applied to reflect the reduced level of stress required for this level of damage (Mishima, Schwendiman and Ayer 1979, p. 47).

Aerodynamic Entrainment

Powders and liquids can be entrained in the air passing over their surfaces. Particle suspension results from initiation of movement in larger particles that subsequently transfer momentum to particles in a size-range that allows suspension. Under similar conditions of air flow over a liquid film, droplets are much less likely than particles to become airborne because of the higher energy required to break up the film and form droplets.

- Powder by Air Velocities Greater than 5 mph (2.2 m/sec). A conservative suspension rate (10^{-8}/sec), measured for a homogeneous bed and with wind velocity variations over a year's duration, is applied (Mishima, Schwendiman and Ayer 1978, p. 39).

- Powder by Air Velocities Less than 5 mph (2.2 m/sec). A suspension rate (10^{-8}/sec) measured from a homogeneous bed at these velocities is applied (Sehmel and Lloyd 1974, p. 853, Figure 3).

ATMOSPHERIC EXCHANGE RATE

After the particulate material is injected into the air, it requires the airflow to move it from its starting point to the ambient atmosphere. Diffusion is only a serious consideration for particles less than 1 μm (Dennis 1976, p. 52). The two areas in the NMDF in which plutonium could become airborne are the glovebox room and the filter room/airlock. The glovebox room is located in the central portion of the NMDF and is approximately 90 ft long by 60 ft wide by 17 ft high. The filter room is located in the center of the south end of the facility and is 40 ft long by 30 ft wide by 17 ft high. The airlock connects the glovebox room to the double doors in the south wall of the facility and runs along the west border of the Filter Room. Its dimensions are approximately 30 ft long by 10 ft wide by 17 ft high. The estimated airflows through these areas and the equipment contained therein are described below for the various postulated accident scenarios.

Wind Hazard

Nominal Windspeed of 110 mph

It is postulated that if one of the two standard-sized doors, (approximate dimensions 2.5 ft by 7 ft) in the exterior walls fails, air at its existing velocity could enter the facility and the initial volumetric flow would be 170,000 cfm. The nominal airspeed in an east-west direction is 13 mph. Since flow via the room exhaust system is approximately 9,000 cfm, the inflow via the door is soon reduced due to backpressure. Only minor damage, a crack, is postulated for a single glovebox. Airspeed through the equipment is low (only a fraction of the airspeed in the room).

Nominal Windspeed of 130 mph

All exterior doors are assumed to fail and the air circulating into the airlock causes failure of the interior partition in the filter room. Debris from the failure of the wall damages a portion of filter enclosures. The surface area of the double door is 60 ft^2 and the airspeed is 11,440 fpm. Assuming no losses, air enters the facility at 6.9×10^5 cfm. The nominal airspeed in a north-south direction through the combined filter-room airlock is approximately 18 mph, which reduces to 7.6 mph in the glovebox room. The air is assumed to exit the facility via another unfiltered opening (door).

Nominal Windspeed of 150 mph

All exterior doors are assumed to fail and air circulating into the airlock causes failure of the interior partition of the filter room and the north and south walls of the glovebox room. Debris from the interior partition damages filter enclosures and debris from failure of the walls could damage the gloveboxes nearest the walls. As in the previous scenario, the area of the opening by which the air can enter the facility is 60 ft^2 but the airspeed is increased to 13,200 fpm. The nominal airspeed in a north-south direction through the combined filter room-airlock is approximately 20 mph and 9 mph through the glovebox room. The air is assumed to exit the facility via the failed door at the same rate as it enters.

Nominal Windspeed of 170 mph

Collapse of the roof and exterior walls exposes all the debris from the failed equipment to the existing windfield.

Earthquake Hazard

Approximately 70% of the measured airspeeds at the site are less than 7 mph (NRC 1980, Table 3, p. 7). The exterior walls and roof are assumed to fail at linear accelerations exceeding 0.55 g. Thus, a windspeed in excess of 5 mph is assumed for the upper-bound calculations and less than 5 mph for the average and lower-bound calculations.

SOURCE TERM RANGES

In order to provide some quasi-realistic bounds to the quantity of plutonium estimated to be released from the damage scenarios, three estimates are provided--upper bound, average, and lower bound. The assumptions under which the estimates are made are:

Upper Bound

- the upper-bound damage ratio occurs
- the stated inventory that can be present is found at each location
- all areas have a maximum loading, on the average, of surface contamination
- all exhaust filters are fully loaded
- maximum anticipated airspeeds are assumed for earthquake scenarios

Average

- the average ("best estimate") damage ratio occurs
- the stated inventory at each location is reduced by the fraction of time it is normally found at that location
- all locations have a maximum loading, on the average, of surface contamination
- all exhaust filters are fully loaded
- average wind velocities are assumed for earthquake scenarios

Lower Bound

- the lower-bound damage ratio occurs
- no process material is present and the maximum loading, on the average, of surface contamination is present
- all exhaust filters are fully loaded
- average wind velocities are assumed for earthquake scenarios

SOURCE TERM ESTIMATES

In the previous sections of this document, inventories of dispersible materials in various areas, damage levels, fractional airborne releases, and atmospheric exchange rates required to estimate the source terms for the postulated damage scenarios were described. These components are combined in this section with the specific conditions postulated for each hazard to arrive at three source term estimates for each scenario--an upper limit, a best estimate, and a lower limit.

The estimates are divided into the mass of airborne plutonium particulate material in the respirable size fraction released during five time intervals covering a four-day period. The quantity designated as instantaneous is the mass released from the facility within a few minutes following the hazardous event. The mass estimated for the remaining four time periods comes from two sources--the delayed release of material airborne in enclosures and the resuspension of the dispersable materials exposed to the ambient windfield.

Drawings are used to illustrate the type and range of damage that could result in key areas from the scenarios described. The illustrations are not an attempt to show what actually happens--the data available and the state-of-the-art are not sufficient to predict the precise levels of damage that would be inflicted upon each item. Certain details of the facility have been omitted for clarity in the drawings.

The discussion is divided into wind and earthquake hazards in order of their increasing severity.

SOURCE TERM ESTIMATES FROM WIND HAZARD

Nominal Windspeed 110 mph (49.2 m/sec); 3×10^{-6}/yr Probability of Occurrence

It is postulated that if one of the standard-sized doors in the exterior walls of the glovebox room fails, the window of one of the gloveboxes nearest the door would be cracked by the wind circulating around the room. The enclosure around the exterior door prevents the entry of wind-generated missiles. The ventilation and exhaust system continues to function.

The two gloveboxes nearest the doors are #8 (nearest the door in the west exterior wall) and #16 (nearest the door in the east exterior wall). Glovebox #8, OD Grind Box, is 84 in. x 48 in. x 48 in. and can contain 120 g Pu + 350 g U^{235}. It is assumed to have an internal contaminated surface area of 266 ft^2 (24.7 m^2). Glovebox #16 is an analytical enclosure (x-ray fluorescence) and has no routine inventory. Its dimensions are 42 in. x 42 in. x 42 in. and it is assumed to have an internal contaminated surface area of 147 ft^2 (13.7 m^2). Because of its higher inventory and larger assumed contaminated surface, glovebox #8 was used for this analysis.

It is postulated that if a significant crack occurs in the viewing window of glovebox #8, the mixed carbide present would be completely oxidized by the air drawn into the enclosure (see Figure 4). The exhaust system is functional and 99% of the material airborne is drawn into the exhaust filter. It is assumed that as much as 1% of the inventory in the glovebox (1.2 g Pu) as an upper bound can back-diffuse through the crack and be released to the glovebox room atmosphere. The room exhaust system also remains functional and most of the particles released into the glovebox room are carried to the room filters or are deposited on various surfaces. It is assumed that the 1% of the material released to the glovebox room diffuses from the facilities at a linear rate over the next 8 h.

The assumption for the average case is that 0.06 x 120 g of Pu are available in the glovebox and only the finely divided carbide oxidizes. Essentially all of the material is carried to the exhaust filters and the material released to the room behaves as described above. Thus, the quantity released to the atmosphere around the building is less than 10^{-7} g Pu.

Surface contamination at the level of 10^{-4} g Pu/m^2 is present in all cases. The assumed area contaminated is 24.7 m^2 and the postulated inventory is 2.5 mg Pu. The release factor for a perforated glovebox is 10^{-4} and 2.5 x 10^{-7} g Pu become airborne from this source. If 10^{-2} back-diffuses from the glovebox and 10^{-2} of that quantity is released to the ambient atmosphere around the facility, the calculated airborne release would be much less than 10^{-7} g Pu.

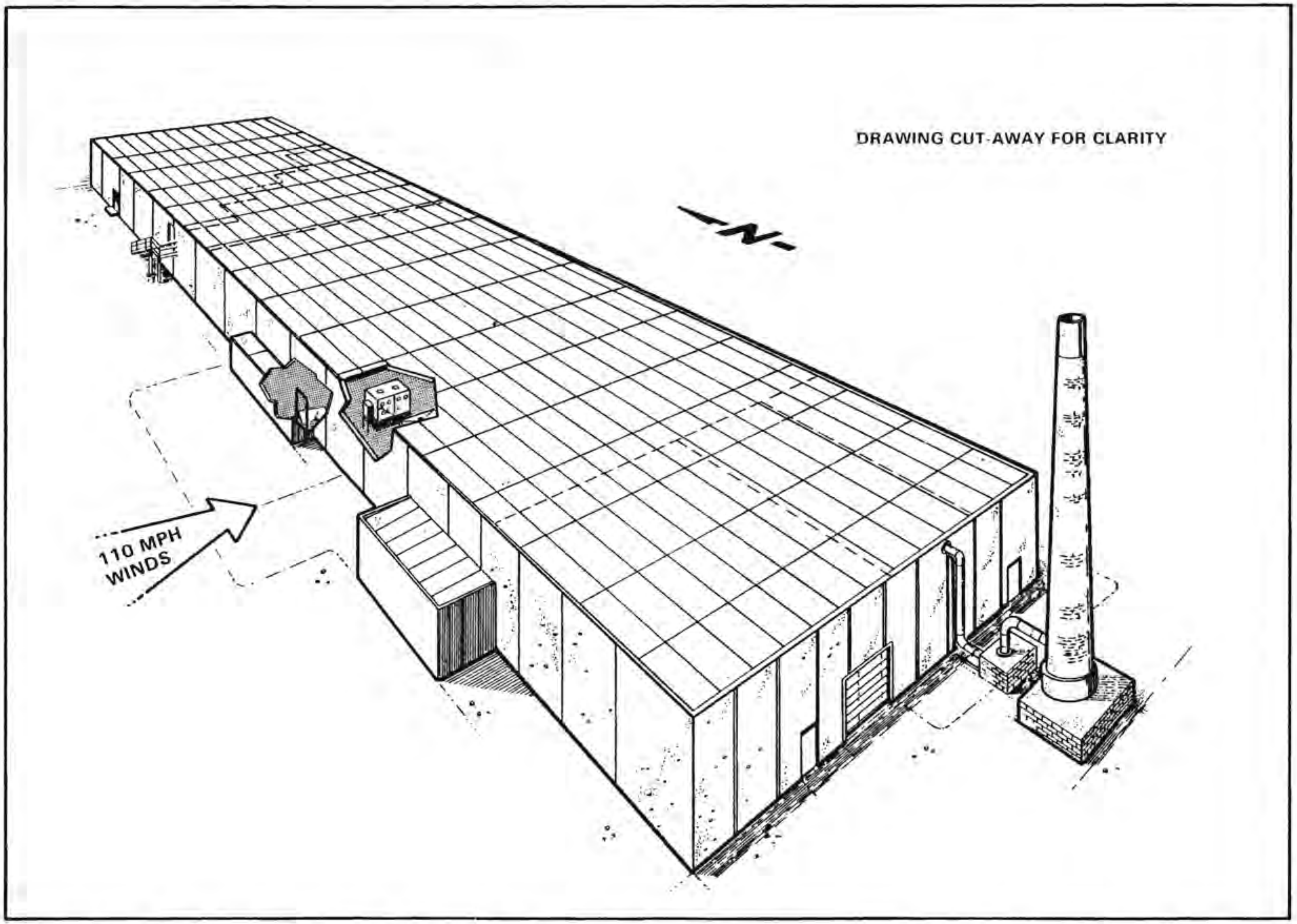

FIGURE 4. The Range and Types of Damage Postulated for the NMDF at a Nominal Windspeed of 110 mph

Airborne release of Pu by aerodynamic entrainment is not considered to be of concern in this scenario since no new contaminated surfaces were exposed to the glovebox room atmosphere.

The estimated airborne releases are listed in Table 1. All particles airborne from this scenario are assumed to be less than 10 m AED.

<u>Nominal Windspeed 130 mph (58.1 m/sec); 8 x 10^{-7}/yr Probability of Occurrence</u>

In addition to the damage postulated in the previous scenario, if the interior partition between filter the room and airlock fails at this windspeed, debris from the failure of the partition could damage 1/3 of the filter enclosure with upper and lower bounds of 2/3 and 1/6, respectively. Damage to any of the filter enclosures would likely make the exhaust system not able to function. The situation is illustrated in Figure 5.

Each enclosure holds three standard-size HEPA filters that sequentially filter the room air and periodically filter the glovebox exhaust. The filters were assigned inventories of 0.1, 0.05 and 0.01 g Pu, respectively. The estimated total inventory for all nine enclosures is 0.151 g Pu. The release factor for crushed filters is 10^{-1} and the estimated releases to the ambient atmosphere around the facility are:

- upper bound--2/3 (0.151 g Pu x 10^{-1}) = 0.01 g Pu
- average--1/3 (0.151 g Pu x 10^{-1}) = 0.005 g Pu
- lower bound--1/6 (0.151 g Pu x 10^{-1}) = 0.0025 g Pu.

The Pu not instantaneously airborne is exposed to the air velocity in the area (approximately 18 mph) and is subject to entrainment due to aerodynamic stress. A entrainment rate of 10^{-8}/sec is applied for powders at this airspeed. The estimated airborne releases are:

- upper bound--0.141 g Pu (3.6 x 10^{-5}/h) = 5 x 10^{-6} g Pu/h
- average--0.146 g Pu (3.6 x 10^{-5}/h) = 5 x 10^{-6} g Pu/h
- lower bound--0.148 g Pu (3.6 x 10^{-5}/h) = 5 x 10^{-6} g Pu/h.

The combined estimated airborne releases from this scenario (including the airborne releases from the previous scenario) are shown in Table 1.

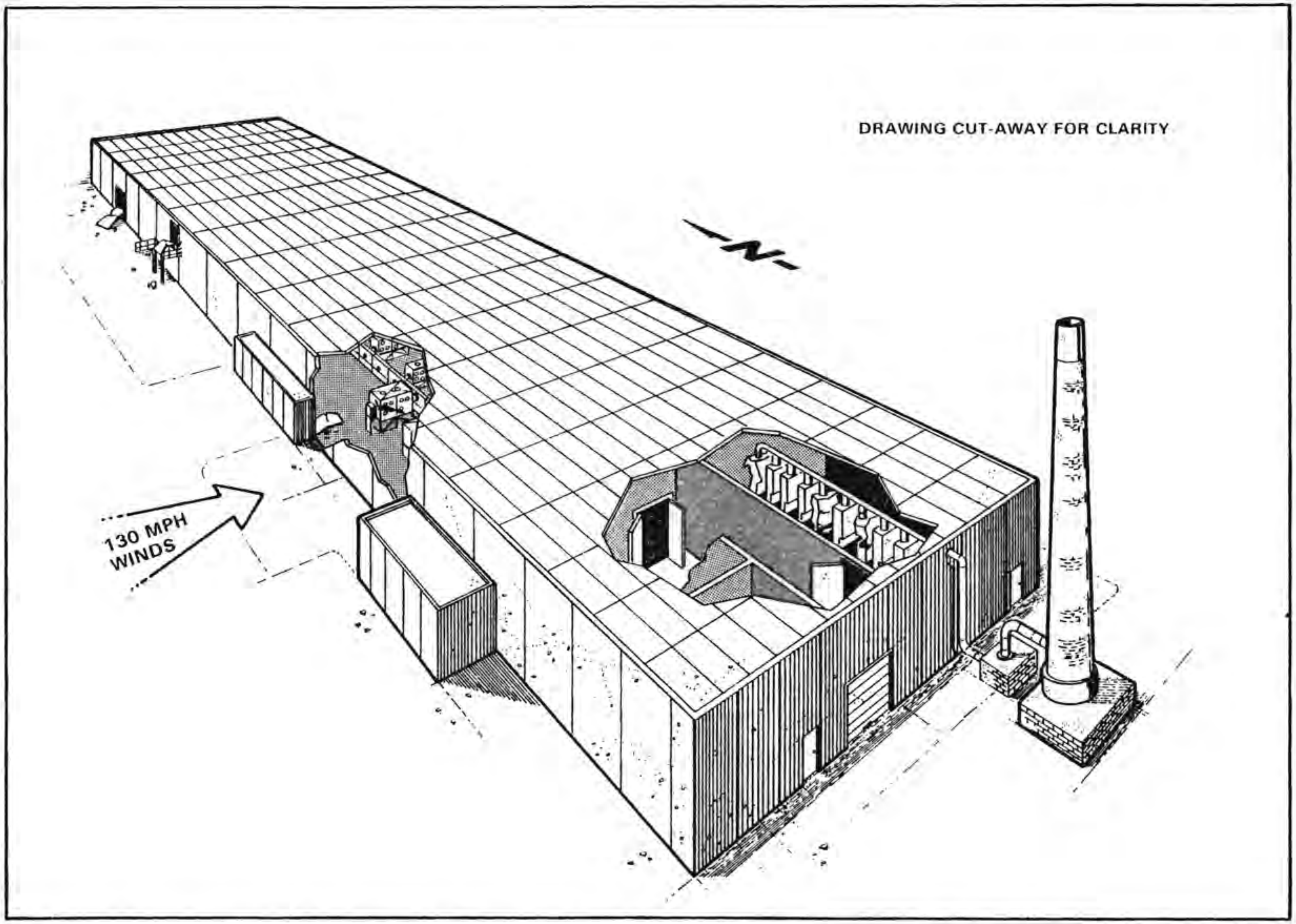

FIGURE 5. The Range and Types of Damage Postulated for the NMDF at a Nominal Windspeed of 130 mph

Nominal Windspeed 150 mph (67.1 m/sec); 4 x 10^{-7}/yr Probability of Occurrence

In addition to the damage described in the previous two scenarios, the north and south interior walls in the Glovebox Room may collapse at 170 mph. A few of the roof panels could be dislodged by the failure of the wall beams and could damage one or two gloveboxes near the walls.

The gloveboxes nearest the north interior wall are #1a, 2a, 13, and 14; and #26, 27 and 28 nearest the south interior wall. Gloveboxes #1a and 2a are air and inert-gas entry boxes, 36 in. x 30 in. x 33 in., and do not routinely contain any radioactive inventory. Glovebox #13 is a pin-loading box, 84 in. x 42 in. x 42 in., and normally only contains Pu during manual operations. Glovebox #14 is a waste-loading box, 84 in. x 42 in. x 42 in., and normally holds small quantities of highly diluted radioactive materials. Gloveboxes #26, 27 and 28 form a cluster and are designated as pellet-pressing, granulating, and sintering boxes. They appear to constitute a greater hazard than the other gloveboxes and, for this reason, these boxes were used for this analysis. The situation is illustrated in Figure 6.

It is postulated that the damage to the gloveboxes maybe sufficiently severe to constitute a complete loss of integrity--crush. None of the boxes has a stated inventory and therefore the airborne release is based upon surface contamination and exhaust-filter inventory. For this reason, the two larger gloveboxes (#26 and 27) are used in this analysis.

The airborne release for crushed gloveboxes containing surface contamination only is estimated by applying a resuspension factor of 10^{-2}/m. The dimensions of glovebox #26 are 84 in. x 42 in. x 48 in. and its volume is 2.78 m^3. The dimensions of glovebox #27 are 84 in. x 42 in. x 42 in. and its volume is 2.43 m^3. Using a maximum average surface contamination level of 10^{-4} g Pu/m^2, the estimated instantaneous releases are:

- glovebox #26--(10^{-2}/m)(10^{-4} g Pu/m^2)(2.78 m^3) = 3 x 10^{-6} g Pu
- glovebox #27--(10^{-2}/m)(10^{-4} g Pu/m^2)(2.43 m^3) = 2 x 10^{-6} g Pu.

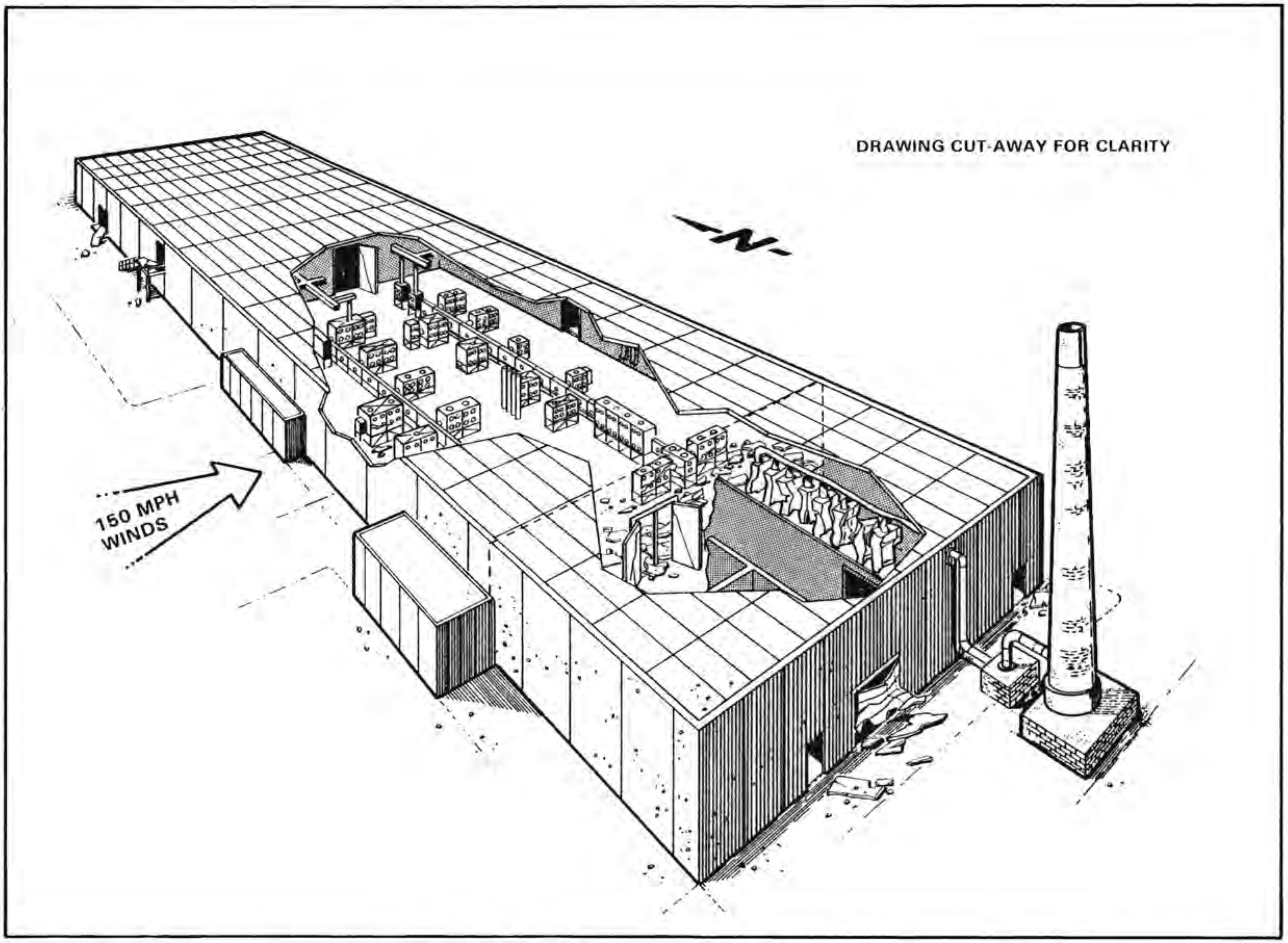

FIGURE 6. The Range and Types of Damage Postulated for the NMDF at a Nominal Windspeed of 150 mph

Both gloveboxes contain equipment that has been used in processing carbide fuels and the equipment is assumed to have some residual, finely divided carbide present. Because the carbide can ignite, the resultant oxide can be more readily entrained. It is estimated that the quantities of Pu which become airborne from this source are:

- upperbound--0.08 g Pu
- average--0.04 g Pu
- lower bound--0.02 g Pu.

The instantaneous airborne release estimate for the crushed exhaust filters is 0.2 g Pu, based upon a maximum inventory of 1 g Pu per filter and a release fraction of 0.1.

All Pu not instantaneously suspended is potentially exposed to the existing windfield. The nominal air velocities in the glovebox room and airlock filter Room exceed 5 mph and the higher resuspension flux applies. The estimated time-dependent airborne release rates are:

- upper bound--5.72 g Pu x 3.6 x 10^{-5}/h = 2 x 10^{-4} g Pu/h
- average--5.76 g Pu x 3.6 x 10^{-5}/h = 2 x 10^{-4} g Pu/h
- lower bound--5.79 x 3.6 x 10^{-5}/h = 2 x 10^{-4} g Pu/h.

The total estimated airborne release of Pu, including the contribution from the two previous scenarios, is listed in Table 1. All airborne particles are assumed to be less than 10 m AED.

Nominal Windspeed of 170 mph (76 m/sec); 1 x 10^{-7}/yr Probability of Occurrence

A total loss of the interior and exterior walls and roof of the NMDF is postulated at this windspeed, resulting in complete loss of contained equipment. The situation is illustrated in Figure 7.

The instantaneous airborne release estimate is calculated from the quantity of Pu, the type of Pu material, the fraction of time the Pu is present, and the degree of damage suffered by the container. Only five gloveboxes (#3, 4, 5, 6 and 8) have significant inventories. Since the process used is a batch process, the Pu would only be found at a single location. Thus, the largest quantity of Pu in its most dispersible form (powder) was used in the

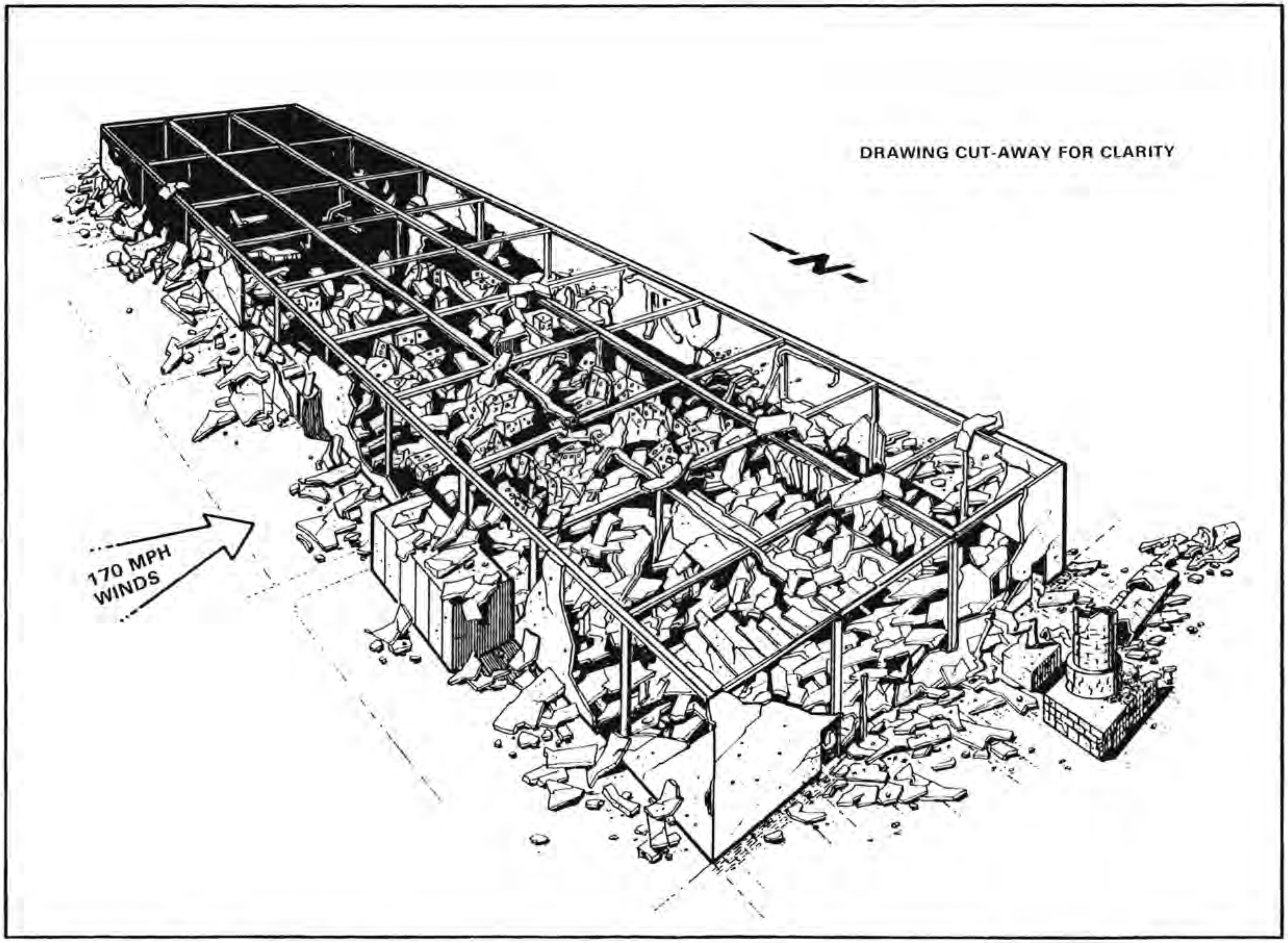

FIGURE 7. The Range and Types of Damage Postulated for the NMDF at a Nominal Windspeed of 170 mph

upper-bound calculation. The fraction of time the various quantities of Pu might be present at various locations was used to estimate the average contribution from this source. The estimates are:

- upper bound--300 mg mixed carbide/oxide/m^3 x 2.43 m^3 = 0.7 g powder (0.3 g Pu)
- average--0.06 (300 mg Pu/m^3 x 2.43 m^3) = 0.01 g Pu
- lower bound--no inventory.

Consistent with previous analyses, it is assumed that 10% of the particles released are less than 10 μm AED.

The instantaneous airborne release from the glovebox and building exhaust filters is based on their inventory and the severity of damage inflicted upon them. There are 33 gloveboxes in the glovebox room, each assumed to hold a maximum Pu content of 1 g. There are 9 enclosures in the filter room, each containing 0.15 g of Pu. The total inventory in the filters is 34.4 g Pu and, applying the release factor for filter crush (0.1), the instantaneous airborne release contributed from this source is:

$$34.4 \text{ g Pu} \times 0.1 = 3 \text{ g Pu.}$$

All of the Pu that becomes airborne from this source is assumed to be less than 10 μm AED.

All of the gloveboxes are assumed to have all internal surfaces contaminated to the maximum average level (1×10^{-4} g Pu/m^2). Airborne releases are estimated by a resuspension factor that relates the surface contamination to airborne concentration. It is assumed that resuspension occurs during the crush of the box and is limited to the volume of box. The total volume of the 33 gloveboxes is 59.7 m^3 and the instantaneous release contributed from this source is 6×10^{-5} g Pu. All of the airborne materials are assumed to be less than 10 μm.

One last potential source for the instantaneous airborne release of Pu is the residual traces of carbide in the process equipment. Since carbide can ignite when exposed to air, it may be more readily suspended during oxidation. For the purposes of this analysis, it was assumed that 20 g Pu was present and that 0.01 fraction was made airborne due to its exposure to air. All airborne particles are assumed to be less than 10 µm AED.

All material not instantaneously airborne is assumed to be exposed to aerodynamic entrainment. Although much of the material is clearly buried by the debris, the time-dependent airborne release is based on all materials using the higher resuspension flux. The estimates are:

- upper bound--275 g Pu x 3.6 x 10^{-5}/h = 0.01 g Pu/h
- average--58.3 g Pu x 3.6 x 10^{-5}/h = 0.002 g Pu/h
- lower bound--49.9 g Pu x 3.6 x 10^{-5}/h = 0.002 g Pu/h.

All of the materials that become airborne from this source are assumed to be less than 10 m AED.

The estimated airborne releases from this scenario are listed in Table 1.

SOURCE TERM ESTIMATES FROM EARTHQUAKE HAZARDS

Linear Acceleration of Less Than 0.55 g; Greater Than 2 x 10^{-3}/yr Probability of Occurrence

No significant damage leading to airborne release of Pu occurs.

Linear Acceleration in Excess of 0.55 g; 0.6 g has 1.3 x 10^{-3}/yr Probability of Occurrence

Although the details and manner of collapse may vary, the consequences of the collapse of the interior and exterior walls and roof are considered identical. All instantaneous airborne releases and the upper-bound time-dependent releases are as shown for the 170 mph wind-hazard scenario. Due to the data on prevailing winds at this site, the average and lower-bound time-dependent releases were estimated using the resuspension flux for windspeeds of 5 mph and less. The estimates are:

- average--58.3 g Pu x 3.6 x 10^{-7}/h = 2 x 10^{-5} g Pu/h
- lower bound--49.9 g Pu x 3.6 x 10^{-7}/h = 2 x 10^{-5} g Pu/h.

The estimated airborne releases for this scenario are listed in Table 1.

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Rockwell
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February 17, 1978 In reply to refer to 78AT-1850

Mr. Richard W. Starostecki, Chief
Fuel Reprocessing and Recycle Branch
Division of Fuel Cycle and Material Safety
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Starostecki:

Subject: Evaluation of Natural Phenomena Effects, Docket No. 70-25

Your letter of January 27 requested additional information necessary for the evaluation of the effects of natural phenomena on our Nuclear Materials Development Facility (NMDF) near Santa Susana, California. The information on "inventory-at-risk" has been summarized in Table I, included as Enclosure 1. I should also indicate that 10 - 12 batches consisting of 120 grams of Pu and 350 grams of U-235 were processed during the last year of the last operational period at the NMDF.

In response to your second question, the one-inch natural gas supply line has been moved outside the building. One other line, which supplies a pre-mixed gas consisting of 94 percent argon and 6 percent hydrogen for regeneration, comes into the glovebox room (Room 127) and is attached to each of 13 inert gas atmosphere purifier units.

The surface contamination in the powder handling boxes (Boxes 3, 5, 7, and 9) has been estimated on the basis of recent smear survey results. These estimates result in contamination levels of 5×10^{-9} gram of Pu/cm^2 and 2×10^{-8} gram of U-235/cm^2. The surface contamination in the other gloveboxes is estimated at a factor of 10 less than the above amounts. The amounts of Pu and U-235 tied-up in the equipment have been estimated to be about 20 grams of Pu and 50 grams of U-235. I should point out that these estimates are subject to a rather large uncertainty, perhaps as much as several hundred percent.

The amounts of combustible materials found in Room 127 during normal operations have been summarized in Table II, included as Enclosure 2. The up-to-date grading plan for the site of the NMDF consists of a group of five drawings (No.'s 303-GEN-C40, -C41, -C42, -C44, and -C45) together with the storm drain master plan (Drawing No. 303-GEN-C92) which are included here as Enclosure 3.

If you have any questions or desire further information, please call me at (213) 341-1000, Extension 2238.

Sincerely,

M. E. Remley, Manager
Health, Safety & Radiation Services
Atomics International Division

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