5.0 SUMMARY

This environmental assessment provides an analysis of several approaches to the handling of hazardous and mixed wastes at DOE's Mound Plant in Miamisburg, Ohio. The first approach considered, the proposed action, involves the operation of an existing glass melter (also known as a Penberthy Pyro-Converter joule-heated glass furnace) for the treatment of hazardous and mixed wastes. The analysis also considers the no-action alternative, involving the continuance of existing practices at Mound for the handling of hazardous and mixed wastes, as well as various on-site and off-site treatment, storage, or disposal alternatives.

Under the proposed action, the primary potential sources of environmental impact are air emissions and effluent discharges. Potential changes in air and water quality may result in impact to biotic resources and human health. This assessment considers the potential effects of routine operation as well as the potential effects of a maximum credible accident scenario on human/worker health and safety. (This maximum credible accident scenario involves a drum fire/explosion on the loading dock outside the building housing the glass melter.)

Air emissions from the glass melter during routine operation include both criteria and noncriteria pollutants, heavy metals, and radionuclides. The EPA-approved screening level model PTPLU-2.0 was used to predict ground-level concentration and downwind distance to the maximum concentration. Results of the analysis indicate that the distance from the source to the predicted point of maximum impact is 220 m. Predicted concentrations met applicable short-term standards, the NAAQS for criteria pollutants and the MAGLCs for all other nonradiological pollutants.

Potential effect of the proposed action on the biota arise through changes in water and air quality. With respect to water resources, no measurable impacts to water quality were projected; as a result, no measurable impact to biological resources was predicted for this pathway.

With respect to radiological concentration parameters, radioactive air emissions were calculated based on typical waste content of radionuclides. Using the AIRDOS-PC model, the effective dose equivalent to the maximally exposed individual was determined to be 0.07 mrem/year from all pathways during routine operations. This estimated dose level is far below the limit of 10 mrem/year (40 CFR Part 61, Subpart H).

Under maximum credible accident conditions, the effective dose equivalent predicted by the model was 0.20 mrem/year. Since human health standards are not exceeded for either case, no impacts to human health are projected as a result of radioactive releases. Likewise, no impacts to biotic resources are projected from this source. Model results for toxic chemical releases under very conservative assumptions indicate that under maximum credible accident conditions, TLV/10 guidelines are not exceeded. Because of the emergency capabilities on site and the low probability of having all the criteria met that are assumed for the maximum credible scenario, it is even less likely that a major fire would result in adverse health effects.

With respect to worker safety, on-site personnel are not exposed to unique hazards. In addition, they are adequately protected from potential exposure to radionuclides or other hazards by the existing health and safety programs.

Two on-site alternatives to the use of the glass melter were briefly considered. Under the no-action alternative, primary impact would arise from additional construction of approximately 23 m^2 (247 ft^2) of storage space. Potential impacts to air and water quality caused by construction-related land disturbance would be minimal and short lived. Some potential for impact to archaeological resources exists for this alternative. The magnitude of such impacts cannot be evaluated until a specific site is selected for the storage facility.

Administrative efforts to reduce the amount of waste generated at Mound would result in minor positive benefits to the environment (air quality and traffic) by reduction of transportation requirements for off-site disposal. With respect to off-site alternatives, distances to be traveled to each potential disposal site were similar. As a result, no substantive differences between the alternatives would be expected with respect to transportation-related impacts.

6.0 REFERENCES

ACGIH (American Conference of Governmental Industrial Hygienists). 1988. Threshold Limit Values and Biological Indices for 1988-1989. Cincinnati, Ohio.

Alexander, B.M. and L.M. Klingler. 1981 (May). Glass Furnace Project: October 1980 to March 1981. MLM-2825.

29 CFR (Code of Federal Regulations) Part 1910.95. Occupational Noise Exposure.

29 CFR (Code of Federal Regulations) Part 1910.106.

29 CFR (Code of Federal Regulations) Part 1910.1200. Hazardous Communication Standard.

40 CFR (Code of Federal Regulations) Part 50.4 to 50.11.

40 CFR (Code of Federal Regulations) Part 61, Subpart H.

40 CFR (Code of Federal Regulations) Part 264.343.

CRC (Chemical Rubber Company). 1988. The CRC Handbook of Chemistry and Physics, 69th Edition., 1988-89, Cleveland, Ohio.

DOE (U.S. Department of Energy). 1988. Environmental Guidance Program Book.

DOE (U.S. Department of Energy). Order 5480.4.

DOE (U.S. Department of Energy). 1979. Final Environmental Impact Statement, Mound Facility, DOE/EIS-0014.

DOE (U.S. Department of Energy). Order 5400.1.

EG&G Mound Applied Technologies, Mound Facility Respiratory Protection Program: Technical Manual MD-10161, Issue 4.

EG&G Mound Applied Technologies, Mound Safety and Hygiene Manual: MD-10286, Issue 15.

EG&G Mound Applied Technologies, Nuclear Criticality Precautions: Technical Manual MD-10038, Issue 8.

EG&G Mound Applied Technologies, Nuclear Radiation Safety: Technical Manual MD-10019, Issue 6.

EG&G Mound Applied Technologies, Systems Manual 721.

Response Plan-1 Master Plan

Response Plan-2 Health Physics Nuclear Emergency Procedures

Response Plan-3 Emergency Medical Plan

Response Plan-7 DAO/Mound Radiological Assistance Team Plan

Response Plan-9 Contingency Plan.

Response Plan-14 Emergency Brigade Plan.

EG&G Mound Applied Technologies. Waste Minimization and Pollution Prevention Awareness Plan: Technical Manual MD-81501, Issue 1.

EPA (U.S. Environmental Protection Agency). 1986a. Superfund Public Health Evaluation Manual, EPA/540/1-86/060.

EPA (U.S. Environmental Protection Agency). 1986b. Guideline for Carcinogen Risk Assessment. Federal Register 51 (185):33992-34003. September 24, 1986.

EPA (U.S. Environmental Protection Agency). 1988. Screening Procedures for Estimating the Air Quality Impact of Stationary Sources. EPA-450/4-88-010.

EPA (U.S. Environmental Protection Agency). 1989. Users Guide for AIRDOS-PC Version 3.0. EPA/520/6-89-035. December 1989.

Federal Register 44(28):8220-8221 (Appendix H).

ICRP (International Commission on Radiological Protection). Recommendation of the ICRP. Publication 26.

Klingler, L.M. 1981 (December). Mound Cyclone Incinerator, Volume I. Description and Performance. MLM-MU-81-072-0003.

Klingler, L.M. 1990. Personal communication with W. Willis, SAIC, April and May.

Klinger, L.M. and K.M. Armstrong. 1985 (February). Glass Furnace Project Final Report. MLM-3229.

Klinger, L.M. and K.M. Armstrong. 1988. A Study of Tritium Waste Processing by Means of the Cyclone Incinerator. First draft.

Koval, P. 1988. State Hygienist, Ohio EPA, Personal Communication with D. Ryan, SAIC, September.

Moore, R.E., et al. 1989. MICROAIRDOS™ Version 2.0 User's Manual and Documentation.

McCann and Bossinade. 1988. Preliminary Flood Hazard Estimates for Screening DOE Sites, UCRL 21045, Albuquerque Operations Office, Albuquerque, NM.

Mound. 1991. RCRA Part B. Application, EPA I.D. No. OH890008984.

MRC (Monsanto Research Corporation). 1975-1982, 1982-1984, 1985, 1986. Mound Environmental Monitoring Reports.

MRC (Monsanto Research Corporation). 1987d. Mound Fire Protection Program Manual.

NFPA (National Fire Protection Association). Portable Fire Extinguishers, NFPA-10.

NRC (U.S. Nuclear Regulatory Commission). Regulatory Guide 1.109.

RAPCA (Regional Air Pollution Control Agency). 1988. Air Quality Report: Air Monitoring Data for 1986, Dayton, Ohio.

Review Report #77-12. 1986. Loss Prevention and Environmental Control, Joule-Heated Glass Furnace System.

SAIC (Science Applications International Corporation). 1988. Transportation of Hazardous Wastes and Substances Training Manual. Prepared for U.S. Department of Energy, Transportation Management Division.

Weston Services, Inc. 1990 (April). Letter to Klinger, EG&G - Mound.

APPENDIX A: AGENCY CONSULTATIONS

United States Department of the Interior

FISH AND WILDLIFE SERVICE

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

Reynoldsburg Field Office
6950-H Americana Parkway
Reynoldsburg, Ohio 43068-4115
(614/469-6923)

September 2, 1988

Ms. Anna S. Hammons
SAIC
P. O. Box 2501
Oak Ridge, Tennessee 37831

Re: Glass Melter Thermal Treatment Unit at Monsanto Research Corporation, Miamisburg, Ohio.

Dear Ms. Hammons:

This responds to your August 26, 1988 request for Federally listed endangered or threatened species which may be found in the Miamisburg, Montgomery County, Ohio vicinity.

This information is provided in accordance with provisions of the Endangered Species Act, of 1973, as amended.

ENDANGERED SPECIES COMMENTS: To facilitate compliance with Section 7(c) of the Endangered Species Act of 1973, as amended, Federal agencies are required to obtain from the Fish and Wildlife Service information concerning any species, listed or proposed to be listed, which may be present in the area of a proposed action. Therefore, we are providing you the following list of endangered (E) or threatened (T) species which may be present in the concerned area:

Name/Status	Habitat	Distribution
Indiana bat (E) Myotis sodalis	Caves and riparian	Statewide, except Athens, Belmont, Carroll, Coshocton, Gallia, Guernsey, Harrison, Jackson, Jefferson, Lawrence, Meigs, Monroe, Morgan, Muskingum, Noble, Tuscarawas, Vinton, and Washington Counties

We appreciate this opportunity to comment on your proposed project.

Sincerely yours,

Kent E. Kroonemeyer

Kent E. Kroonemeyer
Supervisor

cc: Chief, Ohio Division of Wildlife, Columbus, OH
ODNR, Outdoor Recreation Service, Attn: M. Colvin, Columbus, OH
Ohio EPA, Water Quality Monitoring & Assessment, Columbus, OH
U.S.EPA, Office of Environmental Review, Chicago, IL

Ohio Historic Preservation Office

Ohio Historical Center
1982 Velma Avenue
Columbus, Ohio 43211-2497
(614) 297-2470

OHIO
HISTORICAL
SOCIETY
SINCE 1885

March 15, 1991

Mark D. Gilliat
EG&G Mound Applied Technologies
P.O. Box 3000
Miamisburg, Ohio 45343-0987

Dear Mr. Gilliat:

Re: Mound Facility, Miamisburg, Ohio

This is in response to your letter dated February 21, 1991 concerning the Miamisburg facility. Based on the field survey and examination of the Mound Facility undertaken by Dr. Robert Riordan, Wright State University, in 1987 it appears that there are no significant archaeological remains on the Mound Facility due to previous disturbance. No archaeological sites eligible for the National Register will be affected. Please note that the buildings comprising the facility have not been evaluated in regard to National Register criteria. In order to do this we must have photographs of the buildings, their ages, and a brief history of the facility.

Any questions concerning this matter should be addressed to Julie Quinlan at (614) 297-2470. Her hours are from 5-11 a.m. Thank you for your cooperation.

Sincerely,

Judith Kitchen

Judith Kitchen, Department Head
Technical and Review Services

JLK/JAQ:jq

APPENDIX B: HEALTH AND ENVIRONMENTAL RISK OF POLYCHLORINATED DIBENZO-P-DIOXINS

APPENDIX B
HEALTH AND ENVIRONMENTAL RISK OF POLYCHLORINATED DIBENZO-P-DIOXINS

PCDDs and PCDFs form a group of trace environmental pollutants related to the potent carcinogen 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). An assessment of comparative toxicity and biologic activity of the various chlorinated dibenzo-p-dioxins and furans indicates a range of potency extending from approximately 10^{-1} to $<10^{-6}$ relative to TCDD (Kociba and Cabey, 1985). This assessment is summarized below:

> Of all the chlorinated dibenzo-p-dioxins and furans, 2,3,7,8-TCDD has been evaluated most extensively in regard to its biologic activity and toxicologic properties. Thus, TCDD has been used as the reference for comparative evaluation of the other dioxins and furans.
>
> Comparative studies with as many as seven different animal species provided single-dose oral LD_{50} data for sixteen different dioxins and five furans. Results indicate marked differences in acute toxicity when evaluated on the basis of interspecies differential response (same isomer, different animal species) or on the basis of intraspecies differential response (same animal species, different isomers).
>
> Marked differences in response have also been noted for those chlorinated dibenzo-p-dioxins and furans that have been comparatively evaluated in studies of the potential for teratogenesis or carcinogenesis.
>
> When evaluated for comparative biologic activity (as measured by various *in vitro* tests for enzyme induction or epithelial keratinization), a similar wide range of differential response has been noted for the various chlorinated dibenzo-p-dioxins and furans.

TCDD is one of the most potent carcinogens; its carcinogenicity to humans is strongly supported by animal evidence. EPA (1986a) ranked 2,3,7,8-TCDD as a probable human carcinogen (B2) in its weight of evidence scheme (EPA, 1986b). The ranking scheme, based on animal and human evidence, consists of five categories:

Group A	Known human carcinogen
Group B (B1 and B2):	Probable human carcinogen
Group C:	Possible human carcinogen
Group D:	Not classifiable as to human carcinogenicity
Group E:	Evidence of noncarcinogenicity to human

The animal evidence for human carcinogenicity of TCDD is rated as "sufficient," which is the highest evidence in a rating scale consisting of: 1) sufficient, 2) limited, 3) inadequate, 4) no data, and 5) no evidence. However, human evidence for its carcinogenicity in humans is "inadequate," which is lower on the rating scale.

The potency factor (q_1*), also known as the unit cancer risk (UCR), assigned to 2,3,7,8-TCDD was 156,000 mg/kg/d. This is the most potent carcinogen listed in the *Superfund Public Health Evaluation Manual* (EPA, 1986a). From the q_1* value, the dose level associated with acceptable risk (e.g., 10^{-6}) can be derived.

The acceptable intake levels of 2,3,7,8-TCDD, estimated by extrapolation from high to low concentrations, differ substantially (Table B-1). The province of Ontario has a maximum allowable daily intake of 10 pg/kg/d for humans (Paustenbach et al., 1986). in contrast, EPA has a value of 0.0064 pg/kg/d. The U.S. Food and Drug Administration (FDA) accepted risks associated with the ingestion of up to 13 pg/kg/d. The fundamental difference between the EPA and Canadian analyses is in the mechanism of action. Canada and Western Europe regard TCDD as a tumor promoter in animals; however, EPA regards TCDD as a tumor initiator. Recently, EPA has moved to lower the risk assessment for TCDD by 16 times based on the possibility that dioxin might be a promoter of tumors in humans (Pereva, 1988).

PCDDs have been found in the stack emissions of MWIs. They have also been found to undergo decomposition under high temperatures or sunlight. This section explains why PCDDs/PCDFs are not expected to be a health or environmental problem in the operation of the glass melter. There are no known PCDDs/PCDFs in the feed wastes, and any trace amount of PCDD/PCDF formed in the incinerator is expected to be destroyed by the high efficiency incinerator.

EVALUATION

PCDDs have been found in emissions of MWIs. The glass melter is different from MWIs in temperature, residence time, waste composition and incinerator design. The emission data from MWIs are not appropriate for the risk assessment of the glass melter. As stated in Hutzinger et al. (1985), the PCDDs/PCDFs that may form during combustion of organic substances can be effectively destroyed under adequate incineration conditions. Since PCDDs decompose in air at temperatures above 750°C (1,382°F), they are likely to decompose in the melter chamber, which operates at temperatures between 760°C and 1,510°C (1,400° to 2,750°F).

There are no known PCDDs present in feed wastes to the melter. Instead, the question of potential PCDD emissions focuses on formation of PCDDs in the glass melter and on glass melter performance. A surrogate POHC approach has been used to determine the DRE of a system for organic compounds, including PCDDs. Use of low-concentration feed quantities of PCDD is not practiced because the expected low emission concentrations are very difficult, if not impossible, to detect (EPA, 1985).

Spiking high levels of PCDDs in feed wastes to measure the DRE is prohibitive because of their potential health problems. Thus a surrogate POHC is used.

Table B-1. TCDD Cancer Risk Estimates by Different Agencies

Agency	Daily Intake Dose at Acceptable Risk Level (pg/kg/d)	Model
Ontario	10	Safety factor (100)
U.S. EPA[a]	0.0064	Linear multistage
CDC[b]	0.028 - 1.428 0.63	Linear multistage (Best estimate)
FDA	13	Safety factor (77) Linear multistage (10^{-5} risk)

[a] Acceptable defined as 10^{-6} risk (upper bound).
[b] Based on mouse and rat bioassay (10^{-6} risk).

Source: Paustenbach et al., 1986

According to the heat of combustion hierarchy, hexachlorodibenzo-p-dioxin (H_xCDD) is more difficult to incinerate than other listed PCDDs/PCDFs because it has the lowest heat of combustion (2.81 kcal/g). Therefore, the selected surrogate should have a heat of combustion value lower than 2.81 kcal/g (Table B-2).

With a heat of combustion value of 1.99, 1,1,1-trichloroethane would be a suitable surrogate for all PCDDs/PCDFs in the DRE tests (EPA, 1985). Carbon tetrachloride (tetrachloromethane) is an even better surrogate because it has a lower value, 0.24 kcal/g, and is very difficult to incinerate (Table B-2). In the six performance tests on the glass melter at temperatures between 934°C and 1,079°C (1,714°F to 1,974°F), the six 9s DRE was achieved using carbon tetrachloride as a surrogate (see Table 4.1-2). The six 9s DRE is a conservative measure of melter performance because of the use of carbon tetrachloride as a surrogate.

Excessive water content in liquid feed waste appeared to have some effect on melter performance. Fluctuation in the DRE of methylene chloride was noted during the incineration of liquid feed wastes containing extremely high percentages of water (Table B-3). The melter achieves a five 9s DRE for methylene chloride in liquid feed wastes containing 44 to 83% of water. In comparison, the melter reached a six 9s DRE for carbon tetrachloride in liquid feed waste free of water (see Table 4.1-2). Note that carbon tetrachloride is harder to burn than methylene chloride, according to their heats of combustion. When the water content increased to 99.27%, the DRE of methylene chloride fluctuated somewhat and fell to the four 9s level in several cases. This apparent effect of extremely high water content on the DRE is evident also in the parameters which will result in feed shutdown (Table 2.1-2), ensuring that waste streams which effect DRE are avoided, or introduced to the melter in a manner which will not upset combustion parameters.

The stack tests establish that even the most difficult organic compounds will be effectively destroyed by the glass melter furnace. Therefore, if any trace PCDDs are present in the furnace feed, it is expected that undetectable quantities will be emitted.

Many studies have shown that dioxins can be formed in the post-flame environment of an incinerator. These studies have shown that in air PCDDs are destroyed at temperatures over 1,380°F and can be formed in the temperature range 390 to 1,350°F. Studies have shown that dioxins can be formed either in the combustion airstream or on ash particles in both the fly ash and grate ash. Dioxins are formed from precursor chemicals such as chlorophenol, chlorinated benzene, and lignin that resemble parts of the dioxin molecule. Elimination of the precursor chemicals effectively prevents any possibility of dioxin formation. For example, Shaub (1983) reported that dioxin formation was proportional to the square of the unburned chlorophenol concentration; thus, a municipal incinerator with a DRE of 99.9% will emit one million times the quantity of PCDDs that an incinerator with a DRE of 99.9999% emits. The glass melter has a very high DRE that effectively eliminates precursor chemicals.

Table B-2. Heats of Combustion for PCDDs, PCDFs, and POHCs

Compound	Heat of Combustion (kcal/g)
Chlorinated Dibenzo-p-dioxins	
Tetra - CDD	3.46
Penta - CDD	3.10
Hexa - CDD	2.81
Chlorinated Dibenzofuran	
Tetra - CDF	3.66
Penta- CDF	3.40
Hexa - CDF	3.07
Typical POHCs	
Tetrachloromethane	0.24
Tetrachloroethane	1.39
Methylene chloride	1.70
1,1,1 -Trichloroethane	1.99

Source: EPA, 1985.

Table B-3. Test Burns Conducted with the Glass Melter System June 2-5, 1987

Waste Name (Mound #)	Physical State	Components	%	POHC?	Minimum Melter Temperature (°F)	DREs
27 Solvent Waste C Run 1	Liquid	Acetone	11.0	N	1,648	
		Ethanol	23.9	N		
		Water	64.4	N		
		Methylene Chloride	0.73	Y		99.99968 99.99989 9999925 -------- 99.99966
27 Solvent Waste B Run 2	Liquid	Acetone	3.7	N	1,325	
		Ethanol	12.9	N		
		Water	82.7	N		
		Methylene Chloride	0.73	Y		99.99983 99.99968 9999968 99.99911 99.99958
27 Solvent Waste D Run 3	Liquid	Acetone	16.5	N	1,880	
		Ethanol	38.6	N		
		Water	44.1	N		
		Methylene Chloride	0.73	Y		99.99932 99.99980 9999966 99.99986 99.99987
27 Solvent Waste A Run 4	Liquid	Acetone	0	N	1,825	
		Ethanol	0	N		
		Water	99.27	N		
		Methylene Chloride	0.73	Y		99.99480 99.99615 9999826 99.99979 99.99972

Source: Mound, 1987

The glass melter's combustion gases are very quickly cooled by a wet scrubber system to around 200°F. This rapid cooling effectively eliminates sufficient time for any precursors to react and form dioxins. EPA recommends use of this approach to prevent formation of dioxins in municipal incinerators. Prior to entering the wet scrubber and a few seconds after leaving the combustion chamber, glass melter exhaust gases are approximately 300°F lower than the combustion chamber temperature. Thus, only rarely is it possible for any PCDDs to form, and the time is exceedingly short.

PCDD formation is thought to occur on the surface of ash particles. The limiting factor in this formation scenario is the available surface area on ash at temperatures low enough for dioxin formation to occur. The glass melter has a liquid surface instead of an ash grate and thus will have a much smaller surface area for dioxin formation than the ash surface. The glass surface will also be very close to the bulk glass temperature due to conduction and convection and to its high specific heat. Airborne particulates will encounter the same rapid cooling experienced by the gases and will not encounter favorable temperature regimes for PCDD formation.

The conclusion is that any PCDDs or precursors will be eliminated effectively by the incinerator. The rapid quenching of the combustion gases effectively eliminates the possibility of formation of PCDDs in the gas phase, while the nature of the surface of the glass and the rapid cooling of any particulate matter minimize the possibility of PCDD formation on ash surfaces. Therefore, there is no perceived risk due to PCDDs in the glass melter.

REFERENCES

EPA (U.S. Environmental Protection Agency). 1985. Hazardous waste management system; Dioxin containing wastes. Federal Register 50:1978-2005, January 14, 1985.

EPA (U.S. Environmental Protection Agency). 1986a. Superfund Public Health Evaluation Manual, EPA/540/1-86/060.

EPA (U.S. Environmental Protection Agency). 1986b. Guidelines for carcinogen risk assessment. Federal Register 51 (185): 33992-34003. September 24, 1986.

Hutzinger, O., M.J., Blumich, M.V.D. Berg, and K. Olie. 1985. Sources and fate of PCDDs and PCDFs: An overview. Chemosphere 14:581-600.

Kociba, R.J. and O. Cabey. 1985. Comparative toxicity and biologic activity of chlorinated dibenzo-p-dioxins and furans relative to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Chemosphere 14:649-660.

Mound. 1987. RCRA Part B Permit Application, EPA I.D. No. OH 6890008984.

Paustenbach, D.J., H.P. Shu, and F.J. Murray. 1986. A critical examination of assumptions used in risk assessments of dioxin contaminated soil. Regulatory Toxicol. Pharmacol. 6:284-307.

Pereva, F. 1988. EPA cancer risk assessment. Science, p.1227, March 11, 1988.

Shaub, W.M. and W. Tsang. 1983. Dioxin formation in incinerators. Environ. Sci. Technol. 17: 721-730.

APPENDIX C: HUMAN HEALTH AND SAFETY

APPENDIX C
HUMAN HEALTH AND SAFETY

C.1 ON-SITE PERSONNEL EXPOSURES DURING ROUTINE OPERATIONS

Radiation Exposure

The principal hazard associated with ^{3}H and Pu, the primary radionuclides processed at the glass melter facility, is internal radiation exposure. Strict precautionary measures have been implemented to prevent the inhalation, ingestion, or absorption of the substances into the body. Engineered controls such as gloveboxes and negative pressure systems have been incorporated into the building design to prevent employee exposure to radioactive contaminants in the glass melter and WD building. Protective clothing and respirators are provided for employees working in these facilities.

The *Mound Nuclear Radiation Protection Program* is designed to maintain employee exposures ALARA. As a part of the program, a health physics surveyor has been assigned to the WD building. The health physics surveyor performs routine area surveys for surface contamination on a weekly basis, collects daily air samples at fixed locations, and monitors specific jobs when necessary. Glass melter and WD building employees are required to leave urine samples on a regular basis; thermoluminescent dosimeters (TLDs) are changed every two weeks; and nose wipe samples are taken at least twice daily. Radiation survey instruments are located near the exits of the WD building to ensure that contaminants are not removed from the facility on hands, shoes, or clothing.

Nonradiological Exposures

Nonradiological hazards were identified during a visit to the glass melter facility and through a review of facility documents. The traditional major industrial safety hazards have been identified and eliminated by design or have been adequately guarded. The remaining risks to operating personnel are primarily related to ergonomics and industrial hygiene. The ergonomic-related risks are associated with material handling. The handling of solid and liquid feed materials and the handling of solidified glass are considered sources of potential employee injury for which there are neither specific regulatory requirements nor site-specific policies.

Risks related to industrial hygiene are controlled to a large extent by the same engineering controls and procedures which maintain radiological exposures ALARA. Additional site programs adequately address all potential industrial hygiene risks with the exception of heat stress. A heat-stress program was being drafted at the time of this report.

Materials Handling The manual materials-handling task, identified as the most difficult to perform during the glass melter operations, requires the moving of 5-gal buckets of high temperature glass from the drain area. Under current practice, containers for draining glass are placed on carts prior to use. These carts are then used to move the containers under the drain, and then to transport the glass away from the drain area for cooling. Moving the carts from the drain fume hood requires awkward body motions, however, to avoid the heated skin of the furnace, the high temperature glass, and glass melter appendages. The buckets filled with the glass weigh approximately 45 kg (99 lb). Bending, twisting, and reaching motions and excessive object weight are undesirable job characteristics that increase the risk of strain-related injuries. No object weight/force evaluation has been performed to determine appropriate application of ergonomics in the redesign of this manual materials-handling task. Employees performing tasks in the immediate vicinity of the furnace also face some risk of burns resulting from contact with heated surfaces and high temperature glass.

Prior to startup of the glass melter for waste processing, an improved mechanical system will be designed and installed to eliminate manual effort, and operator proximity to the high temperature glass containers during the glass draining and the container cooling processes. As currently envisioned, this system will make use of a high temperature resistant, roller conveyor system to transport containers from the glass melter drain fume hood to a separate storage hood at the rear of the room. The conveyor will be either power driven, or placed on a slight incline to allow for gravitational assisted transport of the containers. A hoist system will be used to place cooled glass containers into secondary containment drums or boxes, and standard hand or power driven equipment will be used to load these containers onto a truck for transport to storage facilities.

Two other strenuous materials-handling tasks performed in this operation are: 1) the receiving and movement of 55-gal drums of waste liquids to the feed system hood, and 2) the loading of buckets of glass frit into the glovebox. Both tasks involve weights typically in excess of 32 kg (71 lb). Mechanical aids are available to assist in the movements of the waste drums to the feed line fumehood. Conveyor rollers are used for movement of the waste drum inside the fumehood. Glass frit are presently transferred to the feed hopper by means of a pulley and bucket system. A track system allows the pulley and bucket to be maneuvered into place for filling of the frit feed hopper.

Hazardous Materials Spills. Of the numerous liquid waste mixtures and pure form solvents, a variety of solvents present in the waste inventory and radioactive mixed oils and solvents can cause adverse health effects from acute exposure during a spill. The severity of the impact to human health is dependent upon a multitude of variables including:

chemical composition of the mixture,
duration of exposure,
route of exposure (inhalation, ingestion, skin absorption),
rate of evaporation, and
weather conditions.

Acute exposures to these waste solvents can cause impairments to many of the body's functional systems. Hazardous thermal decomposition byproducts are presented in Table C-1. The quantities of these byproducts from a spill are expected to be very small compared to those of the prime wastes. Thus, detailed analysis showing possible effects of these is not considered necessary.

Noise Exposure. Exposures to noise generated from the offgas handling equipment and the propane burner on the furnace are intermittent as employees enter their areas from the control room located between the offgas treatment area and the furnace area. Propane-burner noise levels are an exposure factor for approximately three days while the glass is converted to a molten state. Once the glass is molten, the propane burner is turned off, and heat is maintained by the joule heaters. The major noise source during routine waste processing operations is the off-gas handling equipment. Measurements taken during operations have determined that sound levels do not exceed 104 dB within the building. Sound levels outside the building are not significant since building walls are constructed of thick concrete blocks filled with insulation, providing an effective sound dampening barrier.

Toxic Contaminant Exposure. Personnel exposures to toxic contaminants may occur during routine operations if volatile solvent vapors escape into the work area.

Personal sampling conducted by Mound industrial hygienists during furnace tests in January 1985 indicated the exposures shown in Table 4.1-4, Occupational Exposures to Airborne Contaminants During Glass Melter Trial Runs. Sampling was conducted for the following materials:

cadmium dust,
phenol,
acrylonitrile,
carbon tetrachloride,
and chlorobenzene.

A comparison of these exposures with the ACGIH TLVs (ACGIH, 1988) and OSHA Permissible Exposure Limits (PELs) suggests the TLV-TWA for the mixture of contaminants was exceeded. The relatively high sample weights in this 42-min sample suggest the work practices and engineering controls in use would not be sufficient to protect employees for an 8-h exposure without the aid of appropriate respiratory protection.

The *Mound Respiratory Protection Program* provides for Health Physics and Industrial Hygiene to jointly evaluate the respiratory hazards associated with this process and to provide appropriate respiratory protection. The respiratory protection program by design protects workers from airborne hazards that are not otherwise controlled.

Table C-1. Thermal Decomposition Byproducts

Solvent	Byproducts
Acetonitrile	Oxides of Nitrogen (NO_x)
Acrylonitrile	Hydrogen Cyanide (HCN)
Benzyl Chloride	Chloride (Cl)
Carbon Disulfide	Sulfur Dioxide ($S0_2$), Carbon Monoxide (CO)
Carbon Tetrachloride	Phosgene ($COCl_2$)
Chlorobenzene	Phosgene
Chloroform	Phosgene
Cresols	Carbon Monoxide
Dichlorobenzene	Phosgene
Dichloroethane	Phosgene
Dichloroethylene	Phosgene
1,4-Dioxane	Explosive Peroxide Formation
Isobutyl Alcohol	Carbon Monoxide
Methylene Chloride	Phosgene, Hydrogen Chloride (HCl)
Methyl Ethyl Ketone	Carbon Monoxide, Oxides of Nitrogen
Nitrobenzene	Oxides of Nitrogen
Nitrophenol	Oxides of Nitrogen
Nitropropane	Oxides of Nitrogen
Pyridine	Oxides of Nitrogen
Tetrachloroethane	Phosgene
Tetrachloroethylene	Phosgene
Trichlorobenzene	Phosgene
Trichloroethane	Phosgene
Trichloroethylene	Phosgene
Trichloromonofluoromethane	Phosgene
Xylene	Carbon Monoxides, Oxides of Nitrogen

Acrylonitrile is not listed in Table 2.1-3 as a typical waste to be processed through the glass melter. Carbon tetrachloride, a toxic substance of concern in the 1985 sample, is listed in Table 2.1-3. Other substances included in Table 2.1-3 that are listed by the ACGIH as potential carcinogenic agents include:

methylene chloride,
trichloroethylene,
1,4-dioxane,
tetrachloroethane

It is assumed that the recorded exposures to glass melter workers occurred principally from their working directly over open waste drums. It is also assumed the dilution of airborne contaminants combined with the negative pressure maintained in the rooms will prevent any exposures outside the glass melter or offgas equipment rooms.

A secondary source of exposure to toxic substances is by direct skin contact. Materials such as 1,4-dioxane, carbon disulfide, and tetrachloroethane provide employees with potential exposures through the subcutaneous route. The use of appropriate personal protective equipment minimizes the risks of such exposures. The *Mound Safety and Hygiene Manual,* section C-1, "Personal Protective Equipment Approval" (EG&G, 1997), specifies the health physics organization for approval of personal protective equipment in radiation areas such as the glass melter facility. Section D-3, "Carcinogen Control Program," provides for the industrial hygiene staff to determine the controls necessary to maintain employee exposures below the established limits. Direct skin contact with glass melter feed materials is a potential exposure for the glass melter employees only.

C.2 EXPOSURE TO THE GENERAL PUBLIC DURING ROUTINE OPERATIONS

Radiological Effects

In the evaluation of off-site radiological hazards, the assumption was made that the radioactive wastes processed will contain the concentrations shown in Table 2. 15. It was also assumed that the unit will operate 8 hours/day, 5 days/week, 52 weeks/year. The resulting quantities of radioactive materials released to the atmosphere are described Section 4.1.1.2.

Nonradiological Effects

The possibility of off-site personnel being affected by the routine operation of the glass melter was evaluated. From a human health perspective, two possible sources of concern were identified: toxic vapor releases and noise. Potential toxic vapor releases are evaluated in Section 4.1.1.1. Potential vapor releases from drum storage or minor spills are not predicted to be above regulatory ceilings at the property line. Noise exposures inside the facility exceed regulatory limits. This condition has been identified and addressed according to site procedures. Noise levels outside the building are not available. Since the source of the noise is equipment located inside the facility, and the building walls and distance to the nearest point off site are expected to attenuate the noise, no perceptible increase in noise is expected off site from the operation of this facility.

C.3 ACCIDENT ANALYSIS

Natural Phenomena

The following paragraphs discuss the potential impacts to glass melter operations from wind and earthquake extremes.

Winds. Two types of winds are considered in this section: straight winds and whirling-type winds (including tornadoes).

> *Straight Winds.* High velocity straight winds in the Miamisburg vicinity are usually associated with severe summer thunderstorms. Straight winds as a result of thunderstorms have been known to reach 60 to 70 mph. Based on 43 years of data, the "fastest mile" straight wind recorded in Dayton was 78 mph (Freeman and Hauenstein, 1983).
>
> The WD building, which houses the glass melter, has exterior walls constructed of concrete block. This type construction is expected to withstand the impact of a 78-mph straight wind without significant damage. It is unlikely that the glass melter or stored waste in the vicinity of the glass melter will be breached by the high wind.
>
> The probability of occurrence of a straight-line wind event that could damage the glass melter building was estimated using force balances and wind frequency data. The effect of wind on a structure is to produce stresses and bending moments which may cause the materials of construction to fail. The balances of force and moment established that tensile stress in the mortar caused by the presence of a bending moment would be the limiting load for a concrete block building such as the WD building,. Using a conservatively selected tensile strength for the material, an allowable overpressure (0.38 psi) was calculated from the moment balance. This overpressure was then related to the steady wind velocity through use of an energy balance and external pressure coefficients. Using a theoretically based empirical correlation (B1evins, 1984), a wind velocity of 155 mph was estimated for the WD building. Hazard curves, which relate return period for natural events to event severity, have been cataloged for DOE facilities. For straight-line winds at the Mound facility, the return period for a 155 mph wind is greater than a million years (Coats and Murray, 1985). Therefore, the probability of exceeding the estimated threshold in one year is less than 1 .0e-6.
>
> *Tornadoes.* Of the tornadoes that occurred in Ohio during the period 1953 to 1972, 31 occurred in a 1° square centered near Mound Plant (DOE, 1979). Therefore,

tornadoes of sufficient magnitude to damage the WD building and release radioactive and hazardous material from the glass melter cannot be ruled out. Tornado winds exceeding 112 mph (Fujita Class 2) are assumed to directly cause sufficient damage to the WD building and the glass melter that an airborne release would result. Stored waste in the vicinity of the glass melter would also be susceptible to release from a tornado event. Tornadoes are estimated to occur at the Mound site with a frequency of 1.2 x 103/year (Freeman and Hauenstein, 1983).

The estimation of frequency of occurrence of tornado wind forces which might damage the glass melter building is the same as that described above for straight-line winds, with the exception that return period/severity relation is replaced. Using the derived relationship for the Mound site (Coats and Murray, 1985), a return period in excess of ten thousand years is estimated for a 155-mph tornado. Therefore, the probability of exceeding this threshold in one year is 1.0e-4.

Earthquakes. The Mound facility is located in an area where damage might occur from earthquakes. Since the WD building was not designed as a seismic-resistant structure, it is assumed that an earthquake exceeding one-tenth of gravity will directly result in the airborne release of hazardous and/or radioactive waste.

The methodology applied for estimation of probability of occurrence of an earthquake is parallel to that used for wind phenomena. An allowable load is estimated and related to probability of occurrence using hazard curves established for DOE facilities. The allowable load is a peak ground acceleration of one-tenth of gravity and the related return period is 320 years (Coats and Murray, 1984). The probability of exceeding the threshold in one year is 0.003.

Externally Induced Events

Occurrences originating outside the glass melter facility which may adversely impact operations are discussed in the following paragraphs.

Aircraft Crash. A large airplane crashing into the waste disposal building will cause significant damage to the building and the glass melter. This accident assumes a direct hit of the WD building by a large aircraft having a 10,000-lb fuel load. The aircraft is assumed to penetrate the building before the fuel tank ignites and destroys the facility.

Studies related to nuclear power reactors, based on U.S. civil aviation accident data, indicate that the expected frequency of aircraft overflight becomes constant at distances greater than 5 miles from an airport runway. The expected annual frequency is about 3×10^{-9}/flight-miles^2 for commercial aviation and about 7×10^{-9}/flight-miles for general aviation (du Pont, 1981).

Based on a conservatively estimated frequency of 4,000 flights over the Mound facility per year, the expected frequency of an aircraft crash anywhere within the Mound facility boundary is 2.8 x 10^{-5}/y-mi^2. The WD building in which the glass melter is housed represents a "target" area of 1.0 x 10^{-3} mi^2. Therefore, the expected frequency of an aircraft crash into the WD building is 2.8 x 10^{-8}/y. Because of the low frequency of this event, Elder et al. (1986) consider an aircraft crash to be incredible. The consequence and risk of this event were not evaluated.

Adjacent Explosion/Fire. The potential for an explosion or fire from an external source causing damage to the glass melter was evaluated during the course of the analysis. Buildings in the vicinity of the WD building were evaluated to determine their ability to impact the glass melter. The Pyrotechnic Component Fabrication Facility (Building 42) was assumed to represent the greatest hazard potential for the WD building. This building is located approximately 400 ft south of and 50 ft lower in elevation than the WD building. It is conservatively estimated that it would take a blast equivalent to more than 43 lb of TNT outside Building 42 to damage the concrete block walls of the WD building. A blast of this magnitude was not considered a credible event. Therefore, the probability, consequence, and risk of an adjacent explosion were not evaluated. Adjacent fires are unlikely to impact the glass melter operation.

Process-Related Initiators

The process-related accident initiators are grouped according to the energetics involved: high-energetic events, medium-energetic events, and low-energetic events.

High-Energetic Event Initiators. A high-energetic event is defined as one that releases sufficient energy to destroy the primary confinement barrier (glass melter and waste storage drum). The energetics involved from this type event will likely result in the circumvention of the building HEPA filtration system. Therefore, releases from these events will be expected to be unfiltered.

This analysis identified explosion as a potential high-energetic initiator. The preliminary hazards analysis (PHA) identified six explosion scenarios that can result in an unfiltered release to the environment. One of the scenarios identified by the PHA will more likely result in a glass melter pressurization, which is categorized in this analysis as a low-energetic event. The explosion scenarios are described later in this section.

Propane Explosion. The natural gas burner is used to melt the glass before the waste feed is added to the glass melter. After the glass has melted, the energy requirements for raising and then maintaining the bed temperature can gradually be assumed by electrical current. The propane burner is not normally used when waste is fed to the burner. However, in the event of a prolonged loss of electric power, the gas burner would be used to remelt the glass after it contained waste.

If a failure of the burner management system resulted in the continued addition of natural gas to the burner following flameout, reignition will result in a significant natural gas explosion. A propane explosion prior to the introduction of waste can cause serious damage to the building and critical injury to the operator, but no radioactive dose to anyone. This accident is considered a normal industrial hazard in this analysis. In addition to building damage and operator injury, a natural gas explosion following the introduction of waste can result in a radioactive dose to the plant personnel and the public. An event tree that illustrates this accident scenario is shown in Figure C-1.

Evaluation of the probability of occurrence of a propane explosion related to the melter auxiliary heater was based on construction of a simplified fault tree at a conceptual design level of detail. The system was modeled as composed of four subsystems: 1) a storage tank, dual feed valve supply arrangement, 2) an automatic ignition component, 3) a flame detection/feed shutdown circuit, and 4) an air supply subsystem. System failure modes included leakage while not in use, failure to ignite, and loss of flame during operation. Overall event probability was dominated by the failure-while-operating scenario, which included loss of power for more than one-half hour and failure to respond to loss of flame. Base event frequencies were taken from a DOE database (Dexter and Perkins, 1982) and loss of power interval/frequency from a power plant-study (NRC). Overall annual event probability was estimated to be 0.001.

Explosion Resulting from Improper Feed Combustion. Failure in the feeding mechanisms can result in excessive feed reaching the glass melter. Under certain conditions of temperature and pressure, the accumulated, unburned waste can react, causing an explosion. Wastes such as acetonitrile will significantly contribute to this explosion potential. Acetonitrile, under certain conditions of temperature and pressure, is susceptible to deflagration. Because the quantity of acetonitrile to be stored and treated in the WD building is expected to be small, the potential for an acetonitrile explosion is expected to be minimal.

The feed liquid system includes a metering pump, a flow meter, and a shutoff valve. Combustion air is supplied through a combination of supply and exhaust fans. The condition of excess fuel in the melter may occur as a result of feed oversupply coupled with failure to shut down in response to excess flow or through failure to supply adequate combustion air. A simplified fault tree was constructed and solved to derive an estimate of annual probability of occurrence for this event of 0.031. The probability of detonation of the fuel-rich mixture is expected to be low, but no basis was available for quantification; consequently, the derived estimate of annual probability of explosion is equal to the probability of obtaining a fuel-rich mixture.

Offgas Explosion. An explosion in the offgas system was identified as a potential initiator in the PHA. An explosion in the offgas results from ignition of flammable vapors. Incomplete combustion of wastes in the glass melter may result in the release of organic vapors to the offgas system. The circulation of water in the offgas vessels is assumed to preclude an ignition source from contacting the flammable vapors.

Explosion in the offgas system requires incomplete combustion in the melter, failure of the quench system, and presence of an ignition source in the system. As data are not available on potential for incomplete combustion, and ignition may occur spontaneously at the elevated temperature experienced without quench, a conservative upper bound on the probability of this event is provided by the failure probability of the

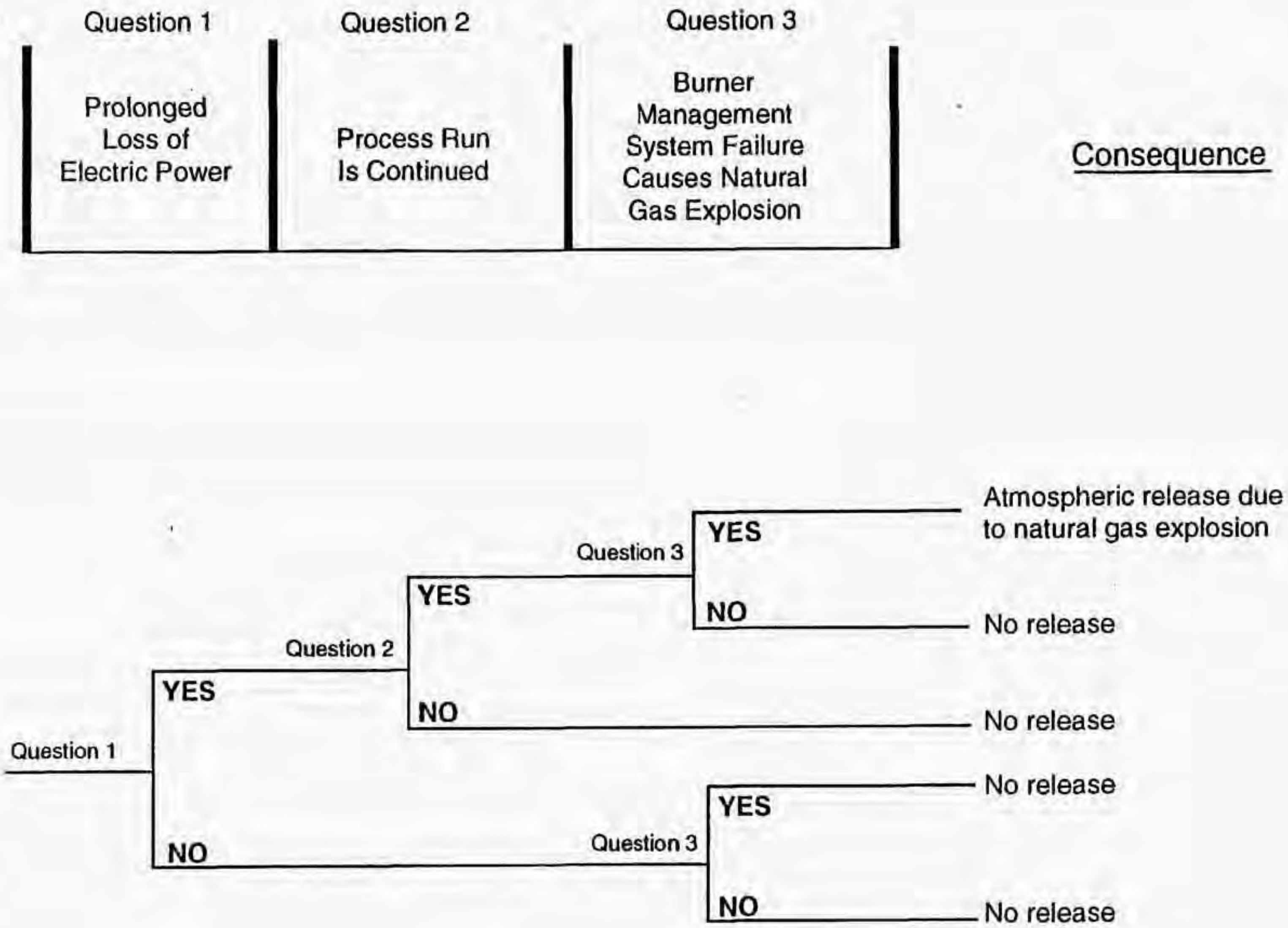


Figure C-1. Natural Gas Explosion Event Tree

loss of offgas cooling/failure to stop waste feed event. As described later in this section, this annual probability is estimated to be 0.003.

Steam Explosion. An accident scenario identified during the course of this analysis involved introduction of a water slurry onto the high temperature molten surface of a glass melter. While the molten glass/water system generally satisfies the necessary requirements for the initiation of a steam explosion, the premixing requirement for a large-scale event is limited to about 0.1 kg of water for a glass melter comparable to that at the Mound Plant (Hutcherson et al., 1984). Detailed stress analysis of the comparable glass melter showed that the design is capable of accommodating an energetic steam explosion well in excess of that involving 0.1 kg of water. This analysis assumes that while a steam explosion is a credible event, pressures developed by the explosion will be insufficient to breach the glass melter. A steam explosion will result in pressurization of the glass melter. The pressure relief device (dip-leg) will relieve the pressure into the building ventilation system. The minimal release of airborne material will be deposited on the HEPA filter.

The steam explosion event requires uncontrolled aqueous waste feed to the glass melter, leading to the accumulation of large quantities of water in the chamber, near instantaneous evaporation of the liquid, and restricted gas flow through the system to produce an over-pressure which might produce a material release. Because of the nature of the feeder, the Mound melter would not be expected to develop these conditions even in the event of operator negligence and feed shutdown system failure (Burkholder and Minor, 1986).

The feed of a large quantity of water scenario was analyzed by formulation of lumped parameter mass, momentum, and energy balances around the melter. In order to facilitate solution of the set of equations, it was assumed that the melter was capable of instantaneously evaporating the largest possible water feed. This eliminated the energy balance and set melter temperature at the operating temperature. This is a conservative approach. A simplified momentum balance was applied to represent the resistance of the offgas system to flow. The resistance coefficient for the system was estimated from the maximum flow and pressure drop conditions specified for the melter offgas system. The volumetric capacitance of the offgas system was neglected in the equations. Again, this is a conservative approach. The equations were solved using a finite difference technique, and input flow rate and effluent resistance were set at ten times the expected values. Even under these conservative conditions, the calculated overpressure was less than 0.1 psi. Consequently, it is concluded that the event, release due to steam explosion, does not occur. The consequences of the event are equivalent to the melter overpressurization event described below. The annual probability of feed-system malfunction leading to high flow without automatic feed shutdown was estimated to be 0.018.

Criticality. The potential for a criticality event in the glass melter was assumed not to be credible based on the following factors:

Most of the plutonium treated in the glass melter is ^{238}Pu.

Gamma scan of the waste is used to detect significant quantities of fissile materials.

The quantity of fissile material permitted in the building is controlled by administrative procedure which holds it to less than the quantity needed to cause criticality.

Concentration of the normally expected waste via the glass melter process is insufficient to cause criticality.

The glass matrix will inhibit any fissile material from forming a critical geometry.

An event tree that illustrates the criticality accident scenario is shown in Figure C-2. Criticality in the recycle tank was identified in the PHA as a potential hazard in the glass melter. A criticality is less likely in the recycle than in the glass melter, since most of the combusted fissile material will be deposited in the glass matrix. Only a small fraction (<10%) of the fissile material in the glass melter is likely to reach the recycle tank. Any fissile material carryover to the recycle tank will be removed by the leaf solution filters in the offgas cooling system.

Criticality events have occurred very infrequently at DOE facilities. The overall frequency for all types of criticality for all facilities is approximately 1.0e-4/year. For the Mound Plant glass melter, the expected frequency would be lower since the waste handled at Mound has a lower concentration of fissionable material than waste handled at other DOE facilities and the total quantity of contaminated waste is small. For example, at the expected average waste-feed concentration, the material could be concentrated continuously for the life of the melter and not reach a critical mass.

Medium-Energetic Event Initiators. A medium-energetic event is defined as one that will breach the confinement barrier (glass melter, glovebox, and storage drum). Initiating factors that can lead to medium-energetic events are discussed later in this section. The release sequence for a medium-energetic event initiator assumes that the building exhaust system and its HEPA filter will continue to filter the airborne release. Fire was identified as the only medium-energetic event in this analysis.

Fire was identified in the PHA as a potential initiating event for the Mound glass melter. Fire sources include the combustible waste (paper, special case, etc.) and propane. Waste drums, screw feeders, and waste feed hoppers are likely places where a fire can occur.

Waste Drum fire. Waste storage drums containing flammable materials are susceptible to ignition from sparks or hot surfaces. Storage of drums inside the room that houses the glass melter also represents a hazard from spontaneous ignition if the building ventilation is off. During glass melter operation, the building ventilation will be operating, minimizing the potential for spontaneous combustion. Assuming operating personnel are present, fire in a drum will be confined to the contents of a single drum. Fire extinguishers are present near the glass melter to facilitate fire suppression. The room that houses the

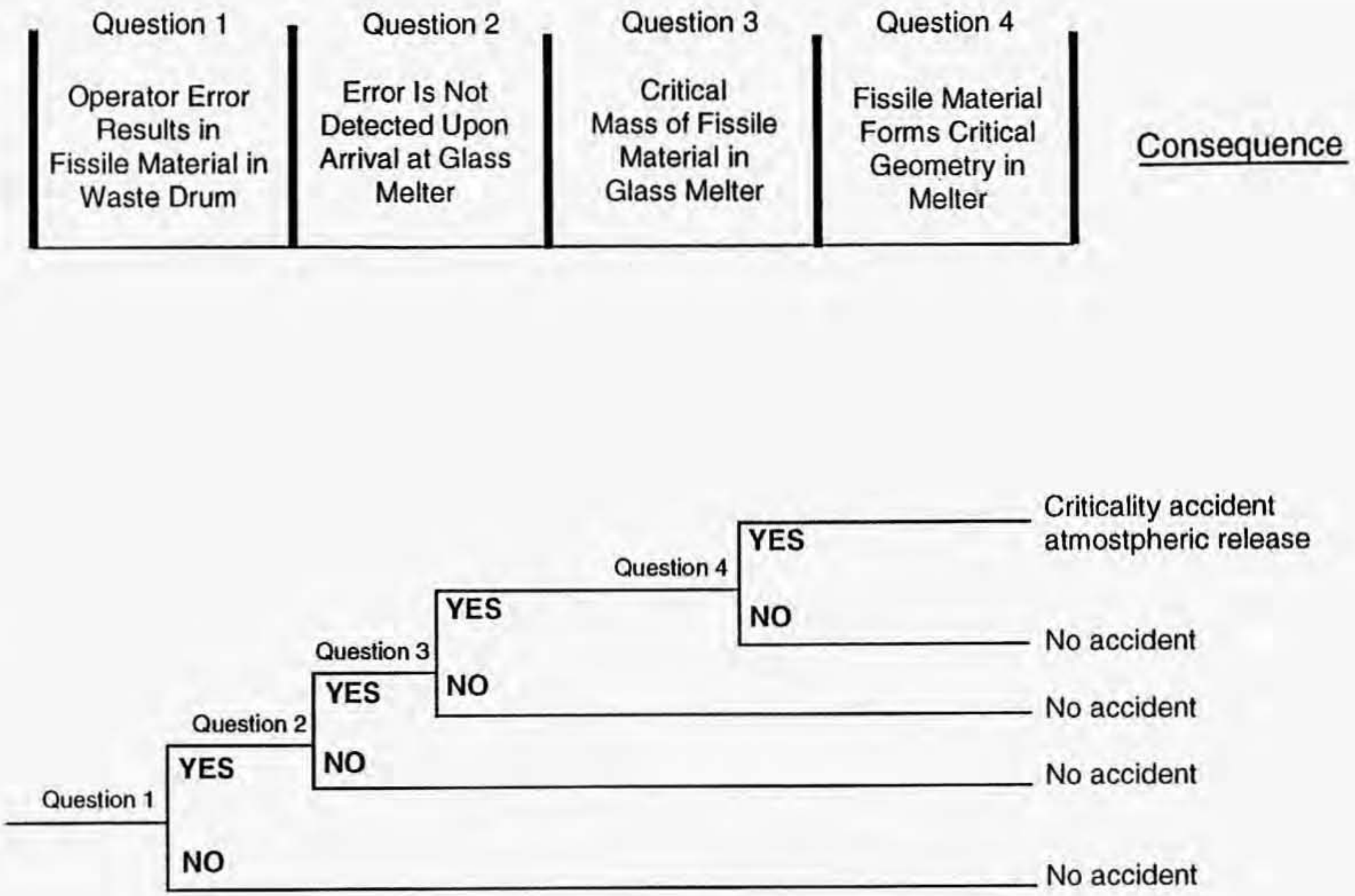


Figure C-2. Glass Melter Criticality Event Tree

glass melter is equipped with a fusible-link sprinkler system that is activated by temperatures above 100°C (212°F).

DOE has considerable experience in the handling and storage of drums containing material with physical and chemical properties similar to the waste to be processed in the glass melter. At DOE facilities, in excess of one million drum-years storage has transpired with only a single drum fire (DOE). Unusual circumstances which contributed to this fire have since been corrected at DOE facilities. At the Savannah River Site (SRS), drums similar to those stored at the Mound facility have accumulated 14,547 drum-years without occurrence of a fire (Hurrel et al., 1988). Since less than two drums are expected to be stored continuously, the predicted annual probability of fire is approximately 0.000001.

Screw feeder fire. Four separate feed systems transport waste to the glass melter. Two feed systems are screw feeders (solid waste) and two are feed tank-type systems (liquid waste). Both screw feeders are enclosed in controlled-air fume hoods. One of the screw feeders is water cooled. Since the other screw feeder is not water cooled, it is assumed to be more susceptible to fires. Sparks caused by operation of the feeder can ignite the wastes. Fires involving this screw feeder are expected to be confined to the fume hood. The event tree for a screw feeder fire is illustrated in Figure C-3.

Fire in the solid-waste screw feeder may occur through generation of a spark in the presence of air. Therefore, occurrence of this fire requires improper operation of the feeder and failure of the nitrogen purge system. A simplified fault tree estimate of the annual probability of occurrence is 0.038 if the screw feeder is used continuously and 0.002 if the feeder is used 5% of the time.

Waste feed Hopper fire. The sludge feeding system consists of a 55-gal hopper and an "open-throat" sludge pump. The pump delivers waste to the glass melter through a nominal 2-in. pipe. The PHA identified hopper fire as a potential hazard for the glass melter. Flashback from the glass melter combustion chamber can result in ignition of the waste in the hopper. This scenario requires failure of the nitrogen purge system that maintains the waste in an inert atmosphere.

The liquid feed system consists of a 55-gal feed tank, metering solvent pump, and control valves. The pump delivers the waste to the glass melter through stainless steel tubing. Flashback from the glass melter combustion chamber can also result in ignition of the solvent in the feed tank. This scenario would also require failure of the nitrogen purge system. The event tree for a waste feed hopper fire is illustrated in Figure C-4.

Fire at the liquid-waste feed hopper requires flashback through the feed system. This is possible on loss-of-flow and requires ignition at the melter, failure of the feed pump, failure to close the shutoff valve on loss-of-flow, and failure of a check valve. A simplified fault tree was constructed for this system, and annual probability of occurrence of fire in the hopper was estimated to be 0.001.

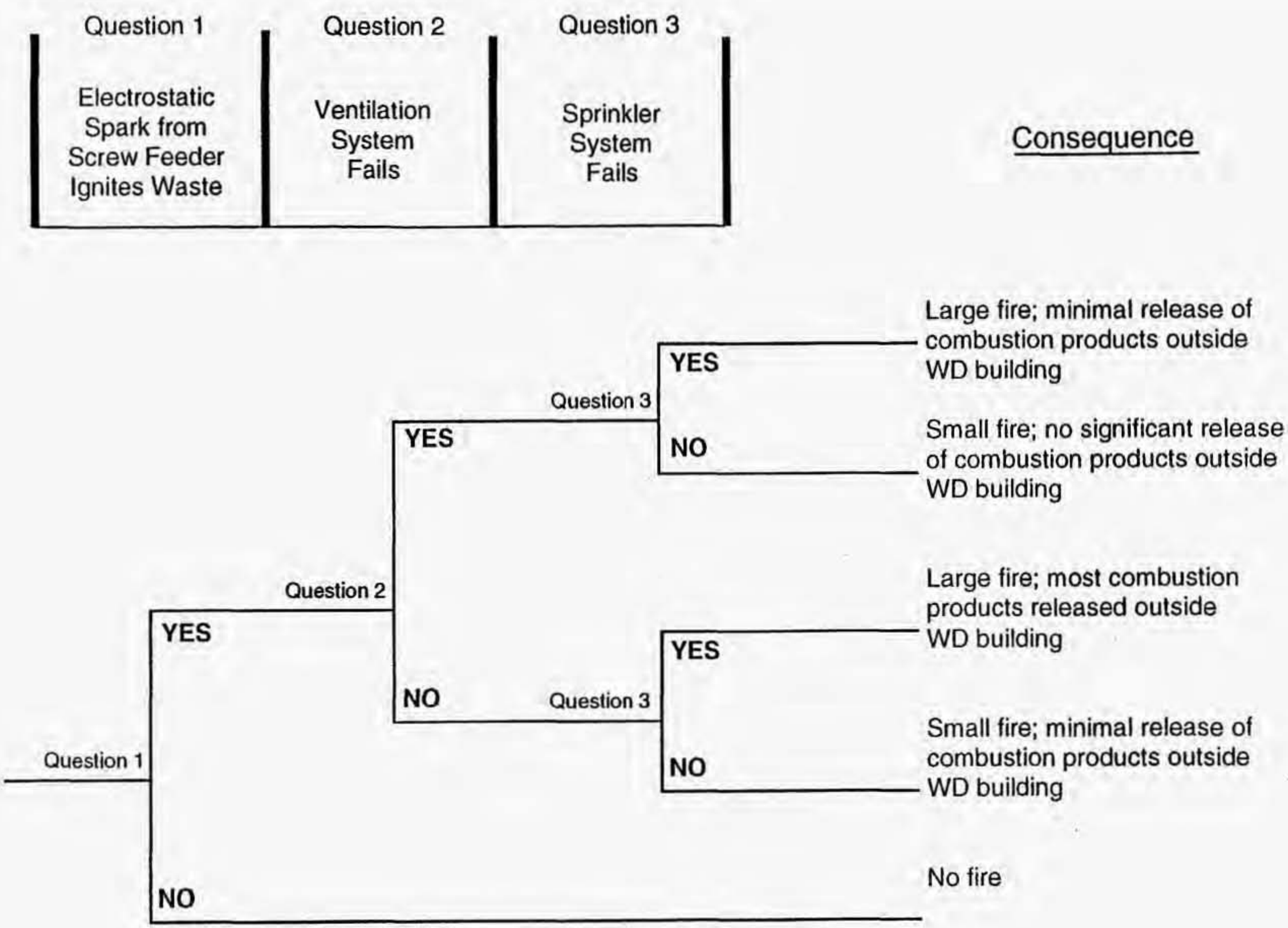


Figure C-3. Screw Feeder Fire Event Tree

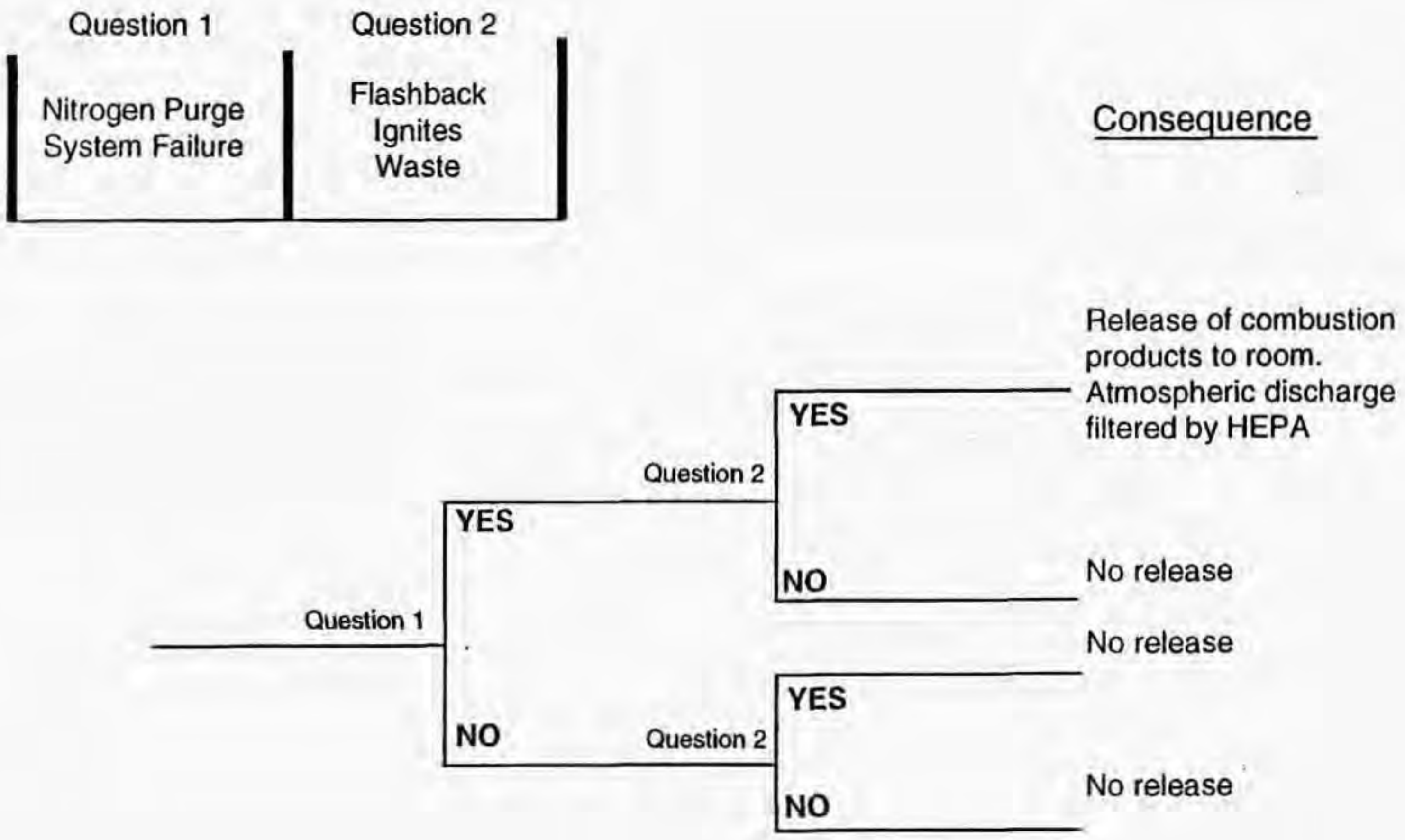


Figure C-4. Waste Feed Hopper Event Tree

Low-Energetic Events. A low-energetic event will not destroy the confinement barrier, but activity may be released from it for a short period. Examples of low-energetic events are pressurization events, glass leaks, refractory breach and loss of offgas cooling.

Melter Pressurization. Pressurization of the glass melter may result in the release of combustion products to the building exhaust. The glass melter is equipped with a pressure-relief system that discharges to the building ventilation system. The pressure-relief system is a water-filled dip-leg. The glass melter can become overpressurized as a result of loss of fan flow or sudden ignition of accumulated unburned waste. A pressurization event could result in the release of combustion products to the HEPA filter. Except under extremely abnormal conditions, the release will be contained in the building by the HEPA filters. Melter pressurization could occur through loss of the exhaust fans. Possible consequences of this event are release through leakage pathways most likely associated with the melter. The estimated annual probability of occurrence of the event is 0.1.

Glass Leak. Abnormal operation of the glass melter may result in a glass leak. The glass is assumed to solidify upon contact with a cooler surface such as the floor. The atmospheric release from such an event is expected to be negligible.

Refractory Breach. Breaching the refractory was identified as a potential hazard for the glass melter. Causes of this event include overfeeding high-Btu waste and electrode failure. The airborne release from this event should be minimal. Most of the airborne release will be contained inside the building by the HEPA filter.

Estimation of the likelihood of breaching the refractory is based upon DOE experience in the operation of joule-heated melters for waste processing. In addition to the Mound experience, refractory corrosion-rate data generated at SRS (du Pont, 1984) and operating histories for the West Valley melter (Barnes et al., 1986) have been reported. Measured corrosion rates project 20-year life for the Mound melter, and no breaches have been reported with typical operating lifetimes of greater than 5 years. Therefore, the annual probability of breech is conservatively estimated at less than 0.2 for the Mound melter.

Loss of Offgas Cooling. Because of extremely high temperatures in the glass melter (>1000°C), considerable offgas cooling is required to maintain the integrity of the exhaust system. Failure of the offgas cooling system was identified as a low-energetic event initiator. Failure of the offgas cooling system coupled with failure of the exhaust fans to maintain forced ventilation may result in damage to the HEPA filter, although natural draft and distance from the HEPA filter make this unlikely. This damage will inhibit the ability of the filters to contain the airborne release. Failure of the offgas cooling system will also increase the atmospheric releases from the glass melter process. An event tree that illustrates a loss-of-offgas cooling event is shown in Figure C-5.

Loss of offgas cooling leading to a release of contaminated material requires failure of the quench recirculation pump and failure to shut down the melter feed system. The

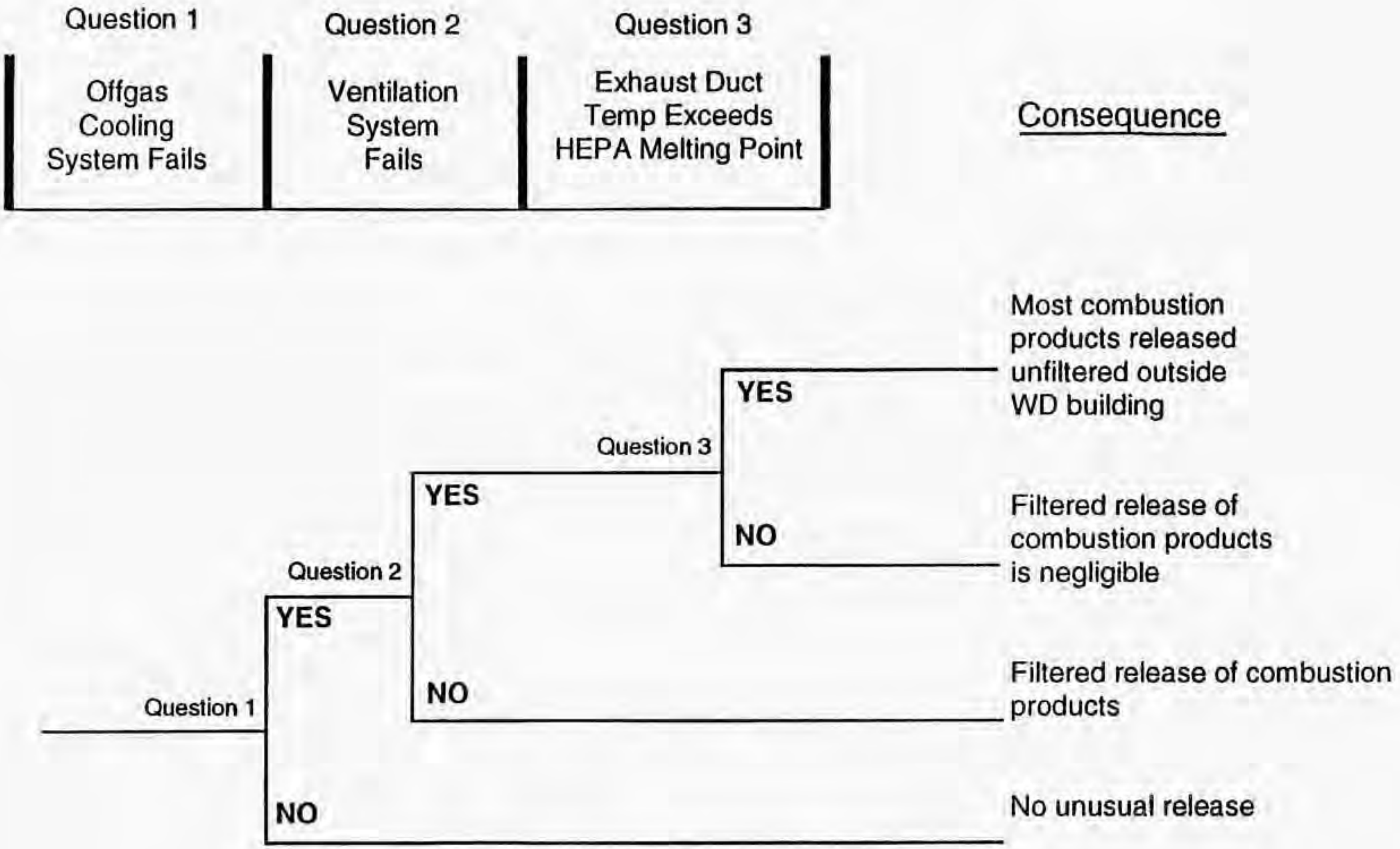


Figure C-5. Loss of Offgas Cooling Event Tree

primary shutdown system is based on flow measurement with a backup temperature measurement system providing redundancy. Exposure of the HEPA filters to hot offgas is assumed to result in complete failure. A simplified fault tree was constructed for this system, and the derived annual probability of the event was estimated to be 0.003.

Maximum Credible Accident Scenario

Several factors in combination were considered in the development of the maximum credible accident scenario. Foremost, an unconfined fire of mixed wastes is assumed to be the greatest potential source of toxic contamination spread. The location at which the greatest quantity of mixed wastes is assembled is the loading dock/storage area outside the glass melter building. At this location there is no fixed fire suppression; therefore, control of such an event will rely entirely upon employee response for detection, reporting, and suppression. This area is not normally occupied. Ignition sources can include direct sunlight on sealed drums, lightning, or nonrelated activities (smoking, cutting, welding, grinding, etc.). No obvious ignition sources are present in this area. The total possible release is bounded by the quantity of materials available. To provide a truly "maximum credible" fire, it was postulated that the 10 drums of mixed wastes allowed in the area will contain the toxic solvents listed in Table 2.1-3.

The unpredictable nature of a drum fire precludes development of a scenario which will account for the action of possible missiles from such an event. Drum failures in fires and the projectile nature of drums are more dependent upon drum strength than content volatility.

Actual drum fire reports from TEMA indicate that drums have been projected up to 150 ft vertically. Horizontal projection distance depends upon trajectory. No reports indicate that projections over 100 m occur. While a drum fire that results in the projection of drums from the storage area toward the nearest inhabited area is more spectacular, it will not endanger the public and will result in a smaller point source in terms of toxic contaminants.

The loading dock/storage area scenario is consistent with other DOE operations for storage of waste drums. In addition, the mode of operation at Mound results in limited opportunity for ignition in the exterior area, and sprinklers are provided inside the building. Therefore, the frequency of occurrence of a drum fire is expected to be approximately one per million drum-years (DOE; Hurrel et al., 1988). Since no more than 10 drums are to be stored outside the glass melter building, the annual probability of occurrence of fire in this area is estimated to be 0.00001.

C.4 RESPONSE AND PREVENTION OF ACCIDENT CONDITIONS

The *Emergency Preparedness Master Plan* and the supporting plans establish the framework for ensuring appropriate response to emergency conditions at Mound. The Mound *Fire Protection Program Manual* provides detailed guidelines for inspection, testing, and maintenance of fire fighting equipment and emergency response training. These and other programs were developed specifically for Mound prior to the glass melter. Their implementation addresses many of the anticipated emergency contingencies that can be presented by the operation of the glass melter thermal treatment facility.

The wet pipe sprinkler system provides fire protection to the indoor areas of the glass melter facility. This system is capable of delivering approximately 40 gpm to each sprinkler head. The sprinkler heads in the furnace room are spaced on a 10 ft x 10 ft pattern designed with a fusible link rated at 100°C (212°F).

The supply of propane for the glass melter is available from a source located outside the WD building. The introduction of hazardous or mixed wastes is made only when the glass can be maintained in its molten state electrically. Table 2. 1-3 identifies the suite of solvents likely to be present in the wastes in their maximum expected concentration. These materials constitute a transient fire load in the rooms where they are stored. Table C-2 identifies the flammable liquids in the waste streams, their flashpoints, exposure limits, and target organs.

Table C-2. Chemical Components/Exposure Data

Material	Flashpoint	TLV ppm (mg/m^3)	Target Organs
Acetone	1.4°F	750 (1780)	Resp. Sys., Skin Kidneys,
Acetonitrile	42°F	40 (70)	liver, CVS, CNS, lungs, skin, eyes
Benzyl Chloride	140°F	1 (5)	Eyes, resp. sys., skin
Butylacetone	NA	NA	NA
Carbon Disulfide	-22°F	10 (30)	CNS, PNS, CVS, eyes, kidneys, liver, skin
Chlorobenzene	84°F	75 (350)	Resp. sys., eyes, skin, CNS, liver
Chloroform	Not combustible	10 (50)	Liver, kidneys, heart, eyes, skin
Cresols	178-187°F	5 (22)	CNS, resp. sys., liver, kidneys, skin, eyes
Cyclohexanone	111°F	25 (100)	Resp. sys., eyes, skin, CNS
Diacetone Alcohol	136°F	50 (240)	Eyes, skin, resp. sys.
Dichlorobenzene	151°F	75 (450)	Liver, kidneys, skin, eyes
Dichloroethane	17°F	200 (810)	Skin, liver, kidneys Resp.
Dichloroethylene	36-39°F	200 (790)	sys., eyes, CNS
Dimethylsulfoxide	192°F	NA	Skin, eyes, GI tract
1,4-Dioxane[a]	54°F	25 (90)	Liver, kidneys, skin, eyes
Ethanol	55°F	1000 (1900)	Eyes, skin, CNS, GI tract
Heptane	25°F	400 (1600)	Skin, resp. sys., PNS Skin,
Hexane	-7°F	40 (180)	eyes, resp. sys. Eyes, skin,
Isobutyl Alcohol	82°F	50 (150)	resp. sys. Eyes, skin, resp.
Isopropanol	53°F	400 (980)	sys. Eyes, resp. sys., skin
Maleic Anhydride	215°F	0.25 (1)	Eyes, skin, CNS, GI tract
Methanol	52°F	200 (260)	Skin, CVS, eyes, CNS
Methylene Chloride	None	50 (175)	CNS, resp. sys.
Methyl Ethyl Ketone	22°F	200 (590)	Eyes, resp. sys., CNS,
Methyl Isobutyl Ketone	73°F	50 (205)	GI tract, blood
Mineral Spirits	104°F	100	Skin, eyes, resp. sys., CNS
Naphthalene	174°F	10 (50)	Eyes, blood, liver, Kidneys, skin, RBC, CNS
Nitrobenzene	190°F	1 (5)	Blood, liver, kidneys, CVS, skin
Nitrophenol	NA	NA	NA
Nitropropane[a]	82°F	10 (35)	Resp. sys., CNS
Petroleum Naptha	100-109°F	100	Resp. sys., eyes, sin
Phenol	174°F	5 (19)	Liver, kidneys, skin

Table C-2. Chemical Components/Exposure Data (continued)

Material	Flashpoint	TLV ppm (mg/m^3)	Target Organs
Pyridine	68°F	5 (15)	CNS, liver, kidneys, skin, GI tract
Tetrachloroethane	Not Combustible	1 (7)	Liver, kidneys, CNS
Tetrachloroethylene	Not Combustible	50 (335)	Liver, kidneys, eyes, resp. sys., CNS
Tetrahydrofuran	6°F	200 (590)	Eyes, skin, resp. sys., CNS
Trichlorobenzene	230°F	5 (40)	Liver, skin, eyes
1,1,1-Trichloroethane	None	350 (1900)	Skin, CNS, CVS, eyes
Trichloroethylene	None	50 (270)	Resp. sys., heart, liver kidneys, CNS, skin
Trichlorotrifluoroethane	Not Combustible	1000 (7600)	Skin, heart
Toluene	40°F	100 (350)	CNS, liver, kidneys, skin
Xylene	81°F	100 (435)	CNS, eyes, GI tract, blood, liver, kidneys, skin

[a] Identifies suspect or confirmed human carcinogen.

NA - Not Available

REFERENCES

American Conference of Governmental Industrial Hygienists. 1988. Threshold Limit Values and Biological Indices for 1988-1989. Cincinnati, Ohio.

Barnes, S.M., L.L. Petkus, T.F. Muraski, C.C. Chapman and J.M. Pope. 1986. Reference Vitrification Process and Equipment Description with Results from Checkout Testing, DOE/NE/44139-32, West Valley Nuclear Services Co., Inc., West Valley, NY.

Blevins, R.D. 1984. Applied Fluid Dynamics Handbook, Van Nostrand Reinhold Co., Inc., New York. NY.

Burkholder, H.C. and J.E. Minor. 1986. LFCM Vitrification Technology, Quarterly Progress Report, January-March 1986, PNL-5904-2/UC-70, Pacific Northwest Laboratory, Richland, WA.

Coats, D.W; and R.C. Murray. 1984. Natural Phenomena Hazards Modeling Project: Seismic Hazard Models for DOE Sites, UCRL 53582, Lawrence Livermore National Laboratory, Livermore, CA.

Coats, D.W. and R.C. Murray. 1985. Natural Phenomena Hazards Modeling Project: Extreme Wind/Tornado Hazard Models for DOE Sites, UCRL 53526, Lawrence Livermore National Laboratory, Livermore, CA.

Dexter, A.H. and W.C. Perkins. 1982. Component Failure-Rate Data With Potential Applicability to a Nuclear Fuel Reprocessing Plant, DP-1633, E.I. du Pont de Nemours & Co.. Savannah River Laboratory Aiken. SC.

DOE (U.S. Department of Energy). Final Safety Analysis Report, Waste Isolation Pilot Plant, Carlsbad, NM, Wp 02-9, Rev. 0.

DOE (U.S. Department of Energy). 1979. Final Environmental Impact Statement, Mound Facility, Miamisburg, Ohio, DOE/EIS-0014.

du Pont. 1981. Preliminary Safety Analysis Defense Waste Processing Facility Staged Case, Internal Report DPST-81-241.

du Pont. 1984. Waste Management Program Technical Progress Report, April-June, 1982, DP-82-125-2, E.I. du Pont de Nemours & Co., Savannah River Plant, Aiken, SC.

Elder, J.C., et al. 1986. A Guide to Radiological Considerations for Siting and Design of DOE Nonreactor Nuclear Facilities. LA-10294MS.

Freeman, S.S. and M.F. Hauenstein. 1983. The Mound Site Development and Facilities Utilization Master Plan. Draft MLM-ML-83-50-3001.

APPENDIX D: PERMITTING FOR THE GLASS MELTER THERMAL TREATMENT UNIT

APPENDIX D
PERMITTING FOR THE GLASS MELTER THERMAL TREATMENT UNIT

D.1 RCRA PERMIT

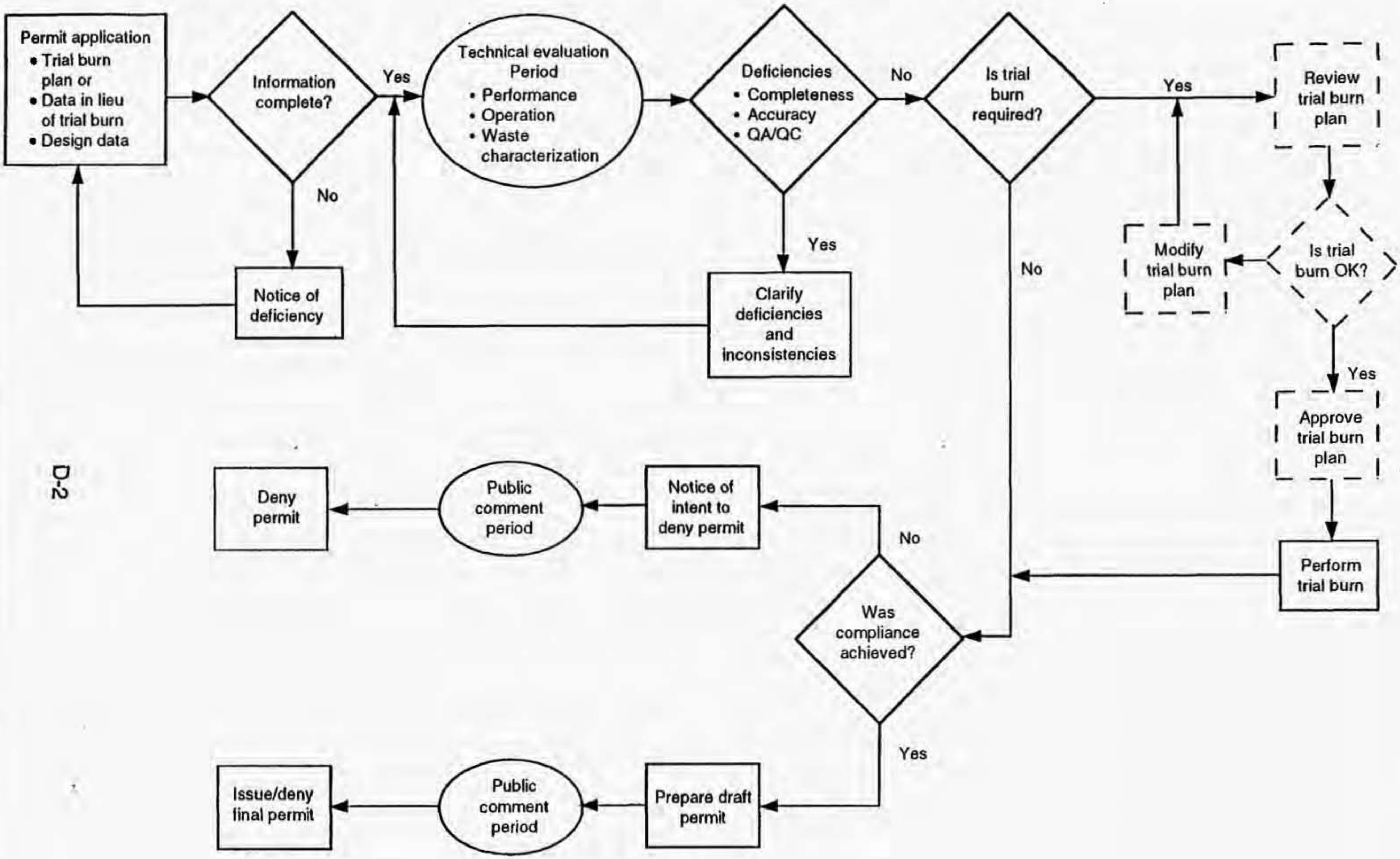
The Resource Conservation and Recovery Act (RCRA) requires the EPA to establish regulations governing the handling of hazardous wastes. Regulations governing incineration of hazardous waste were first promulgated on January 23, 1981, and numerous amendments have been made to date. The regulations that prescribe the permit program and requirements can be found in 40 CFR Part 264, Subpart 0, and Part 265, Subpart 0. The RCRA regulations cover all facilities and set standards for generators and transporters of hazardous wastes including owners and operators of treatment and disposal facilities. The general permit requirements for all treatment, storage, and disposal (TIS/D) facilities are described in Standards For Owners of Hazardous Waste Treatment, Storage, and Disposal Facilities, 40 CFR 264.

The RCRA regulations require all owners and operators of T/S/D facilities to obtain an operating permit from the appropriate regulatory agency. The permit application is submitted to either the EPA Regional Office or a state agency if authority has been transferred. A permit application contains the following information:

description of facility,
description of the waste,
description of maintenance (preventive) procedures,
contingency plan,
inspection schedule and security procedures,
personnel training plan,
closure plan with cost estimate,
and financial statement of owner/operator.

The permitting process for an incinerator usually includes a "trial burn" that determines whether the unit can meet the performance requirements specified by the regulations. It is possible to satisfy this requirement by submitting the current "trial burn" information. The permitting procedure for existing incinerators (operating under interim status permit) is shown in Figure D-1.

40 CFR Part 270 and Part 284, Subpart 0, provide the regulatory requirements for completing the permitting process.



Source: EPA 1989

Figure D-1. Incinerator Permitting Process – Existing Facilities (Interim Status)

D.2 AIR PERMITS

An operating permit for the glass melter is required. A permit application can be obtained from the Ohio EPA (615/644-2270). The completed application will be reviewed by the agency to determine if operation of the glass melter will:

result in emission of more than 250 tons per year of any criteria pollutant, or

cause or contribute to a violation of an NAAQS, or cause excessive ambient concentrations of toxic or hazardous compounds.

National Ambient Air Quality Standards

NAAQS are based on a relationship between exposure to pollutants and the resulting effects on human health and welfare. The primary standards are intended to provide protection to public health. The secondary standards are to protect the public welfare from known or anticipated adverse effects.

Air Toxics Standards

Air toxics standards apply to pollutants which are emitted in addition to the listed criteria pollutants. The state of Ohio has issued a policy on MAGLCs, which cannot exceed the ACGIH TLV divided by 10.

National Emission Standards for Hazardous Air Pollutants

A NESHAP permit pertaining to emissions of radionuclides is required for a facility if the effective dose equivalent from the facility is greater than 0.10 mrem/y. If the glass melter causes an effective dose equivalent greater than 0.1 mrem/y by all radionuclides and all pathways, then a NESHAP permit is required.

D.3 SOLID WASTE PERMITS

The preparation and transport of solid wastes (hazardous materials) produced by the glass melter to an off-site disposal area will involve the hazardous materials transportation regulations promulgated under the HMTA (Pub. L. 93-633) as well as RCRA (for RCRA wastes). It is assumed that CERCLA, SARA, and SARA Title III will not be involved. The OSH Act prohibits OSHA from exercising regulatory authority over working conditions of employees where another federal agency has already exercised its regulatory authority. However, DOE and DOE contractors are subject to OSHA's Hazard Communication Standard (29 CFR 1910.1200) by virtue of DOE Order 5480.4. which adopts 29 CFR 1910 as mandatory as a matter of policy (SAIC, 1988).

REFERENCES

29 CFR (Code of Federal Regulations) Part 1910.1200.

40 CFR (Code of Federal Regulations) Parts 264 and 265.

40 CFR (Code of Federal Regulations) Part 270.

40 CFR (Code of Federal Regulations) Part 284.

DOE (U.S. Department of Energy) Order 5480.4.

EPA (U.S. Environmental Protection Agency), Office of Solid Waste and Emergency Response. 1989. Handbook: Guidance on Setting Permit Conditions and Reporting Trial Burn Results, Volume II of the Hazardous Waste Incineration Guidance Series.

SAIC (Science Applications International Corporation). 1988. Transportation of Hazardous Wastes and Substances Training Manual. Prepared for U.S. Department of Energy, Transportation Management Division.