YAEC 1660

Seabrook Station Off-Site
Hazardous Chemical Analysis Update

December 1988

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## ABSTRACT

A study was undertaken to update and evaluate the effect of any changes in the amount or type of hazardous chemicals transported past or stored by industries near Seabrook Station. A field survey out to five miles of Seabrook Station and interviews with area emergency management personnel, coupled with Federal Regulatory Guides, were used to assess potential effects to Control Room habitability in the event of a chemical release. The results indicate that the previous evaluation, contained in the Seabrook Station Final Safety Analysis Report, remains valid - i.e., the Seabrook Station Control Room is appropriately protected from hazardous chemical releases.

In addition, an analysis was conducted to assess the effects of a nearby chemical warehouse fire on the Seabrook Control Room if meteorological conditions had been unfavorable. An air quality dispersion model was used to demonstrate that the concentrations from fire combustion products would not have had any adverse effects on the Control Room operators even under worst case conditions.

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## 1.0 INTRODUCTION

As discussed in Regulatory Guide 1.78, "The Control Room of a nuclear power plant should be appropriately protected from hazardous chemicals that may be discharged as a result of ... events or conditions outside the control of the nuclear power plant."[1]

The occurrence of such situations and their possible effect on control room habitability has been reviewed in the Seabrook Station Final Safety Analysis Report (FSAR), Section 2.2, "Nearby Industrial, Transportation, and Military Facilities." That review, last revised in 1982, showed that there were no toxic chemicals stored or used in nearby facilities in any significant amount or transported past the Seabrook Station at a frequency that posed an unacceptable risk.

The demography of the Seabrook Station surrounding industries, however, has changed since 1982. In addition, a recent chemical warehouse fire in the Town of Seabrook drew significant area-wide attention. Accordingly, the results for the FSAR analysis were reviewed with regard to the warehouse fire, and a study was undertaken to update and evaluate the effect of any changes in the amount or type of hazardous chemicals either transported past or stored by industries near Seabrook Station. The purpose of this report is to present the results of these efforts.

Section 2.0 briefly summarizes the methodology and results of the chemical fire analysis, which was conducted by a consultant. A copy of the consultant's report is included as an appendix to this report. Section 3.0 describes the approach and results of the nearby industries update, which is followed by a description of the transportation update in Section 4.0. An evaluation of the Seabrook Station Control Room habitability is contained in Section 5.0. References are presented in Section 6.0.

## 2.0 CHEMICAL WAREHOUSE FIRE

On March 12, 1988, a fire occurred at the Johnson Matthey Company chemical storage warehouse in the Town of Seabrook, located at a distance of 4,800 feet from the nearest Control Room intake for Seabrook Station. Approximately 1,200 chemicals, most in small quantities, were stored in the warehouse.

During the course of the fire, the wind was not directly blowing toward Seabrook Station. As a result, no effects were noted in the Control Room. However, a study was commissioned to determine whether dangerous concentrations of chemicals would have arrived at the Control Room intakes if the wind had been blowing toward the station with a worst case speed and atmospheric stability. ERT of Concord, Massachusetts, conducted the study. Their complete report is presented as an appendix to this report.

### 2.1 Approach

To make their determination, ERT employed an air quality dispersion model.[18] The model was modified to include a maximum concentration-duration event and to account for initial dilution, including building wake effects, plume growth due to dispersion, and plume rise due to both momentum and buoyancy effects. ERT also used the extremely conservative assumption that the entire inventory of warehouse chemicals became airborne during the course of the fire.

### 2.2 Results

The model was run for various stability classes to determine the variation of emission concentration with distance and then define a worst case peak concentration. The peak concentration was then modeled for different wind speeds and a normalized value used to determine the maximum concentration of chemicals at the nearest Control Room intake. The resulting concentrations were compared with worst case Immediately Dangerous to Life and Health (IDLH)* levels (see Table 3 in the appendix) to evaluate possible effects to the Control Room operators.

The calculated concentrations in all cases were below the IDLH level.

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* The IDLH level is "a maximum concentration from which... one could escape within 30 minutes without experiencing any escape-impairing or irreversible health effects."[19]

## 3.0 INDUSTRIAL HAZARDOUS CHEMICALS

### 3.1 Approach

Whether an off-site storage area constitutes a hazard to Control Room habitability is determined on the basis of chemicals stored, the distance from the plant, the design of the Control Room, and the applicable toxicity limits. These parameters are detailed in Regulatory Guide 1.78,[1] and are the principal factors followed in this update, as they were in the initial FSAR evaluation. In particular, the location of facilities reviewed extended out to five miles of Seabrook Station.

The approach used to identify such industries was twofold. First, a survey was performed of the most recent directories of manufacturers.[3,4] Emphasis was placed upon Standard Industrial Classification (SIC) codes of facilities that handle, store, use, or produce potentially hazardous chemicals as defined in Regulatory Guide 1.78.

Second, use was made of public information submitted to local and state authorities as required by the Community Right-to-Know Act passed by Congress in 1986. Commonly referred to as SARA, Title III, the Act mandates the establishment of state and local planning authorities with responsibility to develop emergency plans to be followed in the event of an emergency chemical release. The Act also imposes new requirements on a broad range of facilities to report information regarding the presence and release of specific chemicals to these authorities.

### 3.2 Results

A total of 51 industries that store or use hazardous chemicals were identified within five miles of the Seabrook site. They are listed in Table 3.1.

Based upon a review of each facility's SIC code, product line, employment level, a physical survey of its location, and interviews with local officials,[5-8] fifteen were selected as requiring further investigation for potential impact. Each facility was then contacted to determine the type, use, and amount of hazardous chemicals at its plant site. The information is summarized in Table 3.2.

From Table 3.2, it can be seen that nine of the facilities reported limited use, storage, or production of hazardous chemicals. Typically, materials are stored in drums of 55 gal. or less. The six other facilities provide, or may provide, sufficient quantities (usually through bulk storage) of hazardous chemicals to produce a potential hazard to the Seabrook Station Control Room habitability. Figure 3.1 shows the location of these six facilities, and their description is as follows:

1. The Bailey Corporation is located in the Town of Seabrook, one mile west-southwest of the site. Bailey stores Liquid Propane (LP) gas on-site for use in their operations, which include a large paint shop. There are two LP gas storage tanks, each with a capacity of 30,000 gals. In addition, the plant may store approximately 10,000 gals. of paint at one time.[9]

2. The Rockingham Fireworks Company/NH Pyro Products, Inc., is located in the Town of Seabrook, 1-1/4 miles west of the site. The facility uses low energy explosives, primarily black powder, to produce fireworks. The companies maintain nine storage magazines. One magazine (capacity 5,000 lbs.) is utilized for the storage of black powder, but is limited by regulation to 1,000 lbs., according to the owner.[10] The remaining eight magazines are used for storage of the finished product, and have a combined capacity of the finished product is 20,000 lbs.[10]

3. The K. J. Quinn & Company, Inc., is located in the Town of Seabrook, two miles southwest of Seabrook Station, just north of the Massachusetts border. The plant uses several chemicals and solvents in its manufacturing process. Bulk storage is provided for liquified nitrogen (6,400 lbs.), xylene, methyl ethyl ketone, and ethyl acetate, each at 11,900 gals., and 8,500 gals. of toluene di-isocyanate. Drum storage is provided for ethanol (750 gals.),

isopropanol (1,000 gals.), and dimethane di-isocyanate (550 gals.). In addition, up to 10,000 gals. of flammable finished product may be stored.[11]

4. The Sagamore Industrial Finish Company is located in Amesbury, Massachusetts, approximately 4-3/4 miles southwest of the Seabrook site center. The plant has 17,000 gals. of bulk storage for its paints, thinners, varnishes, and industrial solvents. In addition, the plant may have approximately two hundred 55-gal. drums for storage or for shipping out their product.[12]

5. The NANCO facility is a storage depot for industrial gases located in Amesbury, Massachusetts, 4-3/4 miles southwest of Seabrook Station. The facility maintains bulk storage of nitrous oxide (28,000 lbs.), carbon dioxide (62,000 lbs.), oxygen (3,000 gals.), nitrogen (9,000 gals.), argon (1,600 gals.), and propane (2,000 gals.). There is also cylinder storage of helium (34,100 cu. ft.) and acetylene (32,750 cu. ft.), as well as nitrous oxide (2,280 lbs.) and carbon dioxide (8,750 lbs.).[13]

6. The Hysol Aerospace Industries plant is located in the Town of Seabrook, two miles west-southwest of the site. Hysol produces hot melt adhesives and stores bulk quantities of liquified nitrogen and freon of about 100,000 lbs. total. Other chemicals include anhydrous ammonia, corrosives, flammables, and organic solvents, none of which is in bulk quantities. The storage of these materials is either in limited quantity drums or cylinders.[17]

TABLE 3.1
(Sheet 1 of 8)

## List of Manufacturing Firms Within Five Miles of the Seabrook Station

### New Hampshire Manufacturers

| Name of Firm | Address (Sector) | Type of Manufacturing (SIC) | Approximate Number of Employees |
|---|---|---|---|
| Hampton | | | |
| J. D. Cahill Company | Scott Road (N 4-5) | Polyethylene-Coated Paperboard (2649) | 40 |
| Foss Manufacturing* | 380 Lafayette Road (N 3-4) | Nonwoven Textiles (2297) | 190 |
| Whites Welding | 6 Kershaw Avenue (NNE 4-5) | Welding (3446) | 3 |
| Wands, Inc. | 1 Lafayette Road (N 1-2) | Hydraulic Fuel and Electronic Controls (3622) | 17 |
| Rockingham County Newspapers | Depot Square (NNE 3-4) | Newspaper Publishing | 12 |
| Adhesive Technologies | 3 Merrill 2nd Drive (N 3-4) | Hot Melt Adhesives/Glues (2891, 3423) | 40 |
| Carpenter Associates, Inc. | 40 Timber Swamp Road (NW 3-4) | Millwork, Woodworking (2431, 2434) | 25 |
| QA Technology Company, Inc. | 4 Merrill 2nd Drive (N 3-4) | Spring Contact Probes (3825) | 19 |

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TABLE 3.1
(Sheet 2 of 8)

List of Manufacturing Firms Within Five Miles of the Seabrook Station

New Hampshire Manufacturers
(Continued)

| Name of Firm | Address (Sector) | Type of Manufacturing (SIC) | Approximate Number of Employees |
|---|---|---|---|
| Hampton Falls | | | |
| Golden Eagle Coppersmiths | 74 Lafayette Road (N 1-2) | Copper Weathervanes and Lanterns (3645) | 10 |
| Stillmeadow Glass Works | 1 Lafayette Road (NW 1-2) | Blown Glass for Labs (3231) | 4 |
| Kensington | | | |
| None | | | |
| North Hampton | | | |
| None | | | |
| Seabrook | | | |
| Hysol Aerospace Industries* | 1 Dexter Road (WSW 2-3) | Hot Melt Adhesives and Sealants (2891, 3559) | 120 |
| Hale Brothers | Stard Road (W 1-2) | Small Chains (3496) | 7 |
| House of White Birches | Folly Mill Road (SW 1-2) | Publishing Books and Magazines (2721) | 30 |

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TABLE 3.1
(Sheet 3 of 8)

List of Manufacturing Firms Within Five Miles of the Seabrook Station

New Hampshire Manufacturers
(Continued)

| Name of Firm | Address (Sector) | Type of Manufacturing (SIC) | Approximate Number of Employees |
|---|---|---|---|
| Seabrook (cont'd) | | | |
| K. J. Quinn & Company* | 34 Folly Mill Road (SW 1-2) | Industrial Coating Materials (2821) | 40 |
| Rockingham Fireworks/ New Hampshire Pyro Products, Inc.* | Lafayette Road (W 1-2) | Fireworks (2899) | 4 |
| Spherex, Inc. | Walton Road (S 1-2) | Light Duty Wheels (3499) | 75 |
| Bailey Corporation* | 700 Lafayette Road (WSW 1-2) | Plastic, Rubber, and Metal (3465, 3079) | 1200 |
| Withey Cook Associates | 248 Lafayette Road (SW 1-2) | Commercial Printing (2752) | 16 |
| Protective Materials Company, Inc. | Folly Mill Road (WSW 2-3) | Bulletproof Materials (3231) | 40 |
| D. G. O'Brien, Inc. | 1 Chase Park (W 1-2) | Electrical Connectors (3643, 3621) | 150 |
| Amesbury Machine Manufacturing | 142 Batchelder Road (W 1-2) | Rim Clamps (3559) | 30 |

TABLE 3.1
(Sheet 4 of 8)

List of Manufacturing Firms Within Five Miles of the Seabrook Station

New Hampshire Manufacturers
(Continued)

| Name of Firm | Address (Sector) | Type of Manufacturing (SIC) | Approximate Number of Employees |
|---|---|---|---|
| Seabrook (cont'd) | | | |
| Bocra Industries | Batchelder Road (WSW 2-3) | Special Tools and Dies (3599) | 23 |
| Exeter Instruments | 148 Batchelder Road (WSW 2-3) | Medical Instruments (38?1) | 5 |
| Morton Thiokol, Inc.* Chemical Division | Folly Mill Road (WSW 2-3) | Polyurethane Elastomers (2821) | <100 |
| South Hampton | | | |
| None | | | |
| Salisbury | | | |
| Austin Precision Tool | 40 Ferry Street (S 4-5) | Precision Parts and Gauges (3599) | 8 |
| Barton Corporation | 40 Ferry Street (S 4-5) | Custom Shipping Boxes and Crates (2441) | 25 |
| Tucker Machine Corporation* | 284 Elm Street (SSW 405) | Screw Machine Products (3451) | 20 |

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TABLE 3.1
(Sheet 5 of 8)

List of Manufacturing Firms Within Five Miles of the Seabrook Station

Massachusetts Manufacturers

| Name of Firm | Address (Sector) | Type of Manufacturing (SIC) | Approximate Number of Employees |
|---|---|---|---|
| Salisbury (cont'd) | | | |
| Vaughn Manufacturing Corporation* | 386 Elm Street (SW 4-5) | Stonelined Water Heaters and Tanks, Solar Heaters (3639, 2442) | 100 |
| Elm Knoll Farm | 240 Main Street (SW 3-4) | Lumber (2421) | 3 |
| Cambridge Air System, Inc. | 10 Fanaras Drive (SW 3-4) | Ventilating System Components (3144) | 35 |
| Orbit Plastics Corp. | Fanaras Drive (SW 3-4) | Thermoformed Plastic Products (3089) | 25 |
| Amesbury | | | |
| Advanced Absorber Products* | 10 Morrill Street (SW 4-5) | Microwave Absorbers and Radomes (3679) | 21 |
| Amesbury Chair | 63 Clinton Street (WSW 4-5) | Chairs (2521) | 65 |
| Amesbury Metal Products* | 38 Oakland Street (SW 4-5) | Metal Stamping, Fluorescent Lighting Fixtures, Metal Plating (3491) | 100 |

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TABLE 3.1
(Sheet 6 of 8)

List of Manufacturing Firms Within Five Miles of the Seabrook Station

Massachusetts Manufacturers
(Continued)

| Name of Firm | Address (Sector) | Type of Manufacturing (SIC) | Approximate Number of Employees |
|---|---|---|---|
| Amesbury (cont'd) | | | |
| Bartley Machine and Mfg. | Water Street (SW 4-5) | Machinery Parts (3599) | 70 |
| Cado Fabricating | 144 Elm Street (SW 4-5) | Transit Cases, Consoles (Machine Work Only) (3444) | 30 |
| Cargocaire Engineering | 79 Monroe Street (SW 4-5) | Dehumidifiers, Heat Exchangers (3564) | 150 |
| Craig System Division* | 10 Industrial Way (SW 4-5) | Environmental Shelters (3449) | 435 |
| Durasol Drug & Chemical | 1 Oakland Street (SW 4-5) | Erasers, Dental Adhesives, Cleaners (2844) | 20 |
| LeBaron-Bonney Company | 14 Washington Street (SW 4-5) | Upholstery and Top Product Kits (2842) | 55 |
| North Shore Weeklies | 16 Millyard (SW 4-5) | Newspapers and Printing (2711) | 60 |
| Oakland Industries | 11 Oakland Street (SW 4-5) | Sheet Metal Fabrication (3312) | 35 |

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TABLE 3.1
(Sheet 7 of 8)

List of Manufacturing Firms Within Five Miles of the Seabrook Station

Massachusetts Manufacturers
(Continued)

| Name of Firm | Address (Sector) | Type of Manufacturing (SIC) | Approximate Number of Employees |
|---|---|---|---|
| Amesbury (cont'd) | | | |
| R&G Manufacturing (Amesbury Chair) | 63 Clinton Street (SW 4-5) | Chairs, Kitchen Cabinets (2511, 2514) | 120 |
| Sagamore Industrial Finishes* | Rocky Hill Road (SW 4-5) | Industrial Finishes (2843) | 19 |
| Whittier Press | 101 Market Street (SW 4-5) | Commercial Printing (3599) | 5 |
| Erikson-Hedlund Stamponic Company | 33 Oakland Street (SW 4-5) | Tools, Dies (3599) | 8 |
| Flexaust Company | Chestnut Street (SW 4-5) | Flexible Hose (3599) | 50 |
| NANCO* | Railroad Avenue (SW 4-5) | Industrial Gas Depot (4226) | 20 |
| Tech Ceram* | 14 Cedar Street (SW 4-5) | Plastic Products (3089) | 45 |

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TABLE 3.1
(Sheet 8 of 8)

List of Manufacturing Firms Within Five Miles of the Seabrook Station

Massachusetts Manufacturers
(Continued)

| Name of Firm | Address (Sector) | Type of Manufacturing (SIC) | Approximate Number of Employees |
|---|---|---|---|
| Amesbury (cont'd) | | | |
| Aqua Laboratories* | 8 Industrial Way (SW 4-5) | Testing Laboratory (8734) | 15 |
| Eastern Manufacturing Corp.* | 2 Industrial Way (SW 4-5) | Electronic Circuit Boards (3699) | 110 |

* Denotes facility followup concerning hazardous materials.

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TABLE 3.2

Summary of Hazardous Materials Usage

| Facility | Location Direction - Miles | Hazardous Materials Status |
|---|---|---|
| Bailey Corporation** | WSW 1-2 | Storage for 60,000 gals. liquid propane and 10,000 gals. of paint. |
| Rockingham Fireworks** | W 1-2 | Storage capacity for 20,000 lbs. of low energy explosives. |
| K. J. Quinn & Company** | SW 1-2 | Storage for 44,000 gals. of chemicals and solvents. |
| Sagamore Industrial Finishes** | SW 4-5 | Storage for 17,000 gals. of paints, thinners, and finishes. |
| Hysol Aerospace Industries** | WSW 2-3 | Bulk quantities (100,000 lbs.) of nitrogen and freon; unspecified solvents, corrosives, and flammables. |
| Amesbury Metal Products | SW 4-5 | Limited quantities of solvents, oils, and paints used or stored. |
| Advanced Absorber Products | SW 4-5 | Limited quantity of solvents used or stored. |
| NANCO** | SW 4-5 | Storage for 90,000 lbs. of industrial gases. |
| Craig System Division | SW 4-5 | Limited quantities of flammables, corrosives, and compressed gases used or stored. |
| Eastern Manufacturing Corp. | SW 4-5 | Limited quantities of solvents, corrosives, and ammonia used or stored. |
| Tech Ceram | SW 4-5 | Limited quantities of solvents, ammonia, and acid used or stored. |

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TABLE 3.2
(Continued)

| Facility | Location Direction - Miles | Hazardous Materials Status |
|---|---|---|
| Aqua Laboratories | SW 4-5 | Limited quantities of flammables and corrosives used or stored. |
| Vaughn Manufacturing Corp. | SW 4-5 | Tank storage (18,000 - 24,000 lbs.) of urethane. |
| Foss Manufacturing | N 3-4 | Drum storage of flammables, corrosives, and oxidizers (1.200 gallons). |
| Morton Thiokol, Inc. | SW 1-2 | Limited quantities of solvents and propane used or stored; bulk storage of 55,000 gals. of polymers. |

** Bulk storage of potentially hazardous materials.

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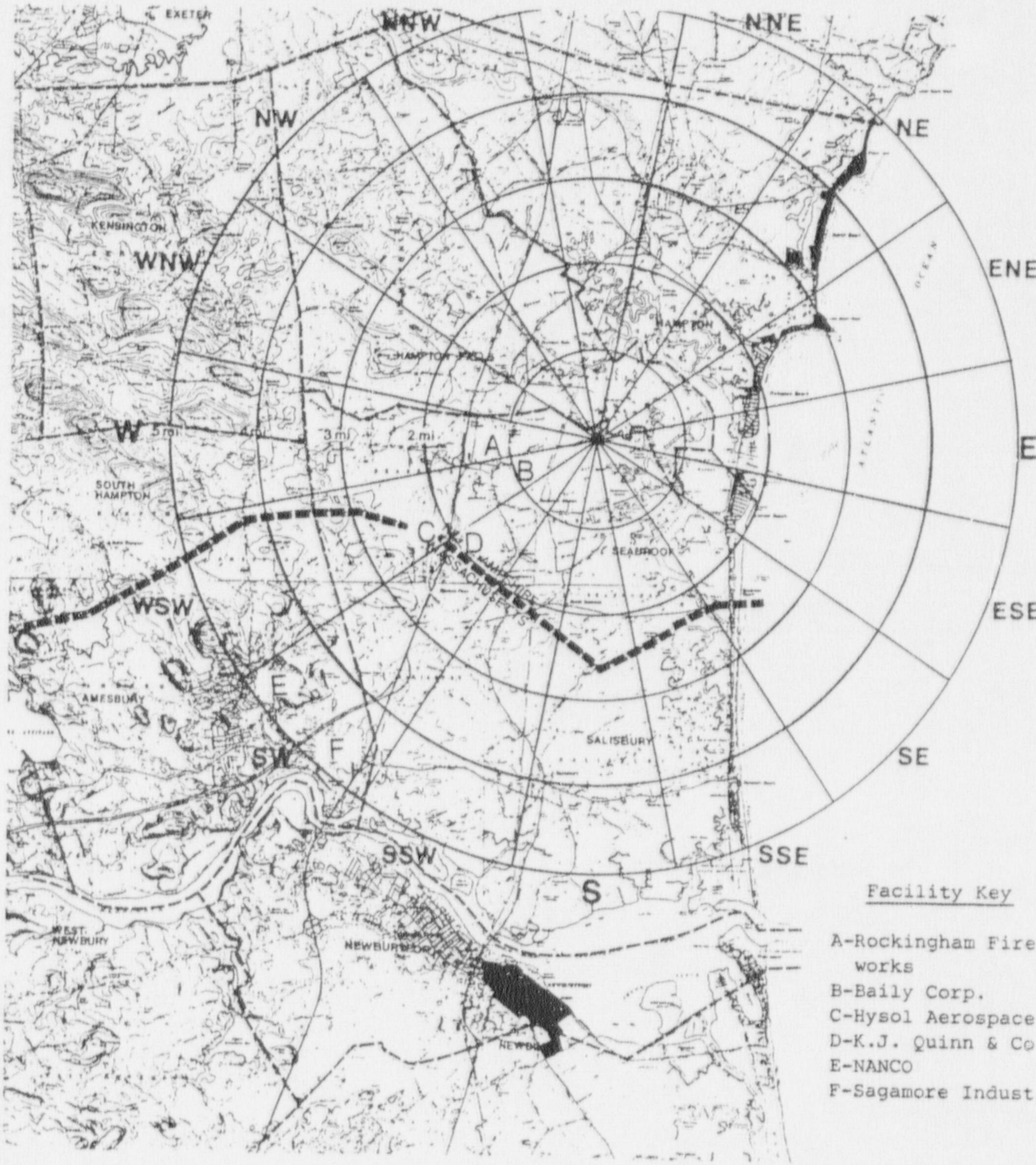
FIGURE 3.1

Facilities With Bulk Hazardous Materials




Facility Key

A-Rockingham Fire-works
B-Baily Corp.
C-Hysol Aerospace
D-K.J. Quinn & Co.
E-NANCO
F-Sagamore Indust.

## 4.0 TRANSPORTED HAZARDOUS CHEMICALS

### 4.1 Approach

As in Section 3.0, Regulatory Guide 1.78 details the parameters needed to evaluate whether the transportation of hazardous chemicals past Seabrook poses a hazard to Control Room habitability. The principal factors to consider are chemical type, quantity, distance, and frequency of transport.

The approach used to identify transported hazardous chemicals was to review and update two earlier studies. The first concerned railroad transportation, and is part of FSAR Section 2.2.[14] The second concerned highway transportation, and was performed in 1982.[21] The results were then compared with Regulatory Guide 1.78 criteria, especially frequency of shipments to determine if further consideration was necessary in the evaluation of Control Room habitability.

### 4.2 Results

Railroad

There is only one rail line that serves the areas within five miles of the Seabrook site, the Boston and Maine (B&M), Salisbury Branch. The branch provides service to areas generally north of Seabrook, as described in the FSAR.[14] Tracks south of the site, however, are present but are not utilized.[22]

There are no hazardous chemicals (vinyl chloride, chlorine, etc.) transported by the B&M on the Salisbury Branch, mostly lumber and plastics.[22] The Newington Branch, north of Seabrook, does transport hazardous materials, but it is located greater than five miles from the site.

Highway

Previous studies[21,23] assessed the transportation of hazardous chemicals by the highway passing Seabrook Station. There were two important results. First, chlorine is the only large-volume hazardous chemical frequently transported past the site - i.e., 16-ton shipments of at least ten per year - that meet Regulatory Guide 1.78. Second, a 16-ton chlorine cargo tank truck accident could result in a buildup to toxic levels of chlorine vapors in the Control Room. A probabilistic hazard model, accordingly, was developed to determine how likely this type of accident is.[21] The result was a distribution of probabilities with the mean probability being $2.8 \times 10^{-7}$ per year.[26]

Recent data[24] showing an increase in the number of chlorine shipments past the site changes the probability. The hazard model previously developed, therefore, was updated to include this new information as well as refinements to other model parameters.

The updated model results now show the probability to be $3.2 \times 10^{-7}$ per year.[26]

## 5.0 EVALUATION

To evaluate the effect on Control Room habitability, the assumptions made in Regulatory Guide 1.78[1] were followed. Of particular importance are the quantity of stored chemicals and the distance to the Control Room. As distances increase, a larger quantity must be released to cause a potentially deleterious effect. Otherwise, atmospheric dispersion will dilute and disperse the released plume to such a degree that the concentration will be of no consequence, or there would be sufficient time for Control Room operators to take appropriate action. In addition, a different methodology recently developed by the U.S. Environmental Protection Agency, et al.,[16] to assess the hazards related to potential airborne releases of hazardous substances, was used to check the results.

Lastly, if the above guidelines were exceeded, the hazardous chemical was viewed with regard to the accident events that may cause its release, and thereby affect Control Room habitability. Such events may be considered acceptable if their probability of occurrence is sufficiently low.

### 5.1 Chemical Warehouse Fire

Even under the most unfavorable meteorological conditions, ERT concluded that "the concentrations of combustion products from the fire would not have adversely affected the ability of the Seabrook Power Plant Control Room operators to perform their duties."[2]

The point is moot, however, because Johnson Matthey does not plan to reopen the warehouse. In addition, the company has removed all hazardous materials from a nearby facility.[20]

### 5.2 Industrial Hazardous Chemicals

Section 3.2, lists those facilities which contain hazardous materials in large enough quantities to be a potential hazard to Seabrook Station. Each was reviewed with regard to the analysis performed in the FSAR, Section 2.2,[14] and new data obtained during this update.

The Bailey Corporation inventory of hazardous chemicals has not changed since last reviewed. Consequently, the analysis of potential accidents in the FSAR (explosion and flammable vapor cloud releases) still applies. This is also the case for the Sagamore Industrial Finish Company.

The Rockingham Fireworks Company and the K. J. Quinn & Company have slightly different inventories than previously reported. The maximum amount of storage for finished product at the fireworks company, for example, has increased. However, applying Regulatory Guide 1.91, the nearest station unit to the company is well beyond the required safe distance for the amount of low energy explosives that can be stored.[15]

Similarly, bulk storage has increased at K. J. Quinn & Company. The additional quantities and the distance from the station, however, are well within the guideline established for Control Room evaluations and emergency planning.[1,16] This also is the case for the NANCO and Hysol facilities, where distance and quantities are within the guidelines.[1,16]

5.3 Transported Hazardous Chemicals

As indicated in Section 4.2, potential hazards to the Control Room depend on the mode of transportation. The railways, on the one hand, are not a concern because no hazardous chemicals are transported within five miles of the Seabrook site.

The highways, on the other hand, pose a potential hazard. In particular, a chlorine cargo tank truck accident could produce toxic vapors within the Control Room under certain conditions. The probability of such an event, however, is very low. Although recent data has increased the likelihood of such an event to $3.2 \times 10^{-7}$ per year, the value still meets the regulatory objective of approximately $10^{-7}$ per year.[25]

Regardless, the probability of this event will decrease in 1990. At that time, the transporter's principal customer for the chlorine is scheduled to discontinue chlorine use.[24] The frequency of transport past Seabrook,

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accordingly, will decrease significantly. The result will be a decrease in the probability of accident occurrence to when little or no chlorine was transported past the site.[21]

## 5.4 Conclusion

All the facilities reviewed that store or use hazardous chemicals have either limited quantities of those chemicals, or are at distances far enough away from Seabrook's air intakes not to affect Control Room habitability. In addition, hazardous chemicals transported past the site do not present an undue risk. The FSAR evaluation of hazards, accordingly, remains valid; i.e., "hazards in the vicinity of the site, due to potential accidents from nearby industrial, transportation ... installations indicate that such accidents cannot affect the safe operation of the plant, and that the probability of those accidents which may affect safe operation is acceptably low, of the order of $10^{-7}$ per year or less. Accordingly, it is not necessary to define any design basis events relating to these hazards."[14]

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## 6.0 REFERENCES


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12. Sagamore Industries Finish Company, Amesbury, Massachusetts, personal communication, September 22, 1988.

13. NANCO, Amesbury, Massachusetts, personal communication, September 21, 1988.

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# APPENDIX

Document No. 7442-001

# Modeling of Combustion Product Concentrations Resulting from the Johnson Matthey Chemical Warehouse Fire

## Final Report

Prepared for:

**Yankee Atomic Electric Company**
Framingham, MA

July 1988

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An ENSR Company

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ERT REF: 7442-001

19 July 1988

Mr. John Snooks
Yankee Atomic Electric Company
1671 Worceste  oad
Framingham, MA 01701

Dear Mr. Snooks:

Enclosed you will find ERT's final report covering the impact of the chemical warehouse fire which occurred in Seabrook, New Hampshire on March 12, 1988. This report confirms our findings communicated you by telephone on Friday, May 27, 1988. Even under the most unfavorable meteorological conditions, the concentrations of combustion products from the fire would not have adversely affected the ability of Seabrook Power Plant control room operators to perform their duties. This conclusion is based upon conservative assumptions regarding the amounts of chemicals released during the course of the fire.

Yours truly,

Michael T. Mills

Michael T. Mills, Ph.D.
Principal Scientist

Document No. 7442-001

# Modeling of Combustion Product Concentrations Resulting from the Johnson Matthey Chemical Warehouse Fire

## Final Report

Prepared for:

**Yankee Atomic Electric Company**
Framingham, MA

July 1988

ERT
An ENSR Company

MODELING OF COMBUSTION PRODUCT CONCENTRATIONS
RESULTING FROM THE JOHNSON MATTHEY CHEMICAL
WAREHOUSE FIRE

## 1.0 Introduction

On Saturday March 12th at approximately 7 pm, a fire started in the Johnson Matthey chemical storage warehouse in Seabrook, New Hampshire, located at a distance of 4800 feet from the nearest control room intake vent for the Seabrook Nuclear Power Plant. The fire in the one-story concrete block building was fueled primarily by wooden shelving, partitions and packaging materials. Approximately 1200 distinct chemicals, most in small quantities, were stored in the warehouse. During the course of the fire, the wind was not directly blowing toward the power plant. The purpose of this study was to determine whether dangerous concentrations of chemicals would have arrived at the control room inlets if the wind had been blowing toward the plant with a worst case speed and atmospheric stability. In making this determination, the extremely conservative assumption is made that the entire inventory of warehouse chemicals becomes airborne during the course of the fire. Section 2 of this report will discuss the method for estimating the quantities of chemicals involved in the fire. This will be followed in Section 3 by a description of air quality modeling assumptions and results. References are presented in Section 4.

## 2.0 Estimation of Chemical Quantities Involved in the Fire

ERT reviewed the inventory of chemicals in the warehouse at the time of the fire. The inventory includes all materials present in the building, without knowledge of which materials or sections of the building were directly involved in the fire. For the emissions calculations, it was assumed that all of the listed materials were subject to the fire, although communications with the New Hampshire Department of Environmental Services(DES) staff and the Johnson Matthey environmental staff indicated that a significant quantity of material was unaffected by the fire( many chemical containers have reportedly been found intact).

The inventory is 139 pages long, listing 25 items per page. Considering that many items had multiple listings( e.g. 2 pages list various forms of copper metal), approximately 1200 distinct chemicals were stored in the building in various quantities. Quantities of individual substances range from grams( e.g. 6 grams of gold sulfide) to over 1000 kilograms( e.g. 1600 kilograms of copper metal). Essentially all of the chemicals were inorganic, with the inventory consisting primarily of pure metals, metal salts and oxides, acids, bases and organometallic complexes. Inorganic compounds based on 73 elements were listed.

The chemistry of fires is complex, and the potential involvement of over 1000 inorganic chemicals compounds the complexity. Fires require a fuel source, usually an organic liquid or gas(such as oil or propane) or an organic solid( such as wood or plastics). The flammability of many chemicals in the inventory was determined using two chemical reference handbooks(References 1 and 2). This review indicated that most of the chemicals are not especially flammable, however several are explosive or would react violently upon contact with air or water. The Seabrook Fire Chief indicated that the fire was primarily fueled by wooden shelving and partitions in the building, which corroborates the supposition that the chemicals were not the primary fuel for the fire.

Toxic chemicals could potentially have been released to the atmosphere during the fire via three mechanisms: combustion, volatilization, and chemical reaction. Combustion generally involves the reaction of a substance with oxygen to produce heat. Combustible substances, such as magnesium and zinc powder, were present in the warehouse. These would form their respective oxides upon combustion. Some of the metal nitrates and perchlorates that were present would also be combustible. The many halogen salts(chlorides, bromides, fluorides and iodides), phosphates and borates present are not generally combustible. In fact, these compounds are used as fire retardants or chemical extinguishers(Reference 3).

The heat of the fire could vaporize some of the solid and liquid chemicals stored in the warehouse. The fire temperature would not be expected to exceed 1000°C during the course of the two hour fire(Reference 3). Although some of the materials present would volatilize at this temperature, most of the pure metal and metal salts have boiling points greater than 1000°C. Of the metals present, only sodium, potassium, rubidium, cesium, cadmium and mercury boil at temperatures lower than 1000°C(Reference 4). Of these, cadmium and mercury are of the greatest concern due to their toxicity.

Chemical reactions between inorganic chemicals in the warehouse could release volatile products to the atmosphere. Based upon the available information, it is impossible to estimate the type or quantity of reaction products formed during the fire. Since any given chemical reaction requires, at a minimum, the direct contact of two or more specific starting materials, it is unlikely that any one metallic reaction product was formed in large quantity during the fire. Some of the likely reaction products of concern are halogens(chlorine, bromine, fluorine or iodine) or halogen acids( hydrochloric, hydrobromic or hydrofluoric acids), formed by the decomposition of chemicals in the fire.

The quantities of the acutely toxic chemicals potentially released during the fire were estimated in a conservative fashion. Acute toxicity, as it is applied here, refers to chemicals which might pose an immediate debilitating human health hazard upon exposure. Carcinogens are not acutely toxic, although they may be potent at low exposure levels.

Acutely toxic compounds were selected by two methods. The National Institute of Occupational Health and Safety(NIOSH) evaluates the toxicity of various industrial chemicals for protection of workers. Table 1 displays the NIOSH IDLH(Immediately Dangerous to Life or Health) limits(Reference 5) for chemicals which could possibly have been released during the fire. Many of the metals in the fire(such as copper, iron oxide, magnesium oxide, etc.) are not acutely toxic and therefore do not have IDLH values. In addition to a review of the NIOSH documentation, a senior ERT toxicologist independently reviewed the list of metal substances in the warehouse to identify acutely toxic materials. Based upon this review, the final list of acutely toxic chemicals potentially released from the fire is shown in Table 2.

Precise calculation of the emitted quantities of each of the substances listed in Table 2 is not possible. For each substance it was assumed that all compounds containing the element or anion(cyanide and carbonyl) of interest were released to the atmosphere during the fire. The chemical inventory was reviewed and the masses of all relevant compounds were totaled to yield a worst-case estimate of the release quantity of each material. These release quantities, given in Table 2, were the basis for the emission rate and dispersion modeling calculations discussed in Section 3.

It is important to recognize that the release quantities calculated are overestimates of the actual quantities released. First, it was assumed that all relevant materials were released to the air. This is unlikely, since not all material would volatilize, combust or react and since parts of the inventory were reportedly unaffected by the fire. Secondly, stoichiometry was not accounted for in the calculations. For example, the entire mass of chlorine compound was included in the sum, even though only a fraction of the compound was the element chlorine. Therefore, the effective mass of chlorine, or any of the other substances is overestimated.

Some items on the inventory could not be readily quantified and, therefore, were not included in the total quantity estimates. Typical examples were metal rods and wire, whose quantities were expressed in units of length or standard solutions of dissolved materials, whose quantities were expressed by volume of a solution of a given concentration. Although metal rods and wire represent a potentially large mass of material, their form makes them less susceptible to combustion. The standard solutions are minor, since they contain a relatively small quantity of toxic material.

## 3.0 Air Quality Dispersion Modeling

To estimate the chemical concentrations associated with the conservative release estimates given in Section 2, an air quality dispersion model was used which accounted for initial dilution(including building wake effects), plume growth due to dispersion, and plume rise due to both momentum and buoyancy effects. The model used was a modified version of the model described in Reference 6. For the purpose of these modeling calculations, it was assumed, based upon conversations with the Seabrook Fire Chief, that the major portion of the fire lasted for 2 hours and that the fire was primarily feed by wooden shelving and partitions. Although no estimate of the amount of wood burned was available, it seems reasonable to assume that at least 1000 kg of wood were consumed during the two hour period. By assuming an average heat of combustion for wood of 19.4 kJ/g, the buoyancy flux for the fire could be computed. According the fire chief, the flames exited the warehouse through a 4 foot by 4 foot hole in the roof, which was opened by the firemen shortly after their arrival on the scene. The dimensions of this opening were used to calculate the momentum rise of the fire plume. Although a flame temperature as high as 1000$^{o}$C could occur in the fire, a conservative value of 600$^{o}$C was used for the modeling. For the building wake effects calculation a building height of 20 feet and an area of 8000 square feet were used. The height of the air intake vent above the ground is 8 feet.

During the actual fire the average wind speed was 1.7 m/s, the average ambient temperature was 33 $^{o}$F, and the stability class was "F". For scaling purposes it was assumed that 1 kilogram of emissions were released during the 2 hour duration of the fire. The variation of concentration with distance and stability class is given in Figure 1. The worst case stability class ("F") turns out to be the stability class which actually occurred. At the distance corresponding to the nearest intake vent(1456 meters), the concentration is estimated to be 0.003

mg/m$^3$. The variation of this peak vent concentration with wind speed is shown in Figures 2 through 6. For each wind speed, the concentration remains at roughly 0.003 mg/m$^3$ due the compensating effects of increased plume dilution and decreased plume rise. This normalized concentration was then used to determine the maximum concentration of chemicals at the nearest intake vent using the kilogram quantities given in Table 2. The resulting concentrations and a comparison with worst case IDLH values are given in Table 3. Even with the extremely conservative assumptions regarding the amounts of chemicals involved in the fire, the calculated concentrations are below the IDLH values.

Table 1. IDLH Values for Chemicals Which Could Have Been Released During the Fire

| Chemical | IDLH Value ($mg/m^3$) |
|---|---|
| Antimony and Compounds | 80 |
| Barium soluble compounds | 250 |
| Bromine | 71 |
| Cadmium dust | 40 |
| Chlorine | 79 |
| Chlorine dioxide | 25 |
| Chromic acid and chromates | 30 |
| Soluble chromic and chromous salts | 250 |
| Cobalt metal fume and dust | 20 |
| Cyanides | 50 |
| Fluorine | 45 |
| Hafnium and halnium compounds | 250 |
| Hydrogen bromide | 181 |
| Hydrogen chloride | 163 |
| Hydrogen cyanide | 60 |
| Hydrogen fluoride | 19 |
| Hydrogen selenide | 7 |
| Hydrogen sulfide | 455 |
| Iodine | 113 |
| Lead arsenate | 300 |
| Manganese | 24,500 |
| Mercury | 28 |
| Nickel carbonyl | 0.0076 |
| Nitrogen dioxide | 103 |
| Osmium tetroxide | 1 |
| Phosgene | 9 |
| Selenium compounds | 100 |
| Sulfur dioxide | 286 |
| Soluble thallium compounds | 20 |

Table 1. IDLH Values for Chemicals Which Could Have Been Released During the Fire(continued)

| Chemical | IDLH Value ($mg/m^3$) |
|---|---|
| Inorganic tin compounds | 400 |
| Uranium and insoluble compounds | 30 |
| Soluble uranium compounds | 20 |
| Vanadium pentoxide fume | 70 |
| Zirconium compounds | 500 |

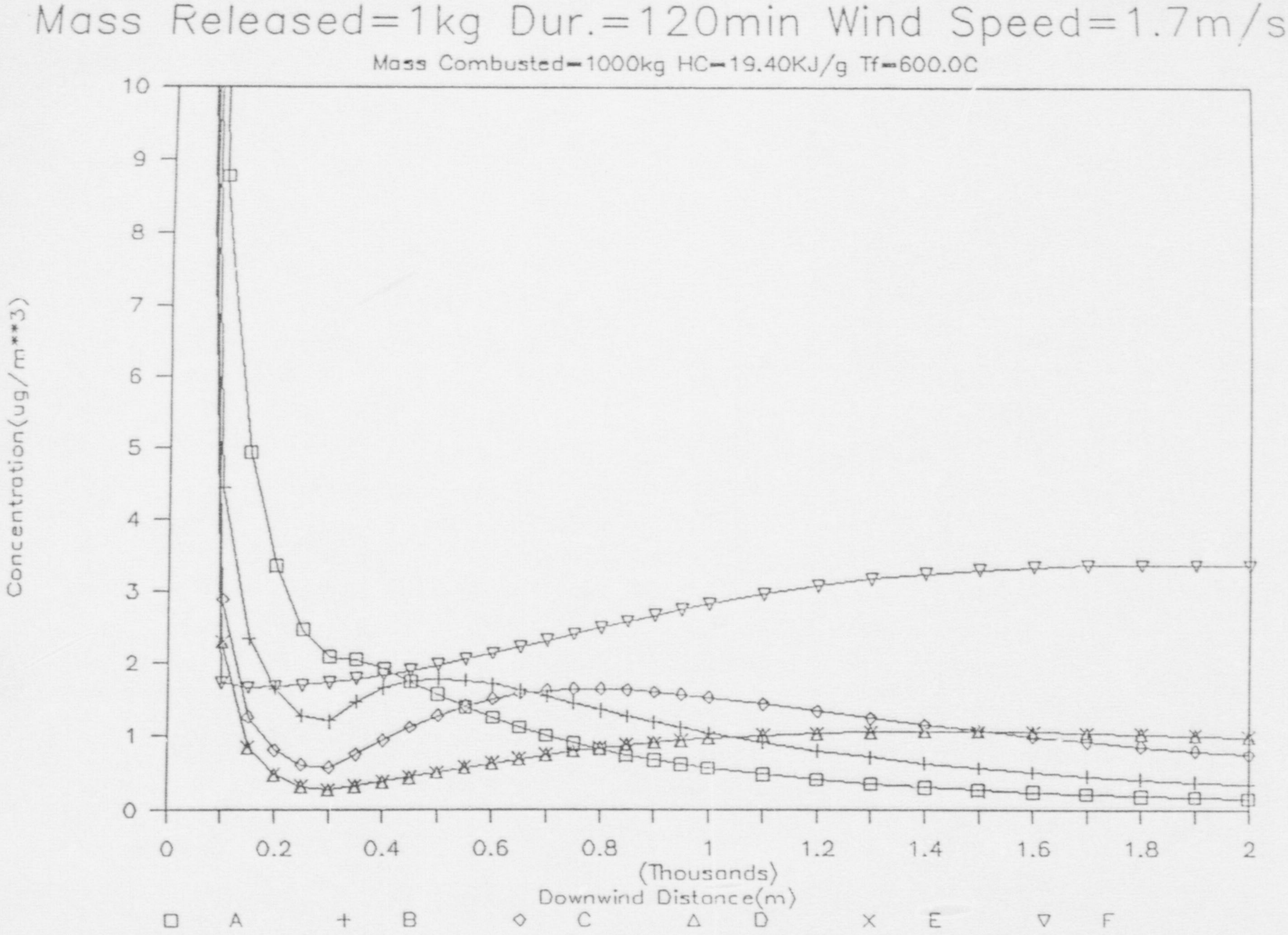
Table 2. Final List of Toxic Chemicals Potentially Released During the Fire

| Chemical Type | Total Mass (kg) | Worst Case IDLH ($mg/m^3$) |
|---|---|---|
| Arsenic compounds | 72 | 300 |
| Cadmium compounds | 257 | 40 |
| Chromium compounds | 2002 | 30 |
| Lead compounds | 771 | 300 |
| Mercury compounds | 165 | 28 |
| Osmium compounds | 0.23 | 1 |
| Selenium compounds | 94 | 100 |
| Bromine compounds | 191 | 71 |
| Chlorine compounds | 1811 | 25 |
| Fluorine compounds | 622 | 45 |
| Iodine compounds | 72 | 113 |
| Carbonyls | 1 | 0.0076 |
| Cyanides | 303 | 50 |

Table 3. Worst Case Calcula'ed Vent Concentrations Compared with IDLH Values

| Chemical Type | Concentration ($mg/m^3$) | IDLH ($mg/m^3$) |
|---|---|---|
| Arsenic compounds | 0.22 | 300 |
| Cadmium compounds | 0.77 | 40 |
| Chromium compounds | 6.0 | 30 |
| Lead compounds | 2.3 | 300 |
| Mercury compounds | 0.5 | 28 |
| Osmium compounds | 0.0007 | 1 |
| Selenium | 0.28 | 100 |
| Bromine compounds | 0.57 | 71 |
| Chlorine compounds | 5.4 | 25 |
| Fluorine compounds | 1.9 | 45 |
| Iodine compounds | 0.22 | 113 |
| Carbonyls | 0.003 | 0.0076 |
| Cyanides | 0.91 | 50 |

Figure 1.



Mass Released=1kg Dur.=120min Wind Speed=1.7m/s
Mass Combusted=1000kg HC=19.40KJ/g Tf=600.0C
Concentration(ug/m**3)
10
9
8
7
6
5
4
3
2
1
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
(Thousands)
Downwind Distance(m)
□ A
+ B
◇ C
△ D
× E
▽ F

Figure 2.

# Mass Released=1kg Dur.=120min Wind Speed=1.0m/s

Mass Combusted=1000kg HC=19.40KJ/g Tf=600.0C

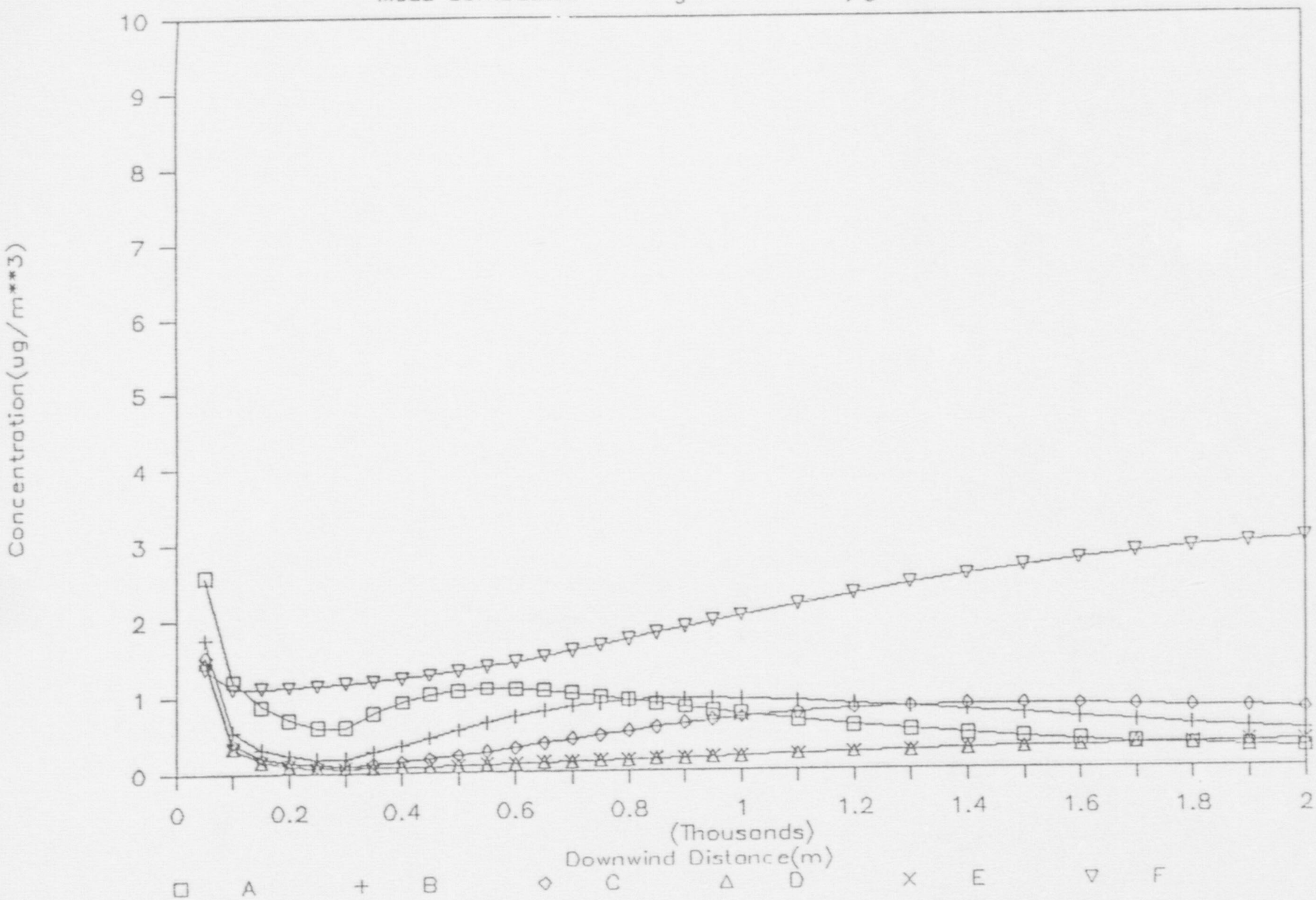
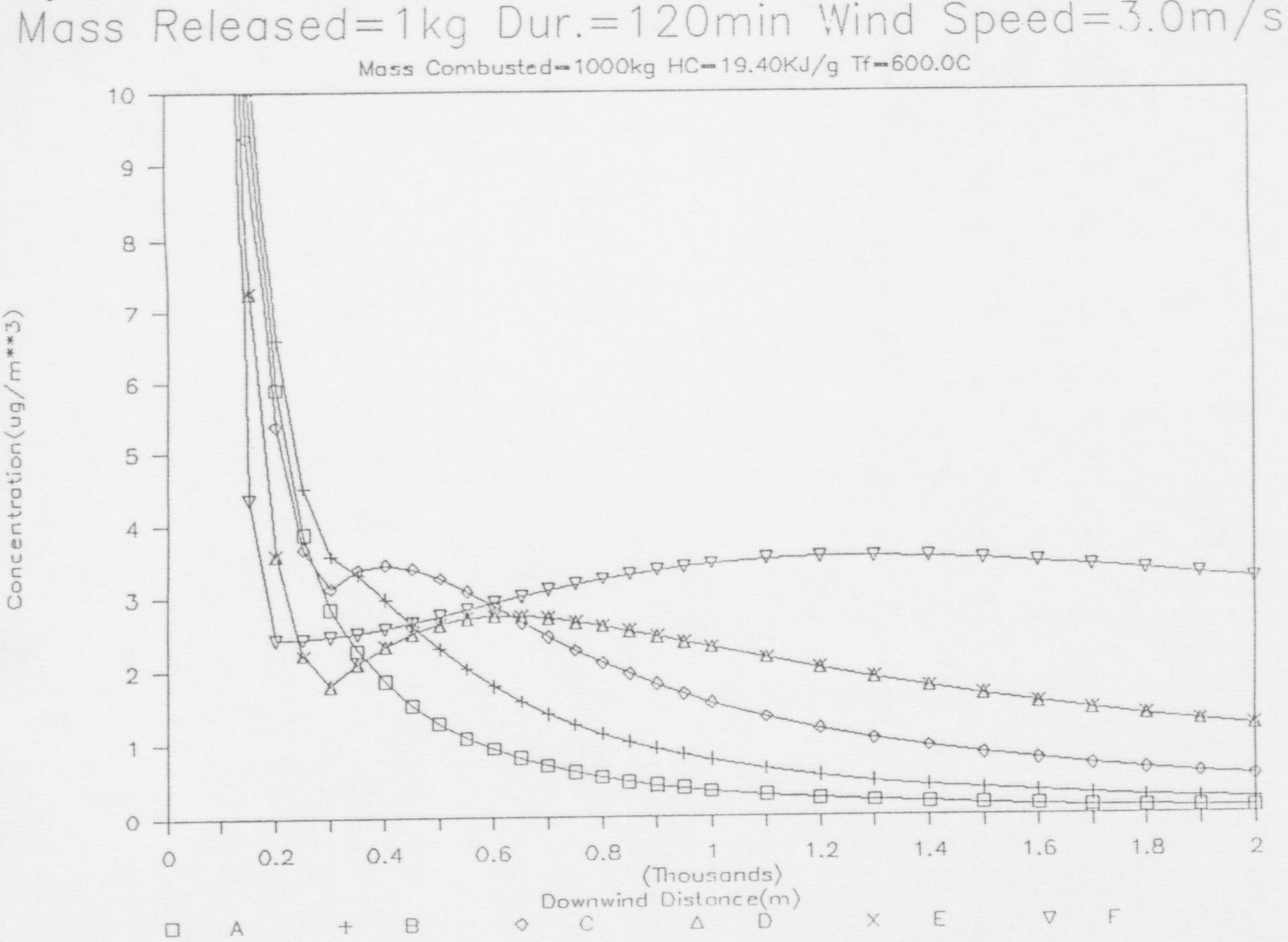


*Figure 3.*



Mass Released=1kg Dur.=120min Wind Speed=3.0m/s
Mass Combusted=1000kg HC=19.40KJ/g Tf=600.0C
Concentration(ug/m**3)
10
9
8
7
6
5
4
3
2
1
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
(Thousands)
Downwind Distance(m)
□ A
+ B
◇ C
△ D
X E
▽ F

*Figure 4.*

Mass Released=1kg Dur.=120min Wind Speed=5.0m/s

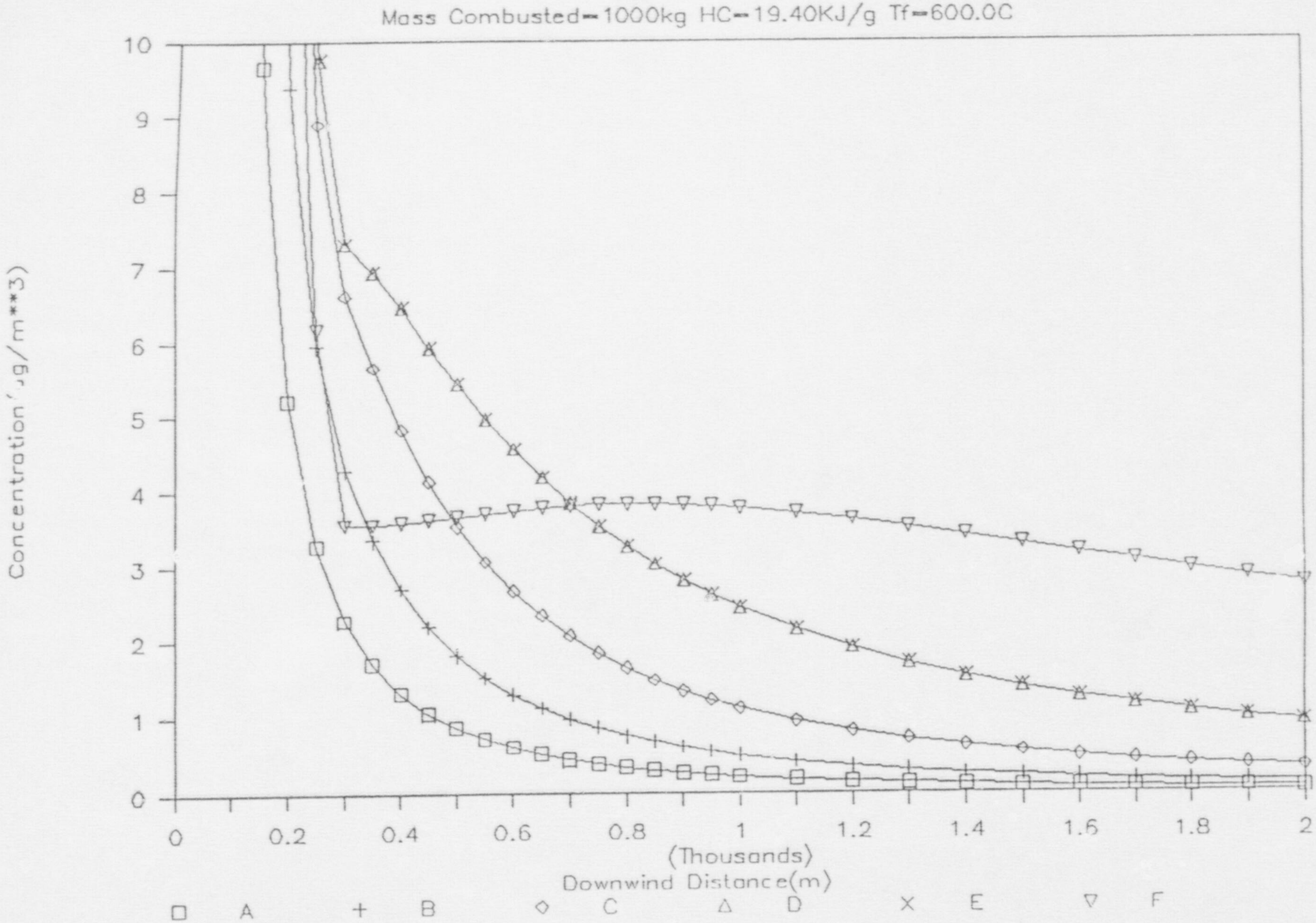


*Figure 5.*

# Mass Released=1kg Dur.=120min Wind Speed=7.0m/s

Mass Combusted—1000kg HC—19.40KJ/g Tf—600.0C

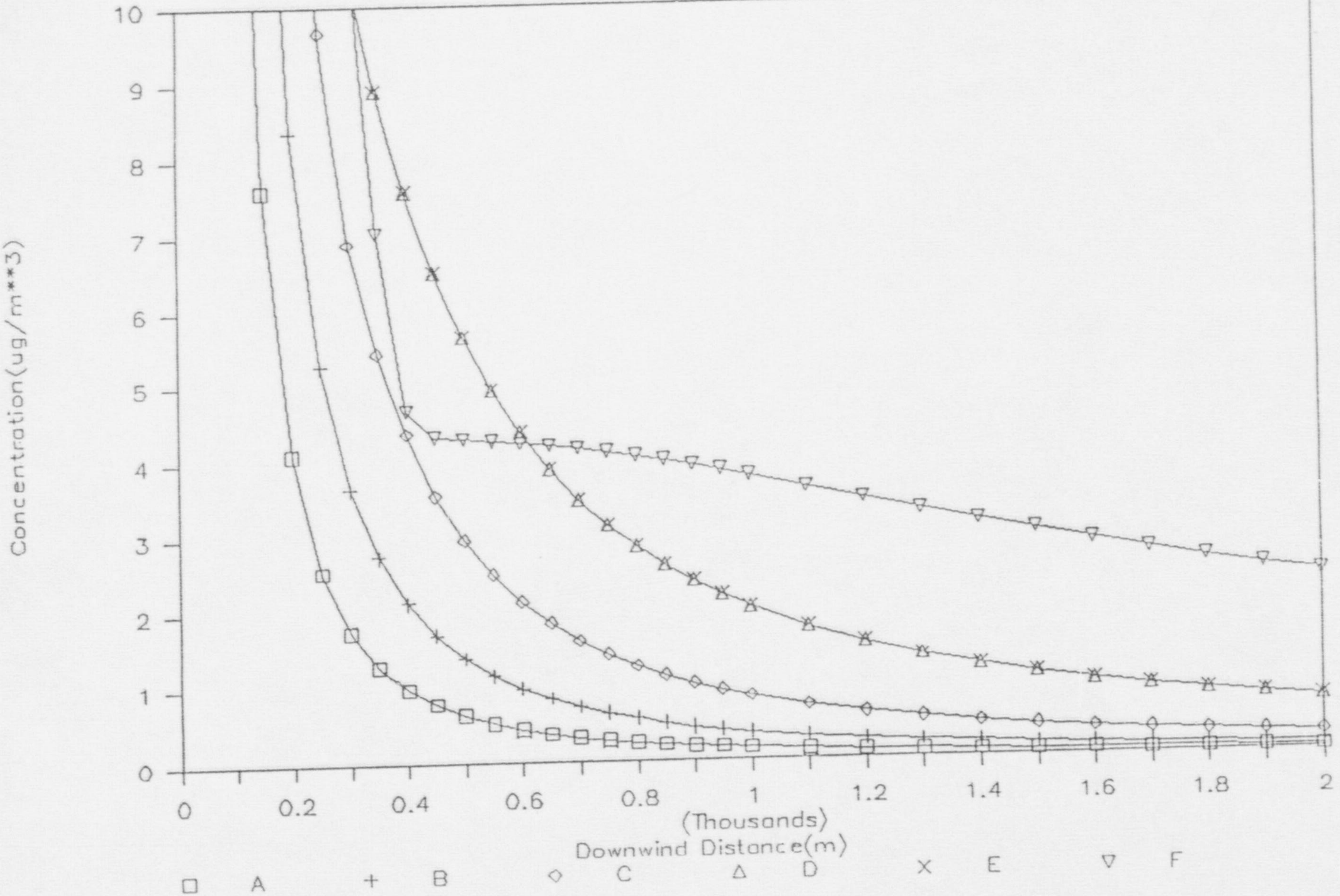
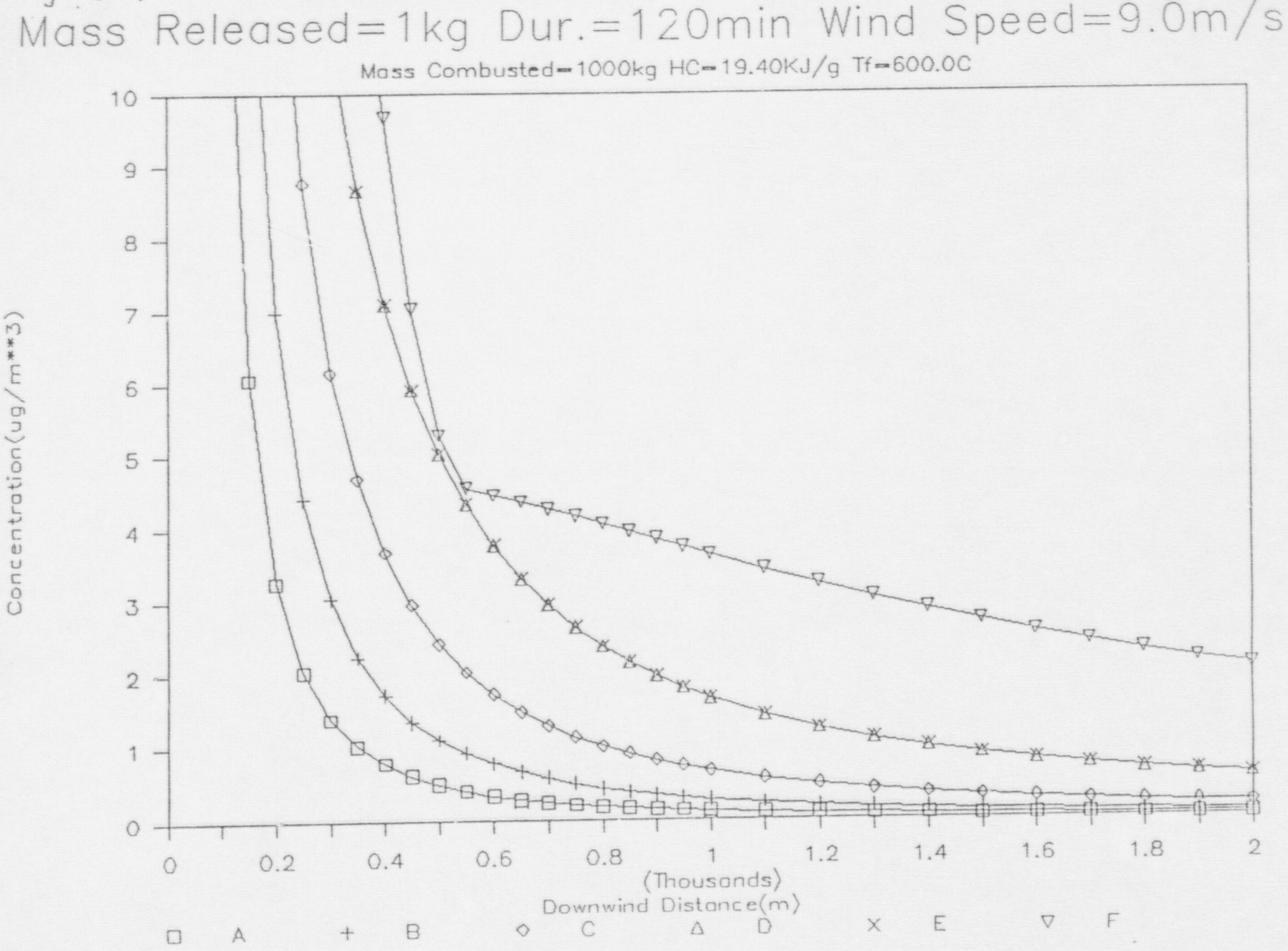


Figure 6.


Mass Released=1kg Dur.=120min Wind Speed=9.0m/s
Mass Combusted=1000kg HC=19.40KJ/g Tf=600.0C
Concentration(ug/m**3)
10
9
8
7
6
5
4
3
2
1
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
(Thousands)
Downwind Distance(m)
□ A
+ B
◇ C
△ D
X E
▽ F

4.0 References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6. Mills, M.T., "Modeling the Release and Dispersion of Toxic Combustion Products from Chemical Fires," paper presented at the International Conference on Vapor Cloud Modeling, November 2-4, 1987, Cambridge, Massachusetts, sponsored by the Center for Chemical Process Safety of the American Institute of Chemical Engineers.

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