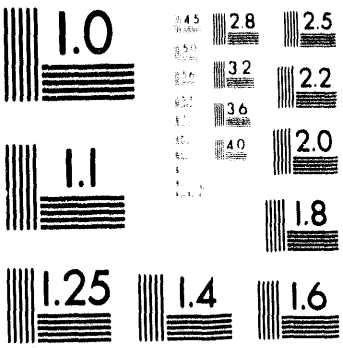
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# FIRE HAZARDS ANALYSIS FOR THE CENTER FOR NATIONAL SECURITY AND ARMS CONTROL (CNSAC) FACILITY

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## Abstract

This Fire Hazards Analysis is sponsored by Plant Engineering and is prepared to support the Safety Assessment for the CNSAC Facility. This is a preliminary fire hazards analysis of a yet to be constructed facility and is based upon the current building design and the current understanding of the potential occupancy hazards. The governing occupancy for this building is personnel offices. The CNSAC facility will be dedicated primarily to two activities: (1) arms control and verification technology and (2) intelligence. This report supplements the Safety Assessment for the CNSAC facility and follows the guidance of DOE Memorandum EH-31.3 and meets the objectives of paragraph 4 of DOE Order 5480.7A, "Fire Protection". This analysis demonstrates that under "worst case" assumptions a fire in the CNSAC facility will result in consequences which are below DOE offsite guidelines for accident conditions. This report is based upon preliminary design information and any major changes to the building design may require additional analyses.

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## 1.0 Introduction

This fire hazards analysis for the Center for National Security and Arms Control (CNSAC) contains all the elements required by paragraph 9.a.(2)(e) of DOE Order 5480.7A, titled "Fire Protection." These requirements are as follows:

1. Description of Construction
2. Fire Protection Features
3. Description of Fire Hazards
4. Protection of Essential Safety Class Systems
5. Life Safety Considerations
6. Critical Process Equipment
7. High Value Property
8. Damage Potential: Maximum Credible Fire Loss (MCFL) and Maximum Possible Fire Loss (MPFL)
9. Fire Department/Brigade Response
10. Recovery Potential
11. Potential for a Toxic, Biological and/or Radiation Incident Due to a Fire
12. Emergency Planning
13. Security and Safeguards Considerations Related to Fire Protection
14. Natural Hazards (Earthquake, Flood, Wind) Impact On Fire Safety
15. Exposure Fire Potential

This is a preliminary fire hazards analysis of a yet to be constructed facility and is based upon the current building design as documented in Reference 1 and the current understanding of the potential hazards. The governing occupancy for this building is personnel offices. The CNSAC facility will be dedicated primarily to two activities: 1) arms control and verification technology; and 2) intelligence. Laboratories will be devoted to such activities as developing methods to monitor certain types of radiation, creating methods to monitor the production or operation of certain military weapon systems, establishing improved methods of interpreting and manipulating the data provided by monitors, and developing and fabricating mechanical, electrical, and optical devices for detection and monitoring. Machine shops will turn out parts for prototype assemblies designed in the labs, machine jigs and fixtures used in experiments, and be used in certain mechanical testing. A small photo lab will provide a processing capability for certain classified photographic products. An unusual aspect of the facility is that approximately two thirds of it will be built to DOE Sensitive Compartmented Information Facility (SCIF)/TEMPEST requirements. A SCIF is a facility particularly constructed for handling and storing sensitive classified information and has special access control. TEMPEST is a code word for compromising emanations; e.g., the electromagnetic signals which are given off by operating equipment such as computers and which might be picked up outside the facility. Special design considerations are required for access control and blocking signals generated in a SCIF facility; however those goals will not interfere with the goal of reaching full compliance with Environment Safety & Health (ES&H) regulations for the CNSAC facility. A threat assessment has been performed for the CNSAC facility using DOE/HQ guidelines and it has been determined that no special shielding of the SCIF portion of the building will be required. TEMPEST protection will be accomplished by the appropriate level of RED/BLACK separation of power and communication systems.

## 2.0 Description of Facility Construction

The Center for National Security and Arms Control (CNSAC) facility will be built in Technical Area I at Sandia National Laboratories on Kirtland Air Force Base located in Albuquerque, New Mexico. It will be built in the area bounded by I street on the north, 9th street on the east, KAFB perimeter fencing on the south and Sandia Buildings 805 and 807 on the west (See Figure 2.1). The area currently contains several temporary buildings and two older permanent buildings of substandard construction quality. Removal of these building will constitute the first phase of construction. The facility will house approximately four hundred people and will contain approximately 153,000 gross square feet and 86,000 net square feet.

The CNSAC facility consists of two structures: a four-story light Laboratory/Office structure and a Lobby/Conferencing structure. The entire facility was designed to the following codes: Uniform Building Code (UBC) 1988, DOE Order 6430.1A General Design Criteria, National Fire Protection Association (NFPA) 101 Life Safety Code, as well as other applicable building codes as required by DOE Order 6430.1A.

The Laboratory/Office side of the facility is rectangular in shape and consists of four stories, and a basement. Each floor is about 28,000 sq. ft. totalling around 140,000 sq. ft. for the entire structure. Although indicated to be almost identical to Building 962 at SNL, special DOE SCIF requirements for security separation walls, interior circulations and exit requirements, additional elevator requirements, and increased requirements for seismic loads necessitated complete vertical and lateral load analysis and redesign of all columns, walls, beams and foundations.

The structural framing system of the Laboratory/Office structure consists of cast-in-place concrete beams, columns, and endwalls with precast concrete double-tee floor and roof framing systems and precast concrete window panels. A cast-in-place concrete separation wall extending from the basement

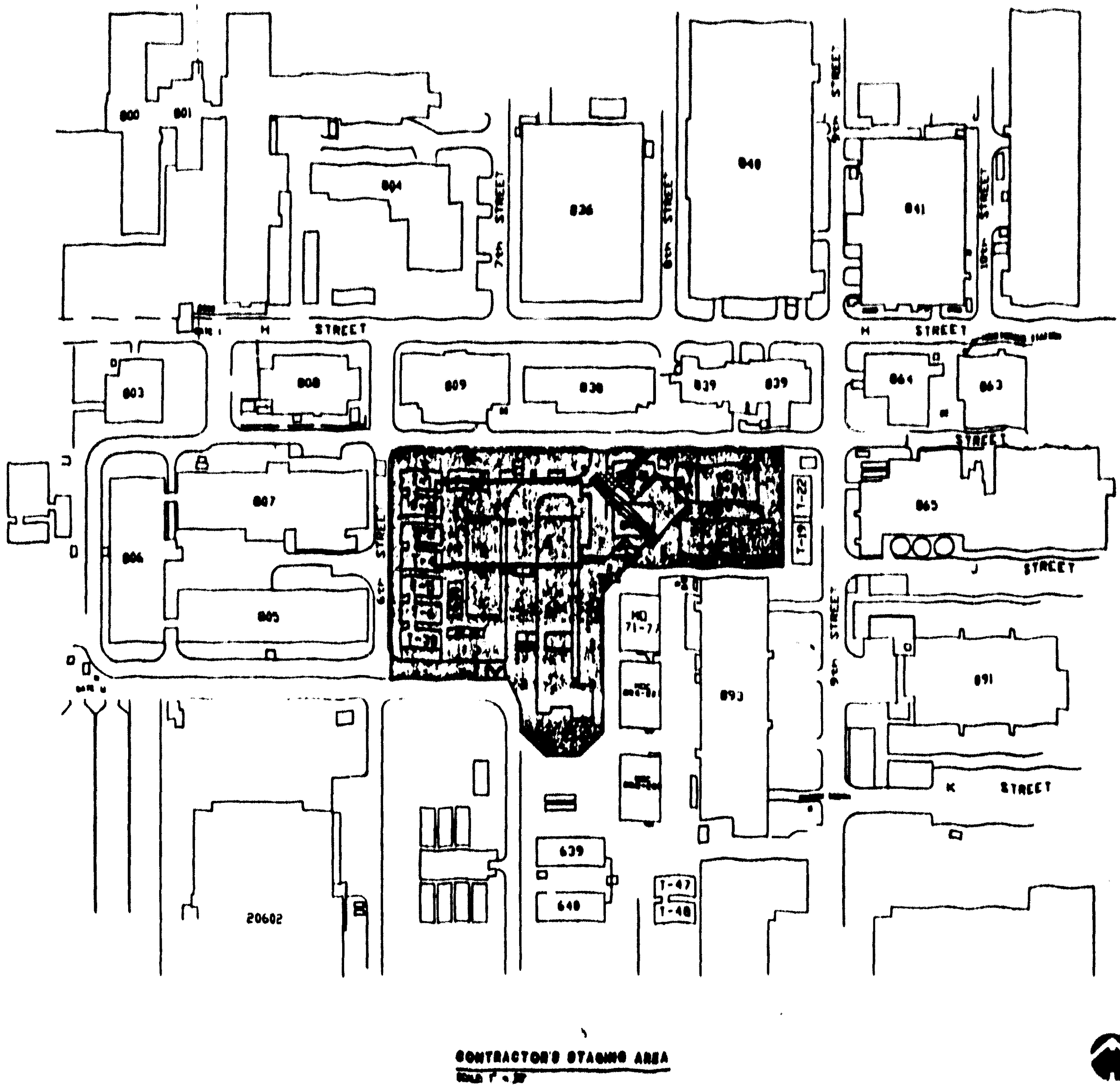



Figure 2.1 CNSAC Facility Area Map

to the roof divides the building into two separate security occupancy areas (DOE "Q" and DOE "SCI"). The interior side of the perimeter walls will be constructed of metal studs, insulation batts, and gypsum board taped, textured and painted. A suspended lay-in ceiling will be installed on each floor.

The Lobby/Conference side of the facility will be a single story building attached to the east end of the four story Laboratory/Office structure and will encompass over 13,000 sq. ft. of additional interior space. The function of this section of the building will be to provide a controlled main entrance with a lobby and conferencing area.

The structural framing system of the Lobby/Conference structure consists of concrete masonry bearing walls with cast in place concrete roof beams and columns at large wall openings. Roof framing consists of open web steel joists and metal deck with a concrete topping slab. Interior walls will be framed using metal studs and gypsum board. Finishes for floors, ceiling, and all conference rooms will be added to the project during the Title II design. These finishes will include ceramic tile, vinyl wall covering, and carpeting.

Existing site utilities such as domestic and fire protection water, sanitary sewer, communications, and similar services will be extended to service the CNSAC facility. Electrical requirements will necessitate that a new master unit substation with a 115 kV subtransmission line be built. Construction around the building will consist of such modifications and improvements as walkways, landscaping, utilities extension, and paving to delivery areas.

## 3.0 Fire Protection Features

At the time of preparation of this document, details concerning the design of the fire protection systems in the CNSAC facility were not available. This section provides limited information concerning the design of the fire protection system available at the time of publication of this FHA. The CNSAC facility will be protected by a redundant (dual path), wet pipe, fusible link actuated, electrically supervised automatic fire sprinkler system to be designed in accordance with NFPA standards and DOE 6430.1A requirements. The fire protection system, designed to NFPA standards, provides a density of 0.16 gpm/ft$^2$ over a 3000 square foot area. Supervised manual pull stations will be installed throughout the CNSAC facility. Also, there will be fire detection equipment (smoke and/or heat detectors) throughout the ventilation system, the basement area, computer areas, and elevators and lobbies. The CNSAC facility will contain portable fire extinguishers to be located in designated areas as defined in

NFPA Standard #10.

The combustible loading per square foot in the CNSAC facility is considered to be light. The active, passive, and operational features of the fire protection design combine to make a significant fire an unlikely event. Automatic or manual fire suppression should overcome the "average" fire and even a severe fire should be contained in the room of origin.

## 4.0 Description of Fire Hazards

Common hazards (electrical, chemical, etc., ) in the CNSAC facility are typical for any personnel office occupancy in most of the facility and for an industrial type machine shop for part of the basement area.

A variety of chemicals are used in the operation of the machine shop and the photo laboratory. These chemicals are stored in accordance with DOE and SNL procedures and all personnel using these chemicals are properly trained. The hazardous chemicals used in these operations can be found in the CNSAC Facility Safety Assessment, Table 5-1 [Ref. 2].

Many of the radioactive sources to be used will be permanently stored in the facility. A storage area will be provided in the basement of the facility for these materials. All of the radioactive sources will be stored in locked fireproof containers. Access to the materials will be limited to those trained personnel whose job functions require the use of the radioactive materials. As these sources are required for laboratory use they will be moved to the appropriate laboratory in appropriate shielded containers so as to limit the exposure to personnel at all times. Tables 5.2-1 thru 5.2-4 of Reference 2 list the typical radioactive sources which will be used and stored in the CNSAC facility.

Most of the radioactive materials that will be used in the facility are sealed sources provided by commercial vendors, such as Isotope Products Laboratory and Amersham.

## 5.0 Protection of Essential Safety Class Systems

The majority of the CNSAC facility does not contain any systems structures or components whose failure would adversely affect the environment, employees, or the safety and health of the public. However, the basement area in the CNSAC facility will contain various amounts and types of radioactive materials and will require additional safety features. Although the design of the basement area has not been specified, it is assumed that the failure of the ventilation system, the sprinkler system, or the radiation monitors could potentially have an adverse affect on the environment, employees, or the safety and health of the public. Therefore these systems will be designated as safety class systems.

## 6.0 Life Safety Considerations

Basic considerations for the construction and operation of the CNSAC facility call for operational procedures which reduce the likelihood of a fire or a fire related catastrophe and facility designs will help mitigate the consequences of such an event. The CNSAC facility was designed per NFPA 101 1981, Life Safety Code classification for a new business occupancy with a hazard of contents classification of ordinary hazard. All egress components have a two hour fire rating. The exit access corridors, stairs, and vertical open space have fire dampers in all the supply air grills. Appropriate exit signage and emergency lighting is within code requirements.

## 7.0 Critical Process Equipment

For the purpose of this fire hazard analysis all systems or components that could reasonably contribute to a fire incident are subject to review and analysis. The systems which may be critical would be those associated with the use of radioactive and/or combustible material. These systems include machining tools, fume hoods and typical lab equipment. These systems will be protected by the full coverage automatic fire protection systems provided in all areas. As a result, the fire threat to or because of critical process equipment is negligible.

## 8.0 High Value Property

The overall value of the CNSAC facility is estimated to be 30 - 40 million dollars. A review of facility operations indicates that there is not a particular area in the facility which contains high value property. However, there could be a significant interruption of facility operations in the event of a fire. Additionally, there will be information, classified and unclassified, stored at the facility that would be costly to replace and measures should be in place to store a backup of critical information at another facility and provide protected backups of information stored on computers.

## 9.0 Damage Potential from the Maximum Credible and Possible Fire Loss (MCFL and MPFL)

Maximum credible fire loss is defined by DOE Order 5480.7A, paraphrased, as that loss that might occur in a fire area if all installed fire protection systems work as designed and the value of manual fire fighting effects is omitted except for post-fire salvage and recovery. The maximum possible fire loss is, paraphrased, that loss within a fire area that could occur if both automatic and manual fire suppression efforts fail. A fire area is defined as an area bounded by a minimum of two hour rated construction. This includes doors, dampers and seals. Fire loss includes restoration costs for real and personal property less any salvage value and also includes related costs such as clean-up, production loss/interruption costs, fire extinguishment costs and consequent effects on related areas.

For the maximum credible fire scenario, it is assumed that the automatic fire suppression system is of adequate design to mitigate the consequences of the fire. It is assumed that the fire begins due to an electrical short and ignites combustibles (flammable liquids, paper products) in the area. The automatic fire protection system (FPS) then performs as designed and extinguishes the fire.

The following section presents the analysis of the maximum possible fire loss scenario. Included as part of this analysis is a discussion of the possible scenarios leading to the MPFL, computer modeling of the maximum possible fire scenario, source term determination and offsite consequence results.

### 9.1 Maximum Possible Fire Loss Scenarios

As stated above, it is assumed that for the MPFL scenario, both automatic and manual fire fighting efforts fail. The event tree in Figure 9.1 presents the sequence of "system" failures required given the occurrence of a fire in the basement area of the CNSAC facility. The specific system failures required for the maximum possible fire loss in the basement area of the CNSAC facility are presented in a fault tree in Figure 9.2. Although the fault tree has not been quantified it provides a picture of potential automatic and manual fire fighting failure scenarios which can lead to the MPFL. This fault tree covers the failure of automatic fire suppression system(s), the failure of early manual suppression by an employee in the area, and the failure of manual suppression of the fire by fire department personnel.

### 9.2 Computer Fire Modeling

As indicated in the DOE guidance on the Fire Hazard Analysis (FHA) [Ref. 3], an acceptable fire model

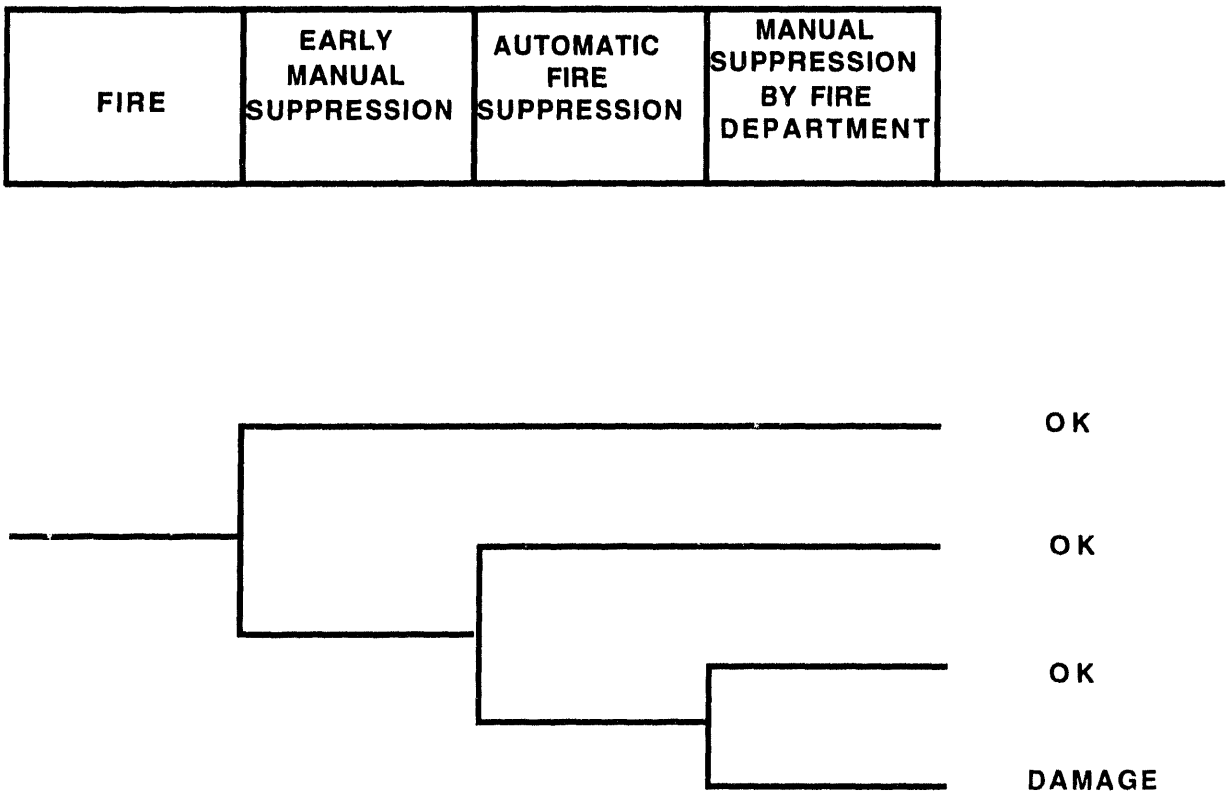



Figure 9.1 CNSAC Facility Maximum Possible Fire Loss Event Tree

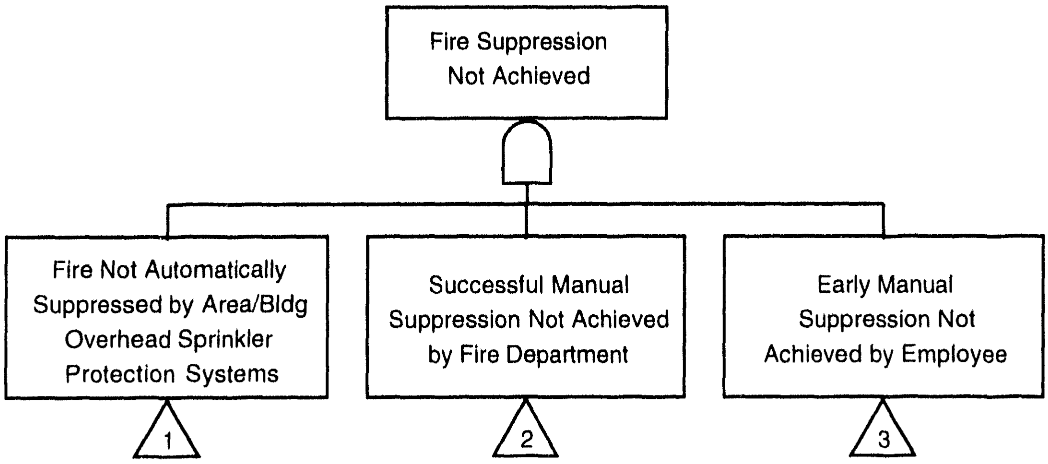



Figure 9.2 CNSAC Facility Maximum Possible Fire Loss Fault Tree

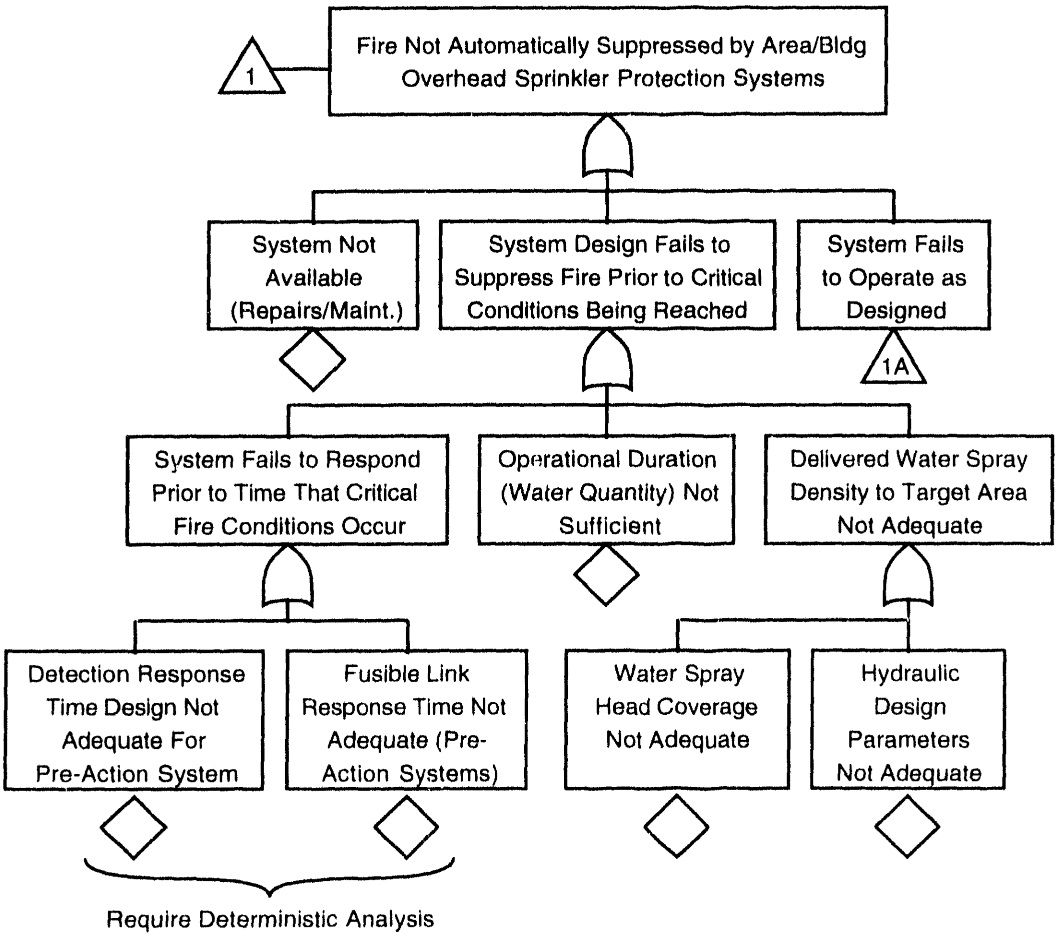



Figure 9.2 CNSAC Facility Maximum Possible Fire Loss Fault Tree (cont.)

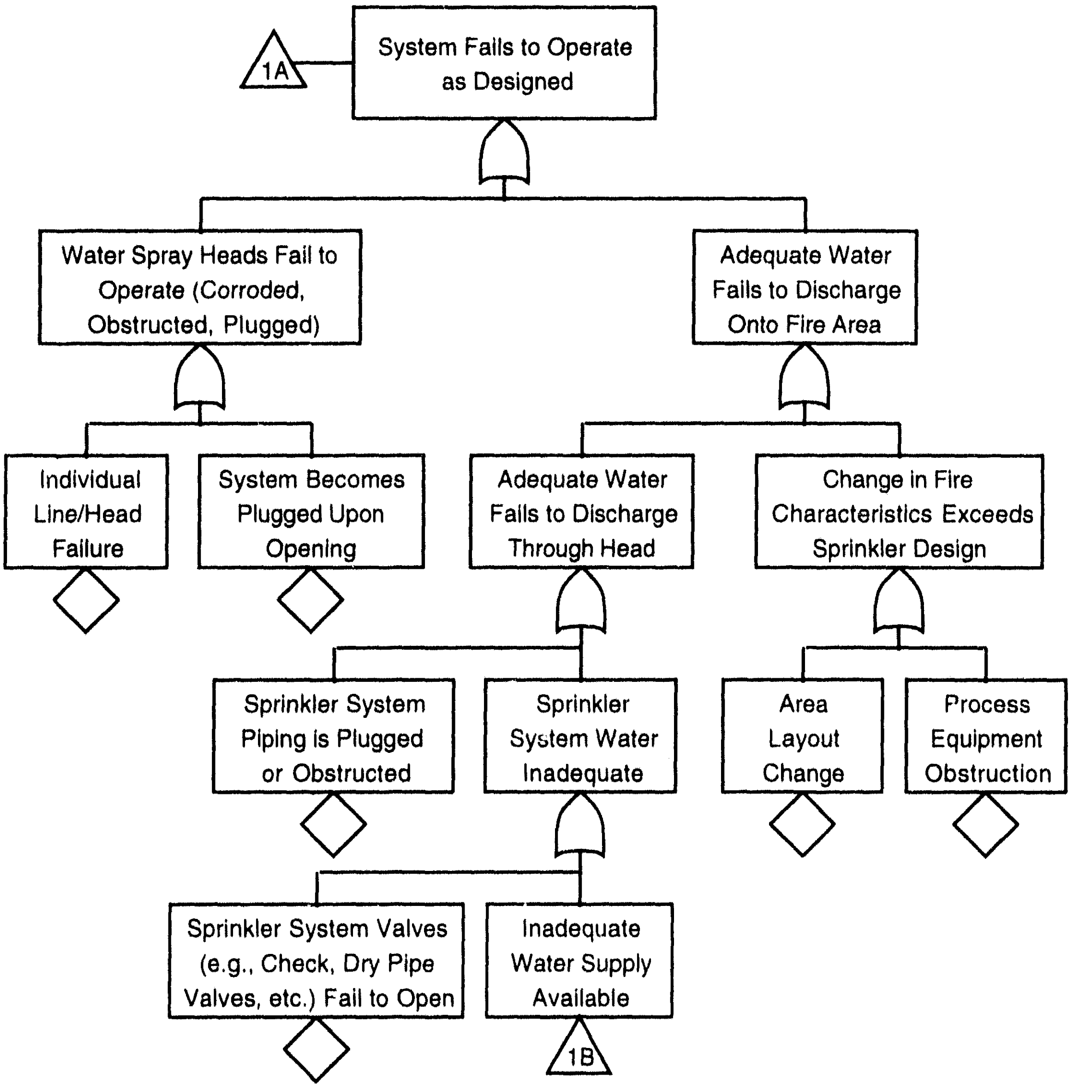
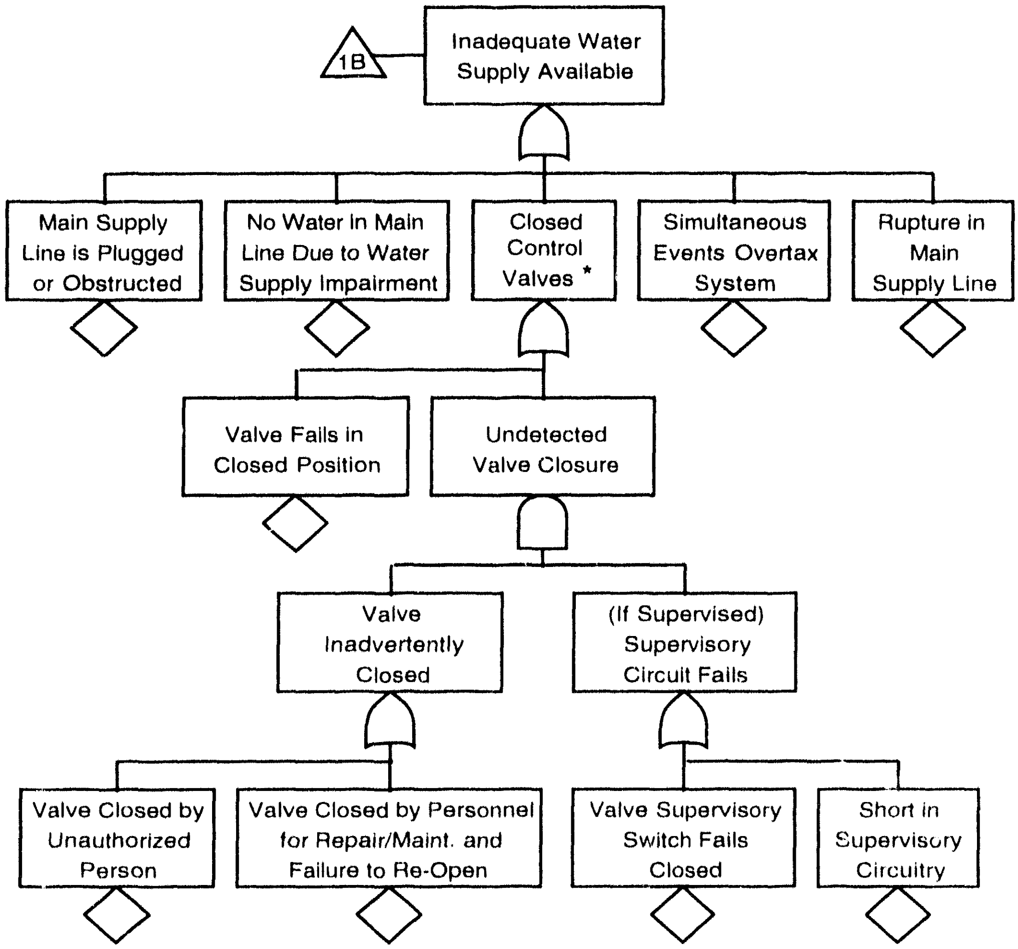



Figure 9.2 CNSAC Facility Maximum Possible Fire Loss Fault Tree (cont.)




* Control valves are usually outside screw and yoke (OS+Y) valves.

Figure 9.2 CNSAC Facility Maximum Possible Fire Loss Fault Tree (cont.)

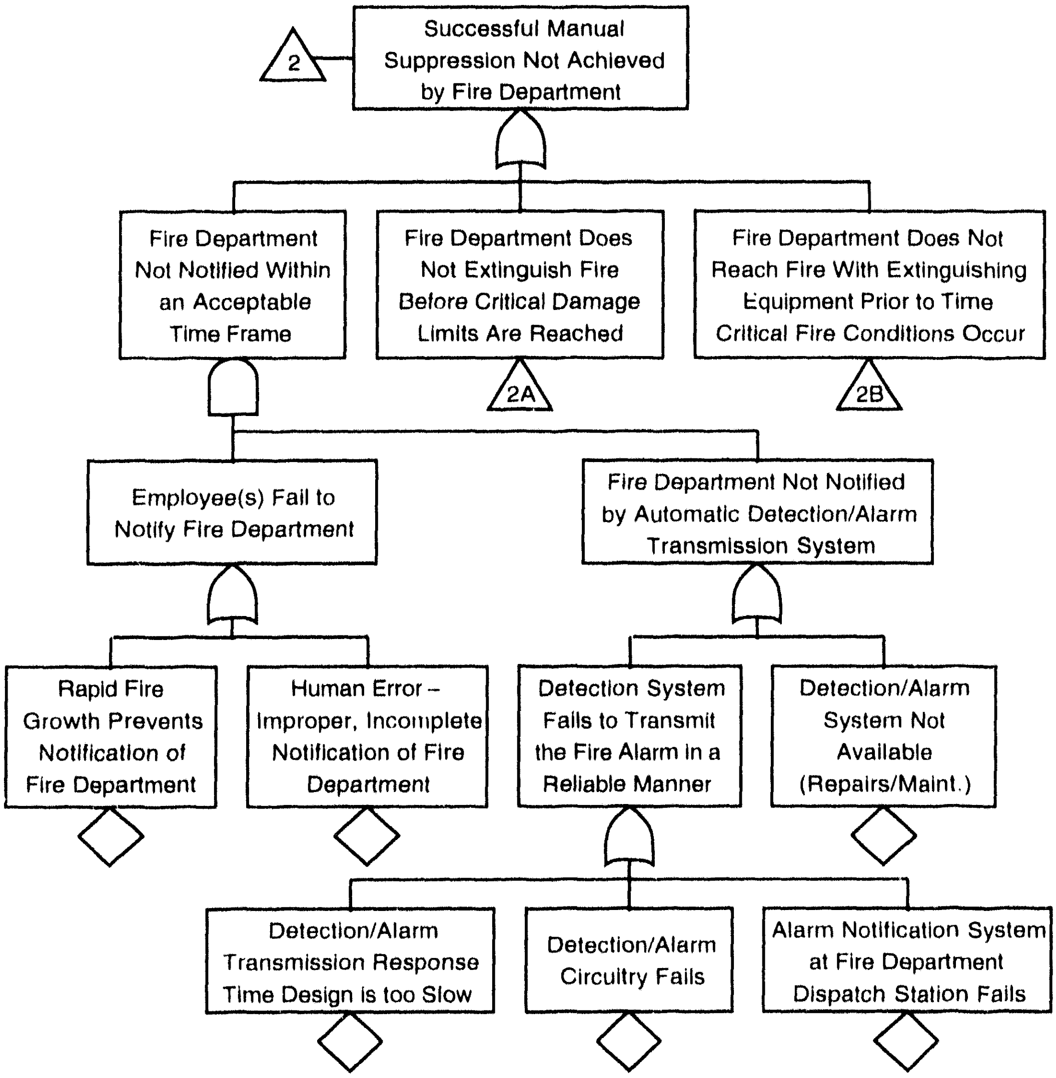



Figure 9.2 CNSAC Facility Maximum Possible Fire Loss Fault Tree (cont.)

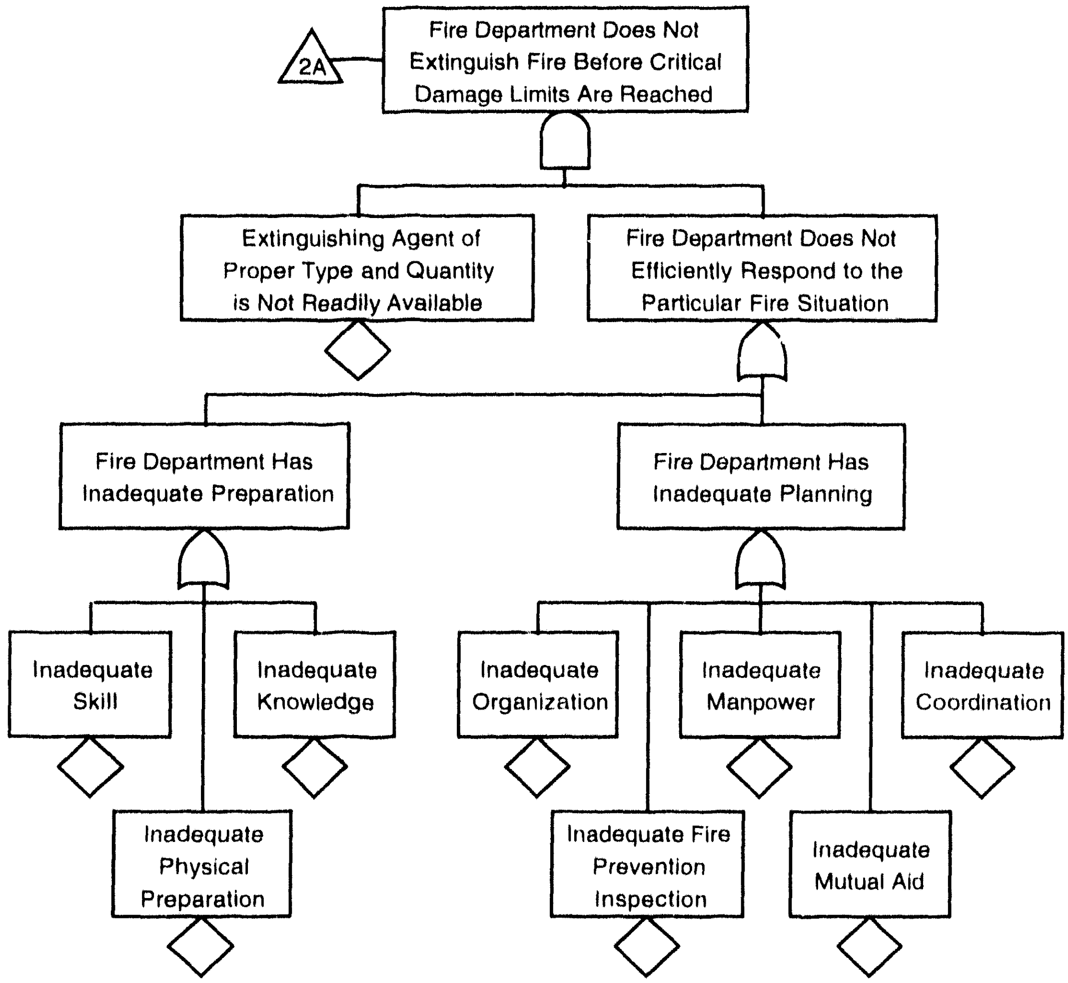



Figure 9.2 CNSAC Facility Maximum Possible Fire Loss Fault Tree (cont.)

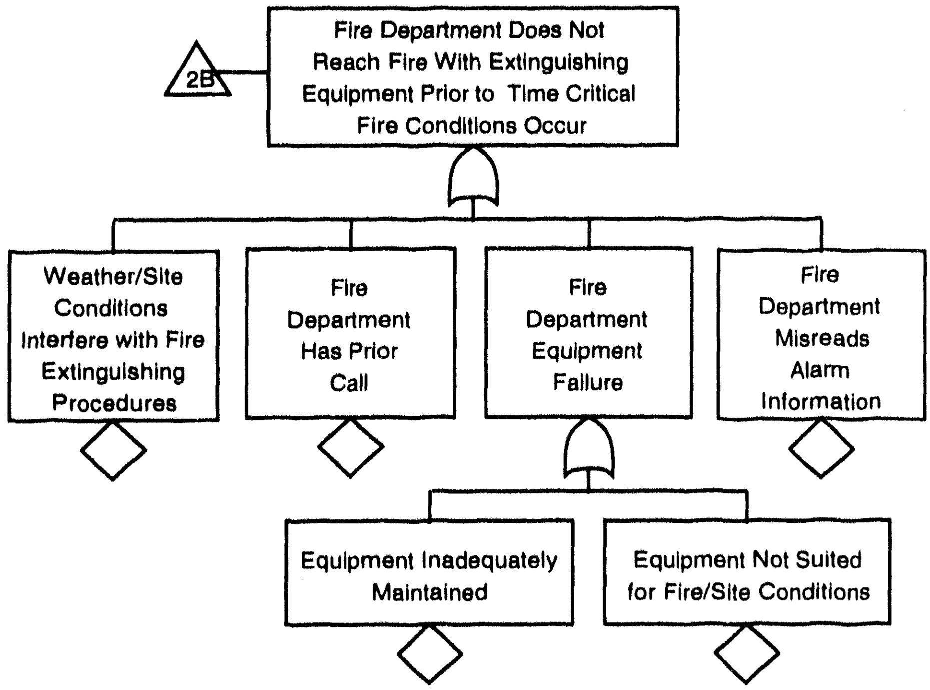
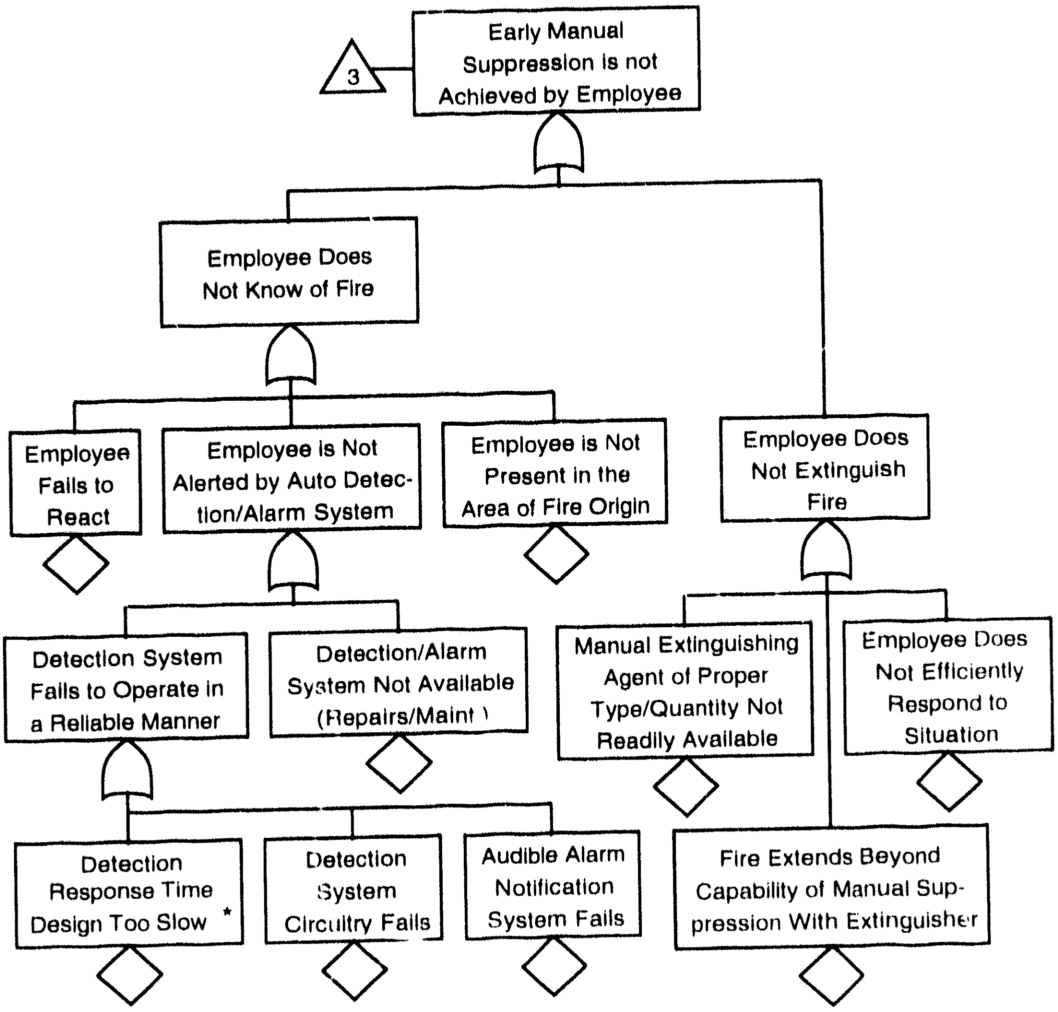



Figure 9.2 CNSAC Facility Maximum Possible Fire Loss Fault Tree (cont.)




* Application of deterministic fire models to assess response time ranges

Figure 9.2 CNSAC Facility Maximum Possible Fire Loss Fault Tree (cont.)

may be used as a tool in the development of the FHA. Such DOE guidance identified FIRAC [Ref. 4] as the model being considered for acceptance by DOE for this purpose. As such, the FIRAC computer code will be used to model the maximum possible fire scenario. The assumptions utilized in the input for FIRAC are outlined below:

- Combustibles are involved near the location where the initiating event (IE) occurs, staff or operators fail to suppress the fire, Fire Department and the automatic sprinkler system fail to suppress the fire such that the fire spreads to include the entire fire zone (or large part thereof) and radioactive material is assumed to be involved.

- Since little or no information on the actual configuration of safety, support, and process systems is known at this phase (shell design), a simple fire room model will be used to model a generic fire area within the office/lab area of the basement. The basement is chosen as the worst case due to the storage of radioactive materials in this area. This fire area will be assumed to have a length of 40 feet, a width of 40 feet, and a height of 13 feet. All the walls, ceilings, and floors will be assumed to be one foot thick concrete.

- Also, since no information is available on the ventilation rate, including exhaust rate, it will be assumed based upon guidance from Reference 5 that 5 to 6 air exchanges per hour will be typical of this fire area or about 2,000 $ft^3$/min. No fans or blowers will be modeled, since no information on these are available at this time. The room pressure will be assumed to be about -0.55 in wg.

- As part of the simple fire modeling, the fire room with two ducts (inlet and outlet), and two boundaries (inlet and outlet) will be modeled as shown in Figure 9.3. The outlet and inlet elevations will be assumed to be at ceiling level (i.e., 13 feet) as shown in the Title II architectural drawings.

- In the FIRIN Module [Ref. 4] of the FIRAC computer code, the fire will be modeled until combustibles in the room are exhausted (approximately for one hour). No radioactive materials will be assumed in this FIRAC/FIRIN analysis, since the release rates and release fraction for radioactive materials available in the code do not represent in any way the form of the radioactive material assumed to be present within the CNSAC facility (i.e., sealed or metal matrix (non-pyrophoric sources)).

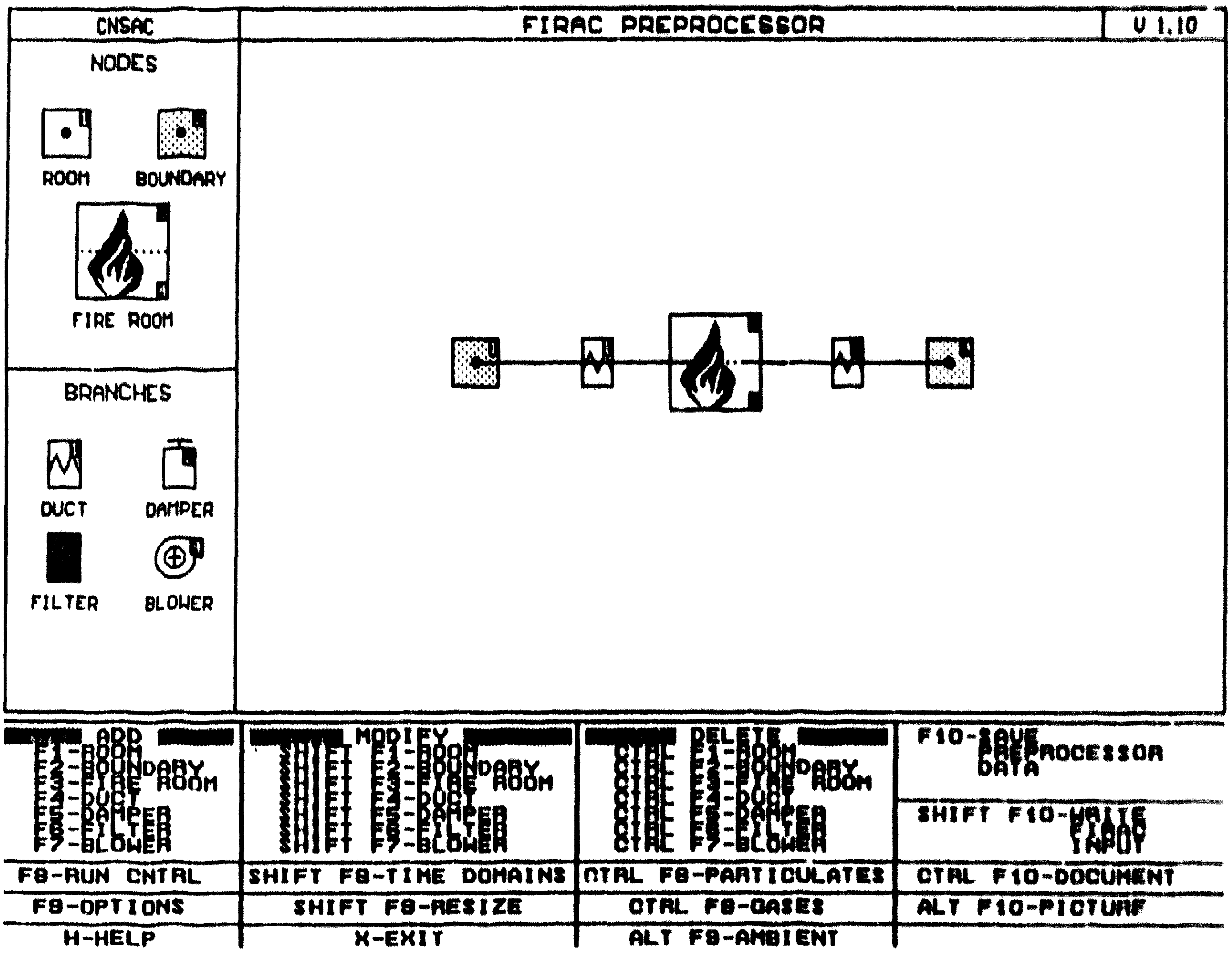



Figure 9.3 CNSAC Facility FIRAC Model

The release of radioactive materials that could potentially be involved in the maximum possible fire scenario will be addressed in the following section.

An ignition energy model will be used instead of the burning order method. This will automatically assign initially burning materials to a burning order of one, while materials at risk are assigned a burning order of two. Based upon walkdowns of other Sandia facilities and engineering judgement, it was assumed that initially 20.0 lbs of paper material, and 4.0 pounds of solvent will be involved in the fire (combustible material near the area in which the initiating event occurs); and that 150.0 lbs of wood, 4.0 lbs of plastic, 250.0 lbs of paper, and an additional 5.75 lbs of solvent material will be at risk in the vicinity of the area where the initiating event is postulated to occur.

Figure 9.4 presents the fire compartment thermal hot layer temperature results for this analysis. From this figure, one can see that in the first 10-15 minutes the temperature is still low enough for the possible suppression or control of the fire by the local staff, the amount of smoke generated and the local temperature (i.e., up to about 105°F) in these first 10-15 minutes will be sufficient to set-off any smoke and local heat detectors in the immediate area. From the time the fire department is assumed to show up (i.e. about 10 minutes after the fire initiates) to the time the sprinkler systems are assumed to be activated (i.e., 30 minutes) the temperature could be as high as 230°F (assuming no cooling).

It is important to notice that FIRAC does not model the action of the cooling of the fire by either the fire department or the sprinkler system mitigating actions. As such, the temperatures shown in Figure 9.4 are the maximum temperatures attained by the MCF, given the assumed fire loading in the fire area. In one hour, even without the mitigating action of the fire department and the sprinkler system, the fire temperature drops rapidly to about 110°F, assuming that no further combustibles are at risk as assumed by the event tree within the fire area.

Appendix A of this FHA, contains a copy of the FIRAC/FIRIN input file, along with a graphical summary of some of the results of the analysis, i.e., fire compartment thermal fire history effects like hot layer temperature, combustible mass burn rate, volumetric flow balance; and smoke source term vs. time accumulation.

It is assumed that, prior to the fire occurring, the bulk of the radioactive material stored and handled in the office/lab (basement) area is securely isolated from the fire by proper storage in their respective

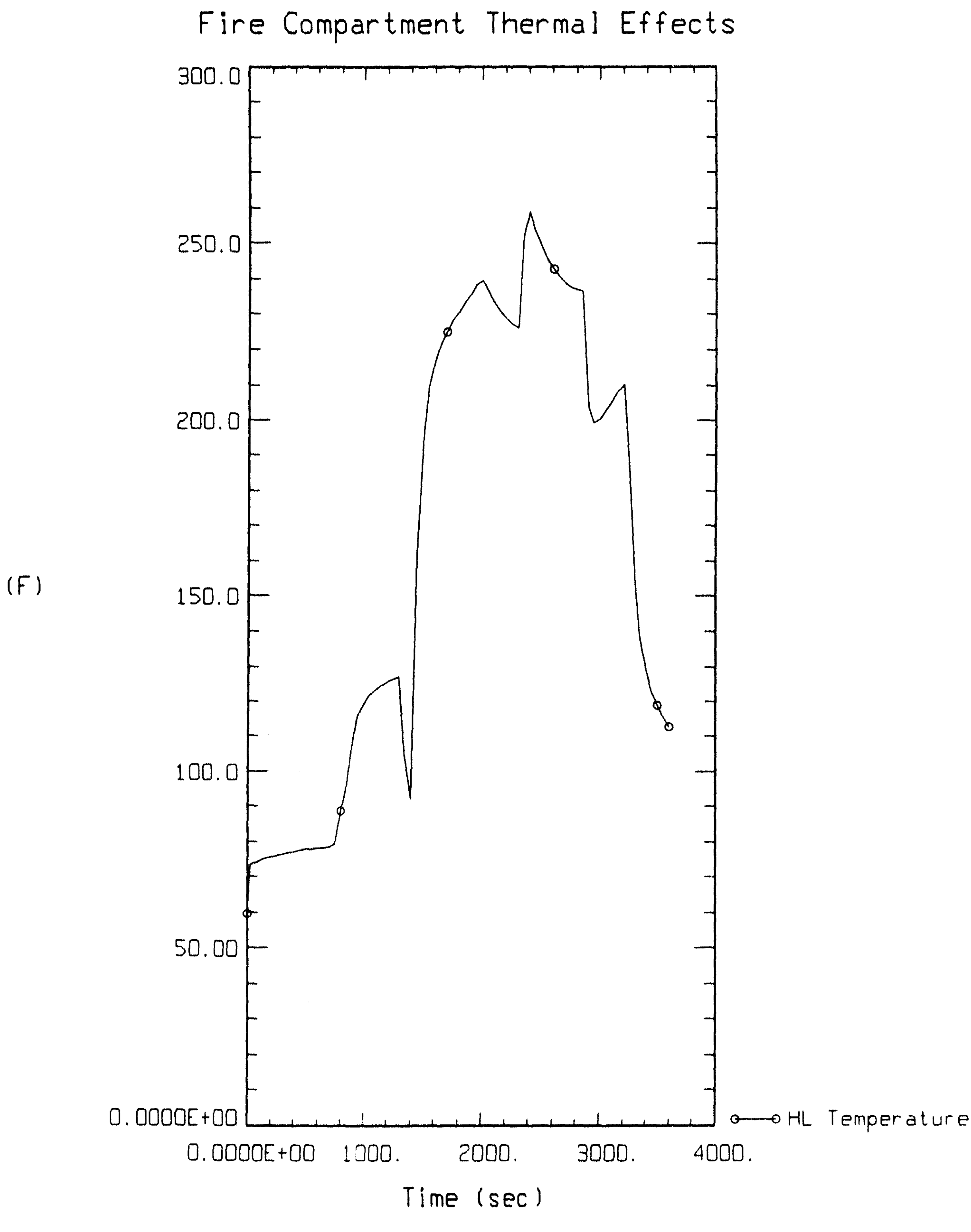



Figure 9.4 Fire Compartment Thermal History

fire rated vaults or cabinets. However, it is very likely that a few sources that may be out of their storage location(s) may be at risk or involved in the fire. In order to bound all the consequences from all credible fire scenarios, it will be conservatively assumed that one source representing each of the radiation types (gamma, neutrons, miscellaneous sources, and alpha/fissile material) will be involved in the fire. Table 9.1 presents the radionuclide sources and inventories (in Curies) selected to represent each of the source types. For consistency, the same sources modeled in the CNSAC Facility Safety Assessment [Ref. 2] were used for this analysis.

**Table 9.1 Radionuclide Inventory**

| Source Type | Radioisotope | Inventory - Curies (g) |
|---|---|---|
| Gamma source | Co-60 | 3.8E-2 (3.4E-5) |
| Neutron source | Cf-252 | 75.0 (0.14) |
| Alpha/fissile source | Pu-239 | 24.5 (400) |
| Miscellaneous source | U-238 | 0.0033 (10,000) |

## 9.3 Source Term Determination

This section identifies the radioactive inventories that are at risk or material-at-risk (MAR), and the initial and building source terms that are expected to be released from the maximum possible fire (MPF) accident scenario. It is expected that the consequences to the public will be dominated by the airborne radioactive material released as a result of the fire.

The bounding consequences to the public can be calculated based on the initial source term (IST) and the building source term (BST). The amount of airborne radioactive material released to the area (IST) where the accident is postulated to occur is dependent on the airborne release fraction (ARF) of the material involved, which itself depends on the energy source produced by the accident (i.e., fire) and the radionuclide involved. In order to determine the IST, the ARF and respirable fraction (RF) must be determined for each source and then multiplied by the quantity of material. Several experiments have been conducted on release fractions from fires, specifically involving Plutonium, Uranium, or corresponding surrogate materials, and the results of such experiments are well documented throughout the literature. Most of these release fractions have been summarized for the NRC and for DOE [Ref. 6 and 7, respectively]. These reports summarize the methodologies that are deemed acceptable by both

NRC and DOE in evaluating various accident scenarios in fuel cycle or similar facilities. However, this data is limited primarily to the burning release rates from metals consisting of Plutonium and Uranium.

NUREG-1320 [Ref. 6] gives a conservative airborne release rate for Plutonium of 8.9E-6% per second. For the maximum possible fire loss, this would result in a total ARF of 3.2E-4. It was also shown [Refs. 7 and 8] that in 60 minutes, complete oxidation of 455.5 g (close to the limit for the CNSAC facility) of Pu led to a total ARF of 3.9E-6 (which is substantially less than the assumed ARF), with a RF of 0.5. Therefore, for conservative purposes, the ARF of 3.2E-04 will be used for Plutonium metal along with a RF of 0.5.

However, because this source is a sealed source encapsulated in Aluminum or stainless steel, complete oxidation during a one hour fire is not expected to occur. It is therefore assumed that only 10% of the sealed source will oxidize, thereby reducing the ARF by one order of magnitude.

Uranium, unlike Plutonium, is non-pyrophoric and is therefore difficult to ignite. Experiments have shown that Uranium has an upper bound ARF of 8E-6 and RF of 1.0 [Ref. 7]. Also, since the Uranium stored in the CNSAC is not limited to sealed sources, there will be no further reduction of the ARF. Since little data is available on the ARFs of Californium or Cobalt sealed sources, the ARF and RF for Uranium will be used for conservative purposes.

Building source terms (BSTs) and ISTs are assumed to be the same because presently there are no plans to put HEPA filters in the CNSAC facility, and no decay or deposition of these airborne materials is assumed to occur within the building. Based on these assumptions the (ISTs) or (BSTs) can be computed for each of the radionuclides assumed to be exposed to the fire and these are summarized in Table 9.2.

## 9.4 Offsite Consequences

The offsite consequences from a release of radionuclides from the CNSAC facility due to the postulated maximum credible fire scenario is expected to be dominated predominantly by the inhalation and immersion pathways. That is, given the dry conditions and low amounts of food stuff grown in the local area (i.e. within 10 miles from the site), other exposure pathways (e.g., ingestion) are expected to have an insignificant contribution to the overall consequences from such postulated releases. The offsite consequences from accident releases will be calculated by hand, instead of using a standard

**Table 9.2 Building Source Term for Selected Isotopes**

| Radionuclide | Inventory - Curies (g) | IST or BST - Curies (g) |
|---|---|---|
| Co-60 | 3.8E-2 (3.4E-5) | 3.0E-7 (2.7E-10) |
| Cf-252 | 75.0 (0.14) | 6.0E-4 (1.1E-6) |
| Pu-239 | 24.5 (400) | 3.9E-4 (6.4E-3) |
| U-238 | 0.0033 (10,000) | 2.6E-8 (8.0E-2) |

code like MACCS [Ref. 9] since presently, MACCS is unable to model half of the radionuclides listed in Table 6.3-2 of the CNSAC Facility Safety Assessment [Ref. 2]. However, MACCS will be used to benchmark the consequence hand calculations for the Plutonium and Cobalt releases, since these are the only radioisotopes modeled included in the MACCS database and the dose or exposure from Plutonium is expected to dominate.

The following equation is used to calculate the 50-year committed effective dose equivalent (CEDE) from the inhalation of radionuclides released to the environment (committed dose to other organs are calculated in similar way).

$$CEDE_{inhalation} = BST * SA * \chi/Q * BR * DCF_{inhalation}$$

Where

$CEDE_{inhalation}$ is the committed 50-year dose equivalent received by the cohort from the inhalation of the radionuclide at a downwind distance X from the release (rem),

BST is the building source term or amount of airborne material released to the environment in curies or grams (Table 9.2)

$\chi/Q$ is the dispersion factor in sec/m$^3$ (See Equation 3.2-1 of the CNSAC Facility Safety Assessment [Ref. 2])

BR is the breathing rate (3.3x10-4 m$^3$/sec) [Ref. 2]

$DCF_{inhalation}$ is the committed effective - dose conversion factor from inhalation for a given radionuclide (rem/Ci) [Ref. 10]

SA is the Specific activity, converts grams to curies (Ci). Notice that, if Q is given in Ci already, SA is equal to 1.

The following equation is used to calculate the committed effective dose equivalent (CEDE) from immersion in the plume containing the radionuclides released to the environment (dose to other organs are calculated in a similar way).

$$CEDE_{immersion} = BST * SA * \chi/Q * DCF_{immersion}$$

Where

$CEDE_{immersion}$ is the committed effective dose equivalent received by the cohort immersed in a radioactive plume at a downwind distance X from the release (rem),

$DCF_{immersion}$ is the committed dose conversion factor from immersion in a plume containing a given radionuclide (rem-m$^3$/Ci- sec) [Ref. 11].

The overall committed effective dose equivalent (CEDE) received by the receptor (i.e., onsite, or offsite) from airborne radioactive sources is calculated by adding the doses received from the two exposure pathways (i.e., inhalation and immersion). In other words, the total committed effective dose equivalent received is given by:

$$CEDE_{Total} = CEDE_{inhalation} + CEDE_{immersion}$$

Besides the above mentioned equations, the following assumptions will be used to determine the offsite consequences from the maximum credible fire scenario:

The BST in Curies for each of the radionuclides representing each of the radiation types is taken from Table 9.2.

- All respirable material will be assumed to have one particle size (i.e., 1 μm AMAD).

- No ingrowth and decay will be assumed for all the radionuclides released to the environment (i.e., BST).

- All exposure or concentration calculations will be made assuming a Pasquill stability class F, with no rain conditions and one meter per second wind speed.

- A breathing rate of 3.4x10-4 $m^3$/sec (heavy activity) will be assumed for conservative purposes.

- Release occurs at ground level. Under realistic conditions, during a fire scenario the release will tend to be elevated due to the buoyancy of the plume due to the heat generated, also due to the fact that the area in which the maximum credible fire scenario is postulated to occur (i.e., office/lab area of the basement) is exhausted through a dedicated exhaust system which will vent to the top of the CNSAC facility, about 20 meters in height).

- A release duration of one hour is assumed.

- Exposure calculations will be carried out to a distance of 1 Km (50, 100, 400, 600, 900 and 1000 meters), since exposures beyond that distance are expected to be below the de-minimus level.

- Building wake effects will be assumed (for conservatism purposes) only at short distances (i.e., <100 meters) since building wake effects will predominate at short distances. For distances greater or equal to 100 meters standard Gaussian plume models will be used (see equation 3.2-1 [Ref. 2]), and no credit will be taken for building wake effects (conservative approach). The following equation will be used to determine the volume created by the wake cavity [Ref. 2]:

  $$\text{Volume wake cavity} = H * W * X_{cavity}$$

Where

H and W are the building height and width, respectively

$X_{cavity}$ is the wake cavity length, and it is calculated from the following equation depending on the ratio between the building length (L) and its height (H), i.e., L/H:

For short buildings ($L/H \leq 2.0$)

$$X_{cavity}/H = L/H + A(W/H)/[1.0 + B(W/H)]$$

Where

$$A = -2.0 + 3.7(L/H)^{-1/3}$$

$$B = -0.15 + 0.305(L/H)^{-1/3}$$

L  al concentration within the wake cavity will be calculated by dividing the amount of airborne material to the environment (BST) by the wake cavity volume calculated with the above equations. The height of the CNSAC facility is about 20 m (65.7 ft), its width about 18.9m (62 ft), and its length about 37.2 m (122 ft). Using these data and the above equations, the volume of the wake cavity is calculated to be about 20,720 $m^3$ (731,649.6 $ft^3$).

As stated before, the MACCS computer code is presently capable of only handling up to 60 radionuclides (in the DOS.DATA file, i.e., there is data on dose conversion factors for only 60 radionuclides). Future analyses at SNL will determine if additional radionuclides will be required for new versions of MACCS, especially in support on non-power-plant facilities (i.e., research facilities and non-reactor facilities). As such, MACCS will be used to benchmark the results of hand calculations for Pu-239 and Co-60, since the other radionuclides are not available in the database for MACCS. The MACCS computer code was run under the following assumptions and input:

- For benchmark purposed, MACCS was run under fixed meteorological condition, i.e., Pasquill F-stability, wind speed = 1 m/s and no rain.

- Consequences calculations were carried out at six intervals to a distance of 1.1 Km (the consequences beyond such a distance are expected to be below the de-minimus level).

- No relocation or evacuation of exposed individuals was considered. This assumes exposure to the total amount of material release for the duration of the accident. That is, mitigating actions (i.e., evacuation, sheltering, decontamination, interdiction, relocation, etc.) were ignored in the public consequence calculations, since the main objective is to determine the doses at the plant boundary, and at different locations around the facility.

- Potential economic impacts due to contamination and mitigating actions were ignored in this analysis.

- Both a release duration and plume duration of one hour was assumed.

- MACCS was configured to calculate the doses and health effects to the same organs evaluated by the hand calculations, i.e., effective whole body dose equivalent (EDE), lungs, bone marrow, and bone surface.

- Public health risks were only evaluated for total cancer latent fatalities; early fatalities were ignored due to the low activities released to the environment (i.e., BST).

Table 9.3 summarizes the results of the dose hand calculations for each of the radionuclides in Table 8.2 for both the inhalation and immersion pathways, and for the three different organs, using the equations presented in this section and the appropriate dose conversion factors.

As shown in Table 9.3, the total effective dose equivalent from all pathways and from all the radionuclides range from 13 to 0.028 rem at distances from 50 to 1000 meters respectively. These exposures are well below offsite guidelines (i.e., 25 rem) under accident conditions for the maximum offsite individual (MOI). Note that the area within 100 to 200 meters from the facility is restricted to personnel working for Sandia National Laboratories, and as such, no public will be expected to be located at shorter distances.

TABLE 9.3

CONSEQUENCE CALCULATIONS FOR THE CNSAC FACILITY

| Co-60 | INHALATION DOSE (rem) | | | | IMMERSION DOSE (rem) | | | | TOTAL DOSE (rem) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DISTANCE (m) | LUNG | MARROW | BONE | EDE | LUNG | MARROW | BONE | EDE | LUNG | MARROW | BONE | TOTAL |
| 50 | 2.3E-06 | 2.8E-07 | 2.3E-07 | 5.8E-07 | 1.9E-08 | 3.8E-08 | 2.0E-08 | 2.0E-08 | 2.3E-06 | 3.2E-07 | 2.5E-07 | 6.1E-07 |
| 100 | 2.2E-07 | 2.7E-08 | 2.2E-08 | 5.5E-08 | 1.8E-09 | 1.8E-09 | 1.9E-09 | 1.9E-09 | 2.2E-07 | 2.9E-08 | 2.4E-08 | 5.7E-08 |
| 400 | 2.2E-08 | 2.7E-09 | 2.2E-09 | 5.6E-09 | 1.8E-10 | 1.8E-10 | 2.0E-10 | 2.0E-10 | 2.2E-08 | 2.9E-09 | 2.4E-09 | 5.8E-09 |
| 600 | 1.1E-08 | 1.4E-09 | 1.1E-09 | 2.9E-09 | 9.3E-11 | 9.4E-11 | 1.0E-10 | 1.0E-10 | 1.1E-08 | 1.5E-09 | 1.2E-09 | 3.0E-09 |
| 900 | 5.8E-09 | 7.1E-10 | 5.8E-10 | 1.5E-09 | 4.7E-11 | 4.8E-11 | 5.1E-11 | 5.1E-11 | 5.8E-09 | 7.6E-10 | 6.3E-10 | 1.5E-09 |
| 1000 | 4.8E-09 | 5.9E-10 | 4.8E-10 | 1.2E-09 | 4.0E-11 | 4.0E-11 | 4.3E-11 | 4.3E-11 | 4.9E-09 | 6.3E-10 | 5.3E-10 | 1.3E-09 |

| Pu-239 | INHALATION DOSE (rem) | | | | IMMERSION DOSE (rem) | | | | TOTAL DOSE (rem) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DISTANCE (m) | LUNG | MARROW | BONE | EDE | LUNG | MARROW | BONE | EDE | LUNG | MARROW | BONE | EDE |
| 50 | 2.8E+01 | 6.5E+00 | 8.1E+01 | 7.8E+00 | 5.2E-10 | 3.0E-10 | 8.6E-10 | 8.8E-10 | 2.8E+01 | 6.5E+00 | 8.1E+01 | 7.8E+00 |
| 100 | 2.6E+00 | 6.1E-01 | 7.6E+00 | 7.4E-01 | 4.9E-11 | 2.9E-11 | 8.1E-11 | 8.3E-11 | 2.6E+00 | 6.1E-01 | 7.6E+00 | 7.4E-01 |
| 400 | 2.7E-01 | 6.2E-02 | 7.8E-01 | 7.5E-02 | 5.0E-12 | 2.9E-12 | 8.3E-12 | 8.5E-12 | 2.7E-01 | 6.2E-02 | 7.8E-01 | 7.5E-02 |
| 600 | 1.4E-01 | 3.2E-02 | 3.9E-01 | 3.8E-02 | 2.5E-12 | 1.5E-12 | 4.2E-12 | 4.3E-12 | 1.4E-01 | 3.2E-02 | 3.9E-01 | 3.8E-02 |
| 900 | 6.9E-02 | 1.6E-02 | 2.0E-01 | 2.0E-02 | 1.3E-12 | 7.6E-13 | 2.1E-12 | 2.2E-12 | 6.9E-02 | 1.6E-02 | 2.0E-01 | 2.0E-02 |
| 1000 | 5.8E-02 | 1.4E-02 | 1.7E-01 | 1.6E-02 | 1.1E-12 | 6.4E-13 | 1.8E-12 | 1.8E-12 | 5.8E-02 | 1.4E-02 | 1.7E-01 | 1.6E-02 |

| Cf-252 | INHALATION DOSE (rem) | | | | IMMERSION DOSE (rem) | | | | TOTAL DOSE (rem) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DISTANCE (m) | LUNG | MARROW | BONE | EDE | LUNG | MARROW | BONE | EDE | LUNG | MARROW | BONE | EDE |
| 50 | 3.9E+01 | 1.0E+00 | 1.3E+01 | 5.3E+00 | 3.6E-10 | 1.8E-10 | 6.3E-10 | 1.3E-09 | 3.9E+01 | 1.0E+00 | 1.3E+01 | 5.3E+00 |
| 100 | 3.7E+00 | 9.7E-02 | 1.2E+00 | 5.0E-01 | 3.4E-11 | 1.7E-11 | 6.0E-11 | 1.2E-10 | 3.7E+00 | 9.7E-02 | 1.2E+00 | 5.0E-01 |
| 400 | 3.7E-01 | 9.9E-03 | 1.2E-01 | 5.1E-02 | 3.5E-12 | 1.7E-12 | 6.1E-12 | 1.2E-11 | 3.7E-01 | 9.9E-03 | 1.2E-01 | 5.1E-02 |
| 600 | 1.9E-01 | 5.0E-03 | 6.2E-02 | 2.6E-02 | 1.8E-12 | 8.8E-13 | 3.1E-12 | 6.1E-12 | 1.9E-01 | 5.0E-03 | 6.2E-02 | 2.6E-02 |
| 900 | 9.7E-02 | 2.6E-03 | 3.2E-02 | 1.3E-02 | 9.1E-13 | 4.5E-13 | 1.6E-12 | 3.1E-12 | 9.7E-02 | 2.6E-03 | 3.2E-02 | 1.3E-02 |
| 1000 | 8.2E-02 | 2.2E-03 | 2.7E-02 | 1.1E-02 | 7.6E-13 | 3.8E-13 | 1.3E-12 | 2.6E-12 | 8.2E-02 | 2.2E-03 | 2.7E-02 | 1.1E-02 |

| U-238 | INHALATION DOSE (rem) | | | | IMMERSION DOSE (rem) | | | | TOTAL DOSE (rem) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DISTANCE (m) | LUNG | MARROW | BONE | EDE | LUNG | MARROW | BONE | EDE | LUNG | MARROW | BONE | EDE |
| 50 | 1.5E-03 | 3.8E-07 | 5.5E-06 | 1.8E-04 | 3.6E-14 | 5.9E-14 | 6.3E-14 | 7.2E-14 | 1.5E-03 | 3.8E-07 | 5.5E-06 | 1.8E-04 |
| 100 | 1.4E-04 | 3.6E-08 | 5.2E-07 | 1.7E-05 | 3.4E-15 | 5.5E-15 | 6.0E-15 | 6.8E-15 | 1.4E-04 | 3.6E-08 | 5.2E-07 | 1.7E-05 |
| 400 | 1.4E-05 | 3.7E-09 | 5.3E-08 | 1.8E-06 | 3.4E-16 | 5.6E-16 | 6.1E-16 | 6.9E-16 | 1.4E-05 | 3.7E-09 | 5.3E-08 | 1.8E-06 |
| 600 | 7.4E-06 | 1.9E-09 | 2.7E-08 | 9.0E-07 | 1.7E-16 | 2.9E-16 | 3.1E-16 | 3.5E-16 | 7.4E-06 | 1.9E-09 | 2.7E-08 | 9.0E-07 |
| 900 | 3.8E-06 | 9.6E-10 | 1.4E-08 | 4.6E-07 | 8.9E-17 | 1.5E-16 | 1.6E-16 | 1.8E-16 | 3.8E-06 | 9.6E-10 | 1.4E-08 | 4.6E-07 |
| 1000 | 3.2E-06 | 8.1E-10 | 1.2E-08 | 3.9E-07 | 7.5E-17 | 1.2E-16 | 1.3E-16 | 1.5E-16 | 3.2E-06 | 8.1E-10 | 1.2E-08 | 3.9E-07 |

| TOTALS | INHALATION DOSE (rem) | | | | IMMERSION DOSE (rem) | | | | TOTAL DOSE (rem) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DISTANCE (m) | LUNG | MARROW | BONE | EDE | LUNG | MARROW | BONE | EDE | LUNG | MARROW | BONE | EDE |
| 50 | 6.7E+01 | 7.5E+00 | 9.3E+01 | 1.3E+01 | 2.0E-08 | 3.8E-08 | 2.2E-08 | 2.2E-08 | 6.7E+01 | 7.5E+00 | 9.3E+01 | 1.3E+01 |
| 100 | 6.3E+00 | 7.1E-01 | 8.8E+00 | 1.2E+00 | 1.9E-09 | 1.9E-09 | 2.1E-09 | 2.1E-09 | 6.3E+00 | 7.1E-01 | 8.8E+00 | 1.2E+00 |
| 400 | 6.4E-01 | 7.2E-02 | 9.0E-01 | 1.3E-01 | 1.9E-10 | 1.9E-10 | 2.1E-10 | 2.2E-10 | 6.4E-01 | 7.2E-02 | 9.0E-01 | 1.3E-01 |
| 600 | 3.3E-01 | 3.7E-02 | 4.6E-01 | 6.4E-02 | 9.7E-11 | 9.6E-11 | 1.1E-10 | 1.1E-10 | 3.3E-01 | 3.7E-02 | 4.6E-01 | 6.4E-02 |
| 900 | 1.7E-01 | 1.9E-02 | 2.3E-01 | 3.3E-02 | 5.0E-11 | 4.9E-11 | 5.5E-11 | 5.6E-11 | 1.7E-01 | 1.9E-02 | 2.3E-01 | 3.3E-02 |
| 1000 | 1.4E-01 | 1.6E-02 | 2.0E-01 | 2.8E-02 | 4.2E-11 | 4.1E-11 | 4.6E-11 | 4.7E-11 | 1.4E-01 | 1.6E-02 | 2.0E-01 | 2.8E-02 |

Also, as predicted, the exposure to Pu-239 exceeds those of other radionuclides. Cf-252 gives a dose which is over 30% lower than that from Pu-239. Exposure from the rest of the radionuclides (i.e., Co-60 and U-238) are orders of magnitude smaller than those from Pu-239. The total dose from the exposure to Pu-239 (EDE in rem) ranges from 7.8 to 0.016 rem for distances from 50 to 1000 meters, respectively.

As stated before, for benchmark purposes, the MACCS computer code was run to determine the exposure from the release of Pu-239 under constant meteorological conditions. The results from MACCS are close to those calculated by hand. Table 9.4 summarizes the results from MACCS for a release of 24.5 Curies of Pu-239 and Table 9.5 summarizes the results from the exposure to 3.8E-2 Curies of Co-60.

As one can see from Table 9.4 and Table 9.5, the doses from MACCS are within the range of those calculated by hand. Notice that MACCS results are given for a given range and not a single location. Appendix B contains the complete results of the MACCS runs (i.e, CNSAC.OUT files).

## 9.5 Summary

Although it is very unlikely to expect that the automatic FPSs will not function as designed or that manual fire fighting efforts would not be effective, even under these "worst case" assumptions the consequences will be below DOE offsite guidelines for accident conditions.

**Table 9.4 Centerline Dose (rem)**
**Pu-239 (MACCS results)**

| Distance (m) | EDE | Lungs | Marrow | Bone |
|---|---|---|---|---|
| 0-100 | 2.1E+0 | 8.2E+0 | 1.7E+0 | 2.1E+1 |
| 100-200 | 2.7E-1 | 1.0E+0 | 2.1E-1 | 2.6E+0 |
| 200-400 | 8.0E-2 | 3.1E-1 | 6.3E-2 | 7.9E-1 |
| 400-600 | 3.1E-2 | 1.2E-1 | 2.4E-2 | 3.0E-1 |
| 600-900 | 1.4E-2 | 5.5E-2 | 1.1E-2 | 1.4E-1 |
| 900-1100 | 8.0E-3 | 3.1E-2 | 6.4E-3 | 7.9E-2 |

**Table 9.5 Centerline Dose(rem)**

**Co-60 (MACCS results)**

| Distance (m) | EDE | Lungs | Marrow | Bone |
|---|---|---|---|---|
| 0-100 | 1.3E-6 | 6.9E-6 | 4.2E-7 | 3.5E-7 |
| 100-200 | 1.6E-7 | 8.7E-7 | 5.3E-8 | 4.4E-8 |
| 200-400 | 4.8E-8 | 2.6E-7 | 1.6E-8 | 1.3E-8 |
| 400-600 | 1.9E-8 | 1.0E-7 | 6.1E-9 | 5.1E-9 |
| 600-900 | 8.6E-9 | 4.7E-8 | 2.8E-9 | 2.4E-9 |
| 900-1100 | 4.8E-9 | 2.6E-8 | 1.6E-9 | 1.3E-9 |

## 10.0 Fire Department/Brigade Response

The DOE has a formal Interdepartmental Support Agreement with Kirtland Air Force Base (KAFB) to furnish fire protection service to all of SNL's facilities. Such services are required to include: responding to all fire alarm calls, performing periodic familiarization tours of all buildings and preparing and keeping current fire plans and run cards for appropriate buildings and making inspections and flow tests of fire protection systems as required by NFPA Standards.

Kirtland Air Force Base maintains a well trained, professionally staffed fire department. All fire detection monitors in the CNSAC facility will be connected directly to the fire department facility. Upon fire detection, it is estimated that the fire department will arrive at the scene within 10 minutes.

The DOE Albuquerque Operations Office furnishes the Kirtland AFB fire department with recommended fire fighting procedures on KAFB facilities which are considered hazardous or warrant special fire fighting techniques. In the event the CNSAC facility is involved in a fire, the DOE Albuquerque Operations Office shall furnish technical consultants when certain hazardous materials are present.

## 11.0 Recovery Potential

Recovery from the most likely fire (such as an electronic appliance fire, a waste paper fire in a trash container or an office machine fire) is likely within approximately one week. Some lost time would be caused by the evacuation of employees, investigation of area/cause and some level of concern/excitement by the employees. However, restoration of any affected fire safety system (e.g., alarms, detectors, sprinkler heads) would be prompt and any cosmetic cleanup would be facilitated because most of the walls are masonry with enamel paint. Sprinkler operation would be unlikely since a reasonable projection of trained employee reaction would be the use of available fire extinguishers.

The occurrence of the maximum credible fire loss would result in damage to the basement area, but no potential for radioactive contamination. Cleanup time would be 4 - 10 days due to the actuation of the automatic sprinkler system.

Recovery potential will depend of the exact processes taking place in the CNSAC facility. The 1st thru 4th floors will consist of mostly office space and probably at least one computer room. The largest potential for long term loss would be from the destruction of important information stored on the computers. Therefore, it is recommended that all important information stored on the computers be backed up at regular intervals and stored in another facility.

The basement of the CNSAC facility has a much larger potential for loss and recovery. This is due to the specialized equipment and experiments taking place in this area. If a fire were to destroy part or all of the basement, the recovery time would depend on the exact nature of the experiments, whether they could be moved to another location, and on the amount of time it takes to replace damaged equipment.

## 12.0 Potential for Toxic, Biological, and/or Radioactive Releases from a Fire

A fire in the CNSAC facility is likely to produce toxic by-products. Common office machines such as photocopiers have produced toxic pyrolysis products. The combustion or partial combustion of plastic materials used in electrical wiring and in packing materials can produce toxic smoke.

There will not be any storage or use of materials which may pose a biological threat. Therefore, there is no potential for a biological release.

A variety of relatively low level radioactive sources are maintained in the building for testing and calibration of detectors. All of these sources have very small amounts of radioactive material. As such, they are exempted from special packaging and labeling requirements for shipment. When not in use, these radioactive sources are kept in locked, fireproof containers. The sources are used and disposed of with DOE and SNL approved procedures, training, signage, and equipment that insure regulatory compliance.

In addition to the sealed sources, pieces of Thorium, Uranium, Neptunium, and Plutonium will occasionally be brought into the facility temporarily for special experiments. Most of these pieces would be expected to have a mass of less than 10 grams with the exception of two pieces of Uranium and one of Plutonium which are in the 100s of grams range. While in the CNSAC facility (according to SOPs), and not in use, these sources will be stored in locked, fireproof containers. Upon completion of the experiments, the sources should be removed from the facility to other storage locations. Packaging and transportation will be in accordance with Federal, State and local regulations.

A radioactive material release is possible and is considered in the maximum possible fire loss (Section 9). However, since most of the sources utilized in the CNSAC facility are sealed sources the potential for radioactive material release from a fire is greatly reduced.

## 13.0 Emergency Planning

Emergency Operating Procedures have not been developed for CNSAC facility, but will be completed before occupancy. Other emergency planning will require: Safe Operating Procedure's (SOP's) for handling and storing flammable and/or combustible chemicals, and combustibles in general. Permanent occupants of the basement will be required to take fire extinguisher training due to the presence of flammables, combustibles and machinery. All fire detection monitors will be required to send signals to the SNL Headquarters Communication Center and the Kirtland Air Force Base Alarm Room. Also, Operational Safety Requirements (OSRs) will be developed based upon the results of the Safety Analysis. The OSRs will define the conditions, safe boundaries and the bases thereof, and the management or administrative controls required to assure the safe operation of the facility.

## 14.0 Security and Safeguards Considerations Related to Fire Protection

From a security standpoint, the Department of Energy Albuquerque Office (DOE/AL) and/or DOE/AL contractor guard forces shall be in charge of entry into secured areas. Kirtland AFB guard forces shall be in charge of entry into Kirtland AFB areas under such emergencies. DOE/AL shall handle press releases for fires occurring within DOE/AL areas.

Fire safety measures will not affect the security of the facility. However, in the event of a fire or the actuation of fire alarms, the CNSAC facility would need to be evacuated and access provided to qualified fire protection and emergency response personnel.

The SCIF portion of each floor will have one opening into the non-SCIF portion and one exit leading directly to a building exit. These doors will be equipped with emergency opening devices to allow egress to persons inside the SCIF during an emergency. In addition, the main entrance door to the SCIF will be open during normal operating hours and will not be closed and locked while anyone is in the SCIF area.

## 15.0 Natural Hazards (earthquake, flood, wind) Impact on Fire Safety

The CNSAC facility is designed to the facility use category of important or low hazard facility per UCRL 15910 Natural Phenomena Guidelines. The design basis natural phenomena events are based on the Sandia site specific information and the usage category of the facility. Natural hazards are not anticipated to affect the operability of the fire protection systems, but could impair the ability of the emergency response personnel to respond to a fire alarm and/or a fire. Therefore this facility would withstand the design basis earthquake and the design basis wind. External flooding is considered highly unlikely, due to the arid climate and the long distance to the nearest river or arroyo. However, the facility is being designed to the maximum credible flood as required by UCRL-15910 [Ref. 12].

## 16.0 Exposure Fire Potential

There are several buildings in the vicinity of the CNSAC facility which could pose an exposure fire potential. However, it is expected that with automatic fire suppression available in these buildings in combination with the response of the fire brigade the exposure fire potential is minimal. Additionally, the threat from transportation fires was considered minimal due to the response of the fire brigade and the magnitude and proximity of the fire required to present an exposure fire potential.

The environment does not support severe growth of trees and bushes in the vicinity of the CNSAC facility. Additionally, there will be an overlay of concrete, stones and gravel to prevent the growth of underbrush.

## 17.0 References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5. A Guide to Good Practices at Plutonium Facilities, PNL-2086, Rev. 1, July, 1987.

6. J. E. Ayer, et. al., Nuclear Fuel Cycle Facility Accident Analysis Handbook, NUREG 1320, U.S. NRC, May 1988.

7. J. Mishima, Recommended Values and Technical Bases for Airborne Release Fractions (ARFs), Airborne Release Rates (ARRs), and Respirable Fractions (RFs) - Draft Rev. 1 Defense Programs Nuclear Facility Safety Survey, U.S. DOE, July 1992.

8. J. Mishma, Plutonium Release Studies II. Release from Ignited, Bulk Metallic Pieces, BNWL-B-257, Pacific Northwest Laboratory, Richland, WA, November, 1966.

9. MACCS - MELCOR Accident Consequence Code System, D.I. Char n et. al., NUREG/CR-4691, February 1990.

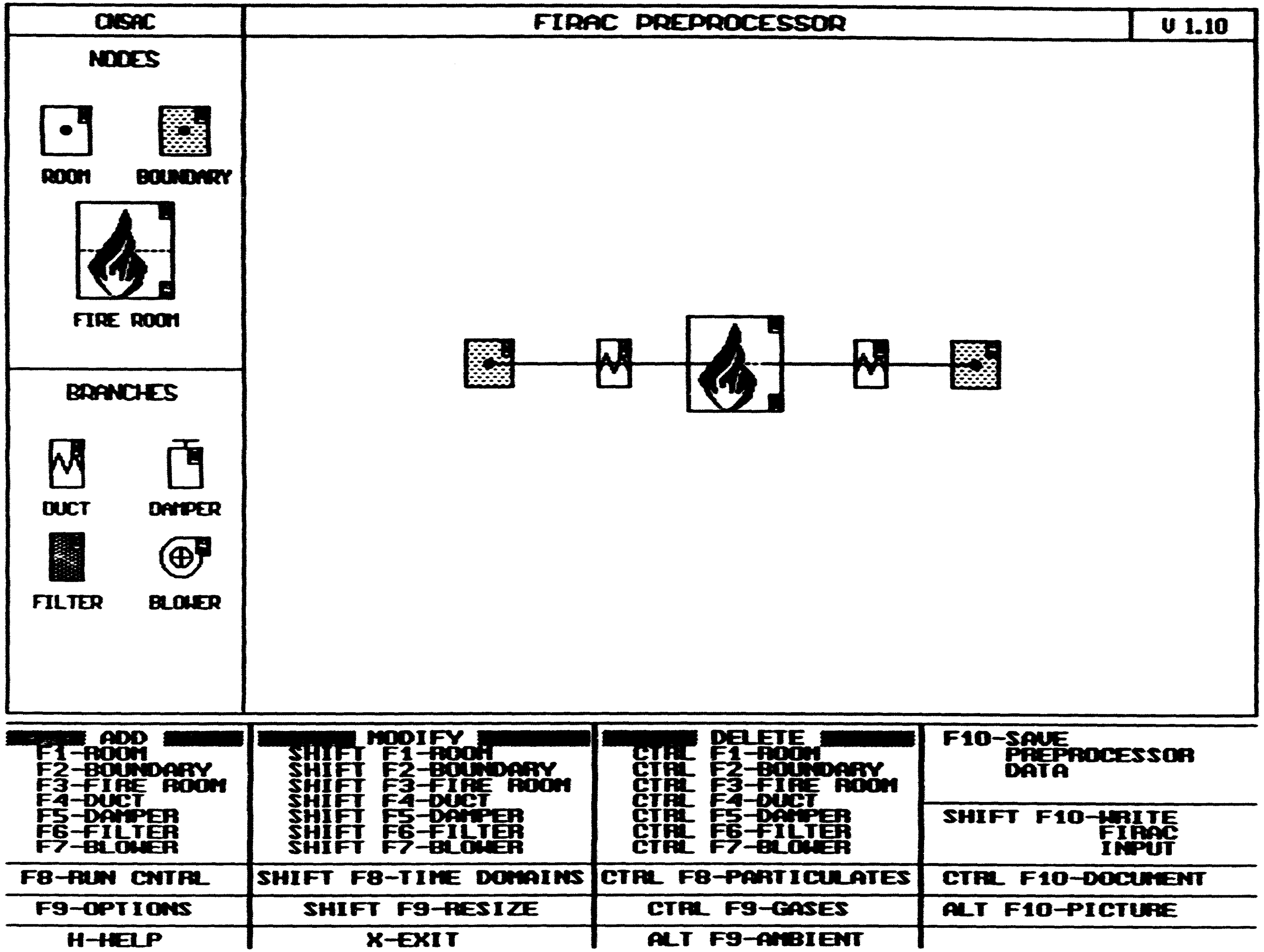
10. Annals of the ICRP , Publication 30, Limits for Intakes of Radionuclides by Workers, Pergamon Press, Elmsford, NY, 1980.

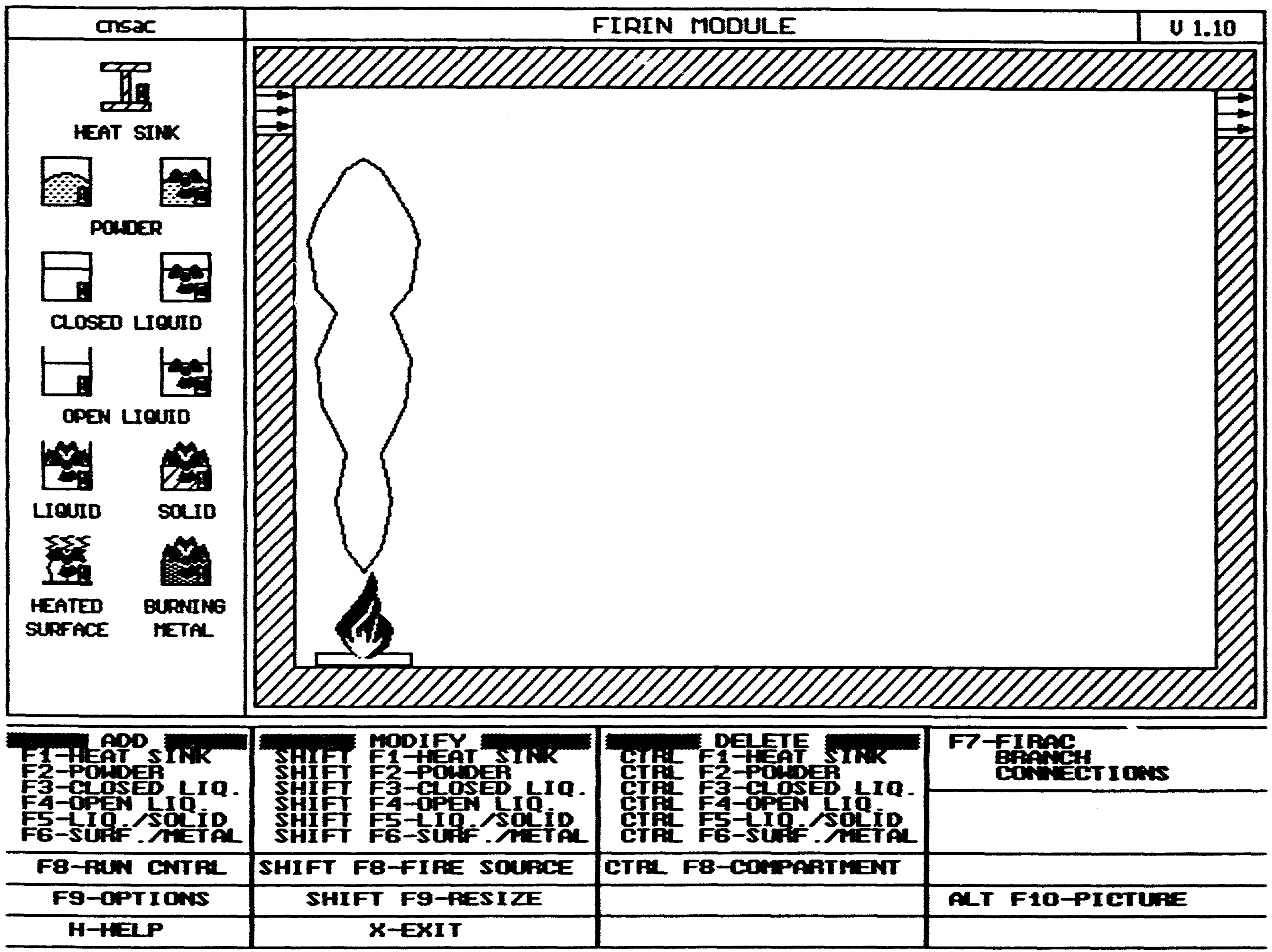
11. External Dose Rate Conversion Factors for Calculation of Dose to the Public, DOE/EH-0070, US DOE, July 1988.

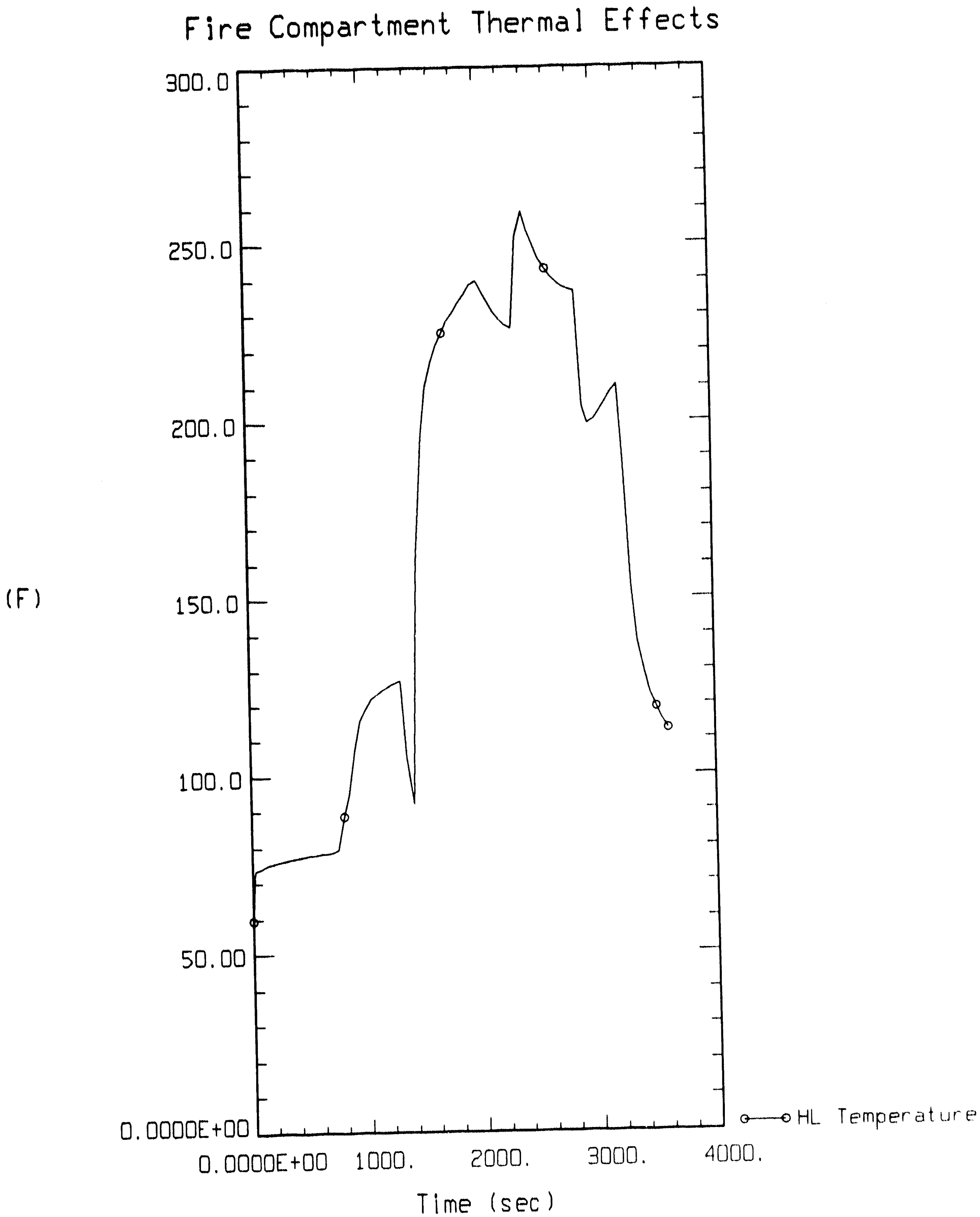
12. R.P. Kennedy, et. al., Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards, UCRL-15910, LLNL, Livermore , CA, May, 1989.

# APPENDIX A

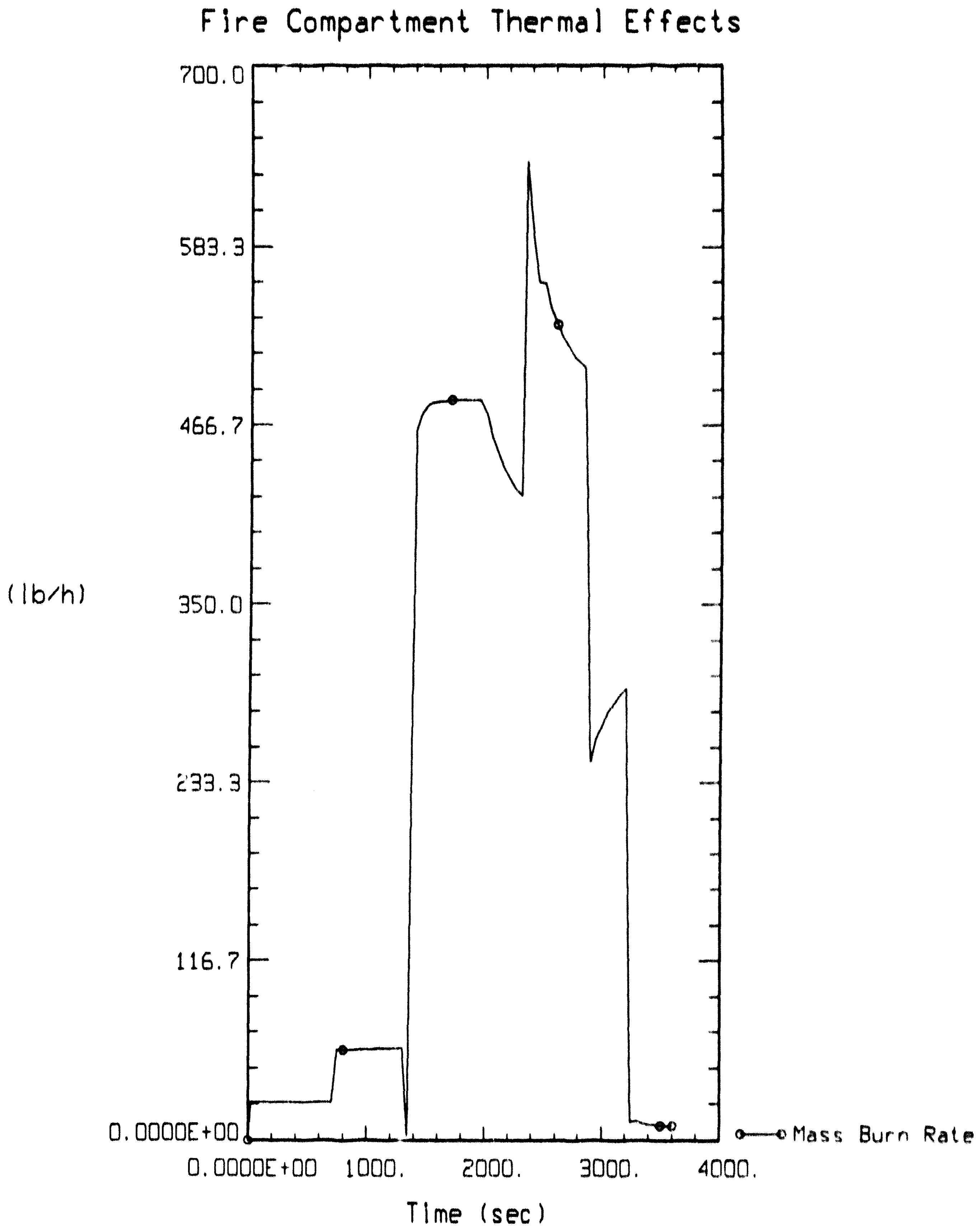
# FIRAC INPUT & OUTPUT


CNSAC
FIRAC PREPROCESSOR
V 1.10
NODES
ROOM
BOUNDARY
FIRE ROOM
BRANCHES
DUCT
DAMPER
FILTER
BLOWER
ADD
F1-ROOM
F2-BOUNDARY
F3-FIRE ROOM
F4-DUCT
F5-DAMPER
F6-FILTER
F7-BLOWER
MODIFY
SHIFT F1-ROOM
SHIFT F2-BOUNDARY
SHIFT F3-FIRE ROOM
SHIFT F4-DUCT
SHIFT F5-DAMPER
SHIFT F6-FILTER
SHIFT F7-BLOWER
DELETE
CTRL F1-ROOM
CTRL F2-BOUNDARY
CTRL F3-FIRE ROOM
CTRL F4-DUCT
CTRL F5-DAMPER
CTRL F6-FILTER
CTRL F7-BLOWER
F10-SAVE PREPROCESSOR DATA
SHIFT F10-WRITE FIRAC INPUT
F8-RUN CNTRL
SHIFT F8-TIME DOMAINS
CTRL F8-PARTICULATES
CTRL F10-DOCUMENT
F9-OPTIONS
SHIFT F9-RESIZE
CTRL F9-GASES
ALT F10-PICTURE
H-HELP
X-EXIT
ALT F9-AMBIENT

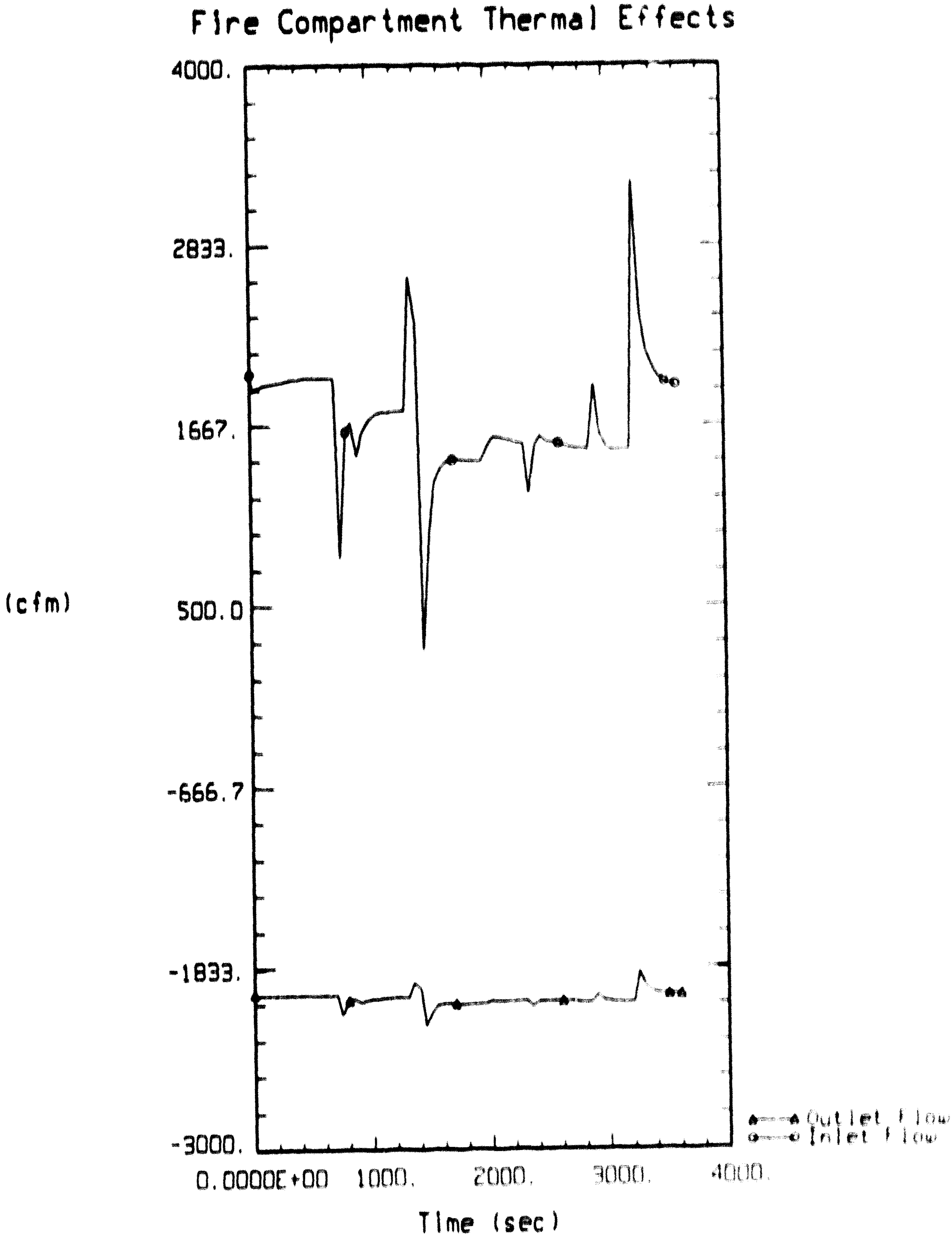

cnsac
FIRIN MODULE
V 1.10
HEAT SINK
POWDER
CLOSED LIQUID
OPEN LIQUID
LIQUID
SOLID
HEATED SURFACE
BURNING METAL
ADD
F1-HEAT SINK
F2-POWDER
F3-CLOSED LIQ.
F4-OPEN LIQ.
F5-LIQ./SOLID
F6-SURF./METAL
MODIFY
SHIFT F1-HEAT SINK
SHIFT F2-POWDER
SHIFT F3-CLOSED LIQ.
SHIFT F4-OPEN LIQ.
SHIFT F5-LIQ./SOLID
SHIFT F6-SURF./METAL
DELETE
CTRL F1-HEAT SINK
CTRL F2-POWDER
CTRL F3-CLOSED LIQ.
CTRL F4-OPEN LIQ.
CTRL F5-LIQ./SOLID
CTRL F6-SURF./METAL
F7-FIRAC BRANCH CONNECTIONS
F8-RUN CNTRL
SHIFT F8-FIRE SOURCE
CTRL F8-COMPARTMENT
F9-OPTIONS
SHIFT F9-RESIZE
ALT F10-PICTURE
H-HELP
X-EXIT



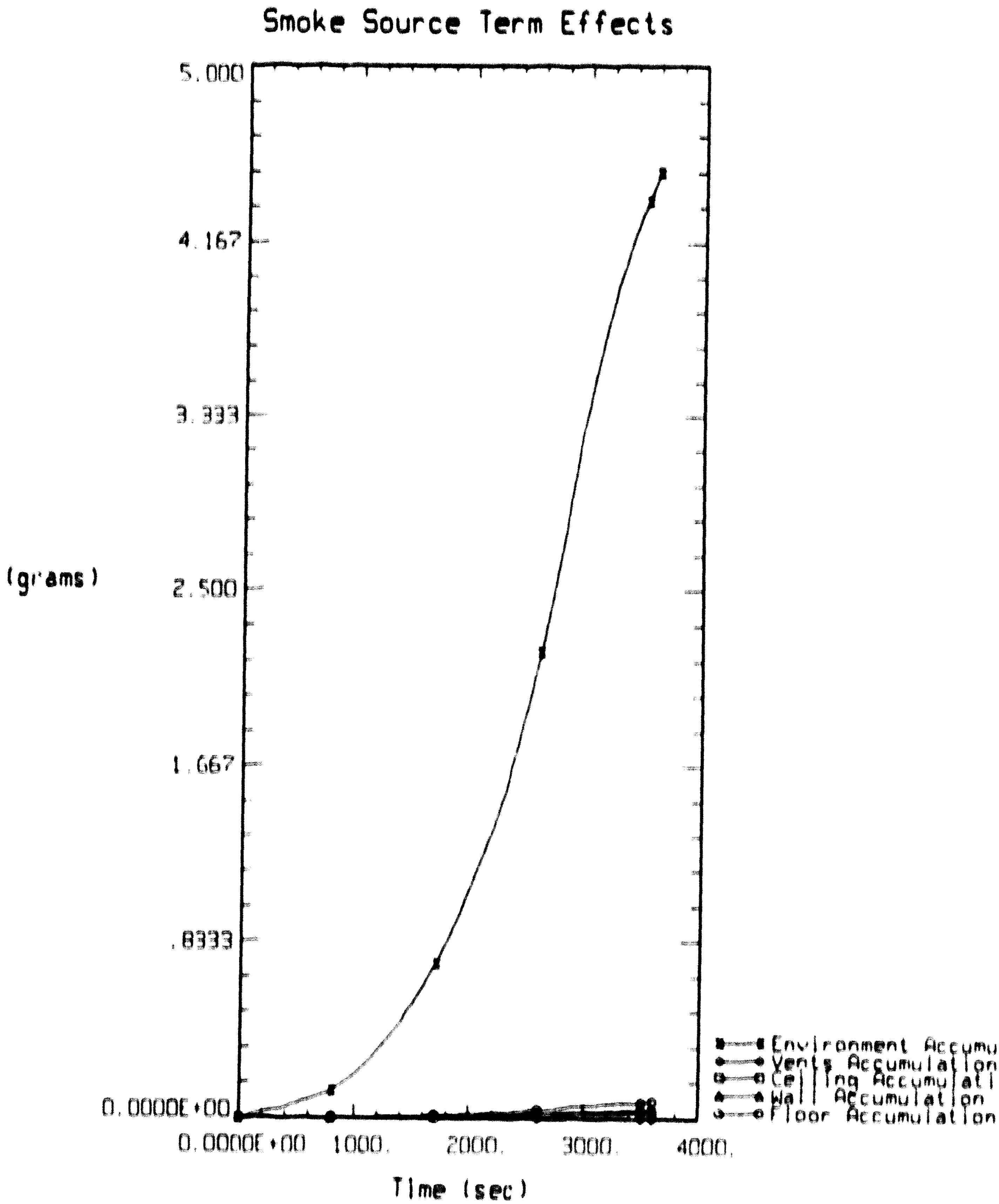
Fire Compartment Thermal Effects
300.0
250.0
200.0
150.0
100.0
50.00
0.0000E+00
(F)
0.0000E+00
1000.
2000.
3000.
4000.
Time (sec)
HL Temperature



Fire Compartment Thermal Effects
700.0
583.3
466.7
350.0
233.3
116.7
0.0000E+00
(lb/h)
0.0000E+00
1000.
2000.
3000.
4000.
Time (sec)
Mass Burn Rate



Fire Compartment Thermal Effects
4000.
2833.
1667.
500.0
-666.7
-1833.
-3000.
(cfm)
0.0000E+00
1000.
2000.
3000.
4000.
Time (sec)
Outlet Flow
Inlet Flow


Smoke Source Term Effects
5.000
4.167
3.333
2.500
1.667
.8333
0.0000E+00
(grams)
0.0000E+00
1000.
2000.
3000.
4000.
Time (sec)
Environment Accumu
Vents Accumulation
Ceiling Accumulati
Wall Accumulation
Floor Accumulation

FP VERSION 1.10

FILE: CNSAC.doc

```
/* ********** RUN CONTROL DATA ********** */

Run Control Option: ST
Initial Output Time (s): 0.0
Time between Outputs (s): 0.5
Last Output Time (s): 3600.0
No. Special Output Times (s): 0
  First:
  Second:
  Third:
  Fourth:
  Fifth:
Max. Iterations:
Convergence Criterion:
Particle Deposition:
Particle Entrainment:
Initial Pressure Input:
Initial Temperature Input:
Buoyancy Term:

/* ********** AMBIENT CONDITIONS ********** */

Pressure (psia): 14.696
Temperature (F): 60.0

/* ********** BOUNDARY NODES ********** */

Number of Boundary Nodes: 4

Description: INLET BOUNDARY
  Node Number: 1
  Node Type: 0
  Initial Pressure (in w.g.): 0.0
  Pressure Function I.D.:
  Initial Temperature (F): 60.0
  Temperature Function I.D.:
  Elevation (ft): 0.0

Description: FIRE INLET
  Node Number: 2
  Node Type: 1
  Initial Pressure (in w.g.): 0.0
  Pressure Function I.D.: 0
  Initial Temperature (F): 60.0
  Temperature Function I.D.: 0
  Elevation (ft): 0.0
```

Description: FIRE OUTLET
  Node Number: 3
  Node Type: 1
  Initial Pressure (in w.g.): 0.0
  Pressure Function I.D.: 0
  Initial Temperature (F): 60.0
  Temperature Function I.D.: 0
  Elevation (ft): 0.0

Description: EXHAUST BOUNDARY
  Node Number: 4
  Node Type: 0
  Initial Pressure (in w.g.): -1.0
  Pressure Function I.D.:
  Initial Temperature (F): 60.0
  Temperature Function I.D.:
  Elevation (ft): 0.0

/* ********** ROOMS ********** */

Number of Rooms: 0

/* ********** BRANCHES AND DAMPERS ********** */

Number of Branches: 2
Number of Control Dampers: 0

Description: INLET DUCT
  Branch Number: 1
  Upstream Node Number: 1
  Downstream Node Number: 3
  Initial Flow (cfm): 2000.0
  Flow Area (ft2): 3.14
  Duct Length (ft): 10.0
  Component Type: D
  Pressure Differential (in w.g.): 0.0
  Blower Curve I.D.:
  Forward Resistance Coefficient: 1.60534
  Reverse Resistance Coefficient: 1.60534
  Filter Type:
  Duct Height (ft):
  Floor Area (ft):
  Heat Transfer Option: 0
  Roughness Height (m):
  Bend Angle (rad):
  Bend Radius (m):
  Drag Coefficient Factor:
  Shape Indicator:

Description: EXHAUST DUCT
  Branch Number: 2

Upstream Node Number: 2
Downstream Node Number: 4
Initial Flow (cfm): 2000.0
Flow Area (ft2): 3.14
Duct Length (ft): 10.0
Component Type: D
Pressure Differential (in w.g.): 0.0
Blower Curve I.D.:
Forward Resistance Coefficient: 1.60534
Reverse Resistance Coefficient: 1.60534
Filter Type:
Duct Height (ft):
Floor Area (ft):
Heat Transfer Option: 0
Roughness Height (m):
Bend Angle (rad):
Bend Radius (m):
Drag Coefficient Factor:
Shape Indicator:

/* ********** FILTERS ********** */

Number of Filter Types: 0

/* ********** PARTICULATE SPECIES ********** */

Number of Particulate Species: 0

/* ********** GAS SPECIES ********** */

Number of Gas Species: 0

/* ********** BLOWER CURVES ********** */

Number of Blower Curves: 0

/* ********** PRESSURE FUNCTIONS ********** */

Number of Pressure Functions: 0

/* ********** TEMPERATURE FUNCTIONS ********** */

Number of Temperature Functions: 0

/* ********** ENERGY FUNCTIONS ********** */

Number of Energy Functions: 0

/* ********** MASS FUNCTIONS ********** */

Number of Mass Functions: 0

```
/* ********** PARTICULATE SPECIES FUNCTIONS ********** */

Number of Particulate Species Functions:  0

/* ********** GAS SPECIES FUNCTIONS ********** */

Number of Gas Species Functions:  0

/* ********** TIME DOMAINS ********** */

Time Domain:  1
  Dtmax (s):  0.5
  Tend (s):  100.0
  Edint (s):  1.0

Time Domain:  2
  Dtmax (s):  1.0
  Tend (s):  3600.0
  Edint (s):  10.0

/* ********************************** */
/* ********** FIRIN MODULE ********** */
/* ********************************** */

IFIRIN flag:  0

Inlet Node Number:  2
Outlet Node Number:  3
Third Node Number  0
Inlet Branch Number:  1
Inlet Branch Diameter (ft):  2.0
Outlet Branch Number:  2
Outlet Branch Diameter (ft):  2.0
Third Branch Number:
Third Branch Diameter (ft):
Third Branch Elevation (ft):
Third Branch Flow Direction:

/* ********** RUN CONTROL DATA ********** */

Fire Duration (s):  3600.0
Fire Start Time (s):  0.0
Print Interval (time steps):  50

/* ********** HEAT SINKS ********** */

Number of Heat Sinks:  0

/* ********** POWDER CONTAINERS ********** */
```

```
Number of Powder Containers:  0

/* *********** CLOSED LIQUID CONTAINERS ********** */

Number of Closed Liquid Containers:  0

/* *********** OPEN LIQUID CONTAINERS ********** */

Number of Open Liquid Containers:  0

/* *********** BURNING LIQUIDS ********** */

Number of Burning Liquids:  0

/* *********** BURNING SOLIDS ********** */

Number of Burning Solids:  0

/* *********** HEATED SURFACES ********** */

Number of Heated Surfaces:  0

/* *********** BURNING METALS ********** */

Number of Burning Metals:  0

/* *********** FIRE SOURCE DATA ********** */

Ignition Energy Flag:  1
  0=Burning Order
  1=Ignition Energy
  2=Burning Rate

Maximum Burning Order:  2

Burning Order:  1
Combustible 1 Fuel Mass (lbm):
              Surface Area (ft2):
Combustible 2 Fuel Mass (lbm):
              Surface Area (ft2):
Combustible 3 Fuel Mass (lbm):
              Surface Area (ft2):
Combustible 4 Fuel Mass (lbm):
              Surface Area (ft2):
Combustible 5 Fuel Mass (lbm):
              Surface Area (ft2):
Combustible 6 Fuel Mass (lbm):  20.0
              Surface Area (ft2):  6.0
Combustible 7 Fuel Mass (lbm):  4.0
              Surface Area (ft2):  1.5
Combustible 8 Fuel Mass (lbm):
```

```
                 Surface Area (ft2):
Combustible 9 Fuel Mass (lbm):
                 Surface Area (ft2):

Burning Order:  2
Combustible 1 Fuel Mass (lbm):
                 Surface Area (ft2):
Combustible 2 Fuel Mass (lbm):
                 Surface Area (ft2):
Combustible 3 Fuel Mass (lbm):  4.0
                 Surface Area (ft2):  2.0
Combustible 4 Fuel Mass (lbm):
                 Surface Area (ft2):
Combustible 5 Fuel Mass (lbm):  150.0
                 Surface Area (ft2):  48.0
Combustible 6 Fuel Mass (lbm):  250.0
                 Surface Area (ft2):  35.0
Combustible 7 Fuel Mass (lbm):  5.75
                 Surface Area (ft2):  4.0
Combustible 8 Fuel Mass (lbm):
                 Surface Area (ft2):
Combustible 9 Fuel Mass (lbm):
                 Surface Area (ft2):

/* ********** USER DEFINED FUELS ********** */

/* ********** USER DEFINED MATERIALS ********** */

/* ********** FIRE COMPARTMENT DATA ********** */

  Length (ft):  40.0
  Width (ft):  40.0
  Height (ft):13.0
  Ceiling Thickness (ft):  1.0
  Wall Thickness (ft):  1.0
  Floor Thickness (ft):  1.0
  Ceiling Material:  1
  Wall Material:  1
  Floor Material:  1
  Number of Additional Flow Paths:
  Compartment Temperature (F):  60
  Compartment Pressure (in w.g.):  -0.55001
  Inlet Vent Elevation (ft):  13.0
  Outlet Vent Elevation (ft):  13.0
  Flame Base Elevation:  0.00
  Floor Temperature (F):  60.0
  Ceiling Temperature (F):  60.0
  Wall Temperature (F):  60.0
/* ********** ADDITIONAL FLOW PATHS ********** */

Number of Flow Paths:  0
```

# APPENDIX B

# MACCS INPUT & OUTPUT

```
MACCS  12/10/92   09:42:22   MACCS VERSION 1.5.11.1, D. CHANIN, 5/26/92
P1:  ATMOS USER INPUT (UNIT 24) = CH1A.INP
P2:  EARLY USER INPUT (UNIT 25) = CH2A.INP
P3: CHRONIC USER INPUT (UNIT 26) = CH3A.INP
        DOSE FACTORS (UNIT 27) = DOSDATA.INP
P4:  METEOROLOGY DATA (UNIT 28) = METSUR.INP
P5:   SITE DATA INPUT (UNIT 29) = SURSIT.INP
P6:       LIST OUTPUT (UNIT 06) = TEMPA.OUT


USER INPUT IS READ FROM UNIT 24
RECORD IDENTIFIER FIELDS  11 CHARACTERS LONG ARE EXPECTED.
THE FIRST 100 COLUMNS OF EACH INPUT RECORD ARE PROCESSED.
THE MAXIMUM NUMBER OF IDENTIFIER RECORDS THAT MAY BE SAVED AS THE BASE CASE IS

RECORD
NUMBER                                  RECORD

       * MACCS analysis for the CMSAC facility
       * Pu-239 source case
       *
    1  RIATNAM1001  'CH1A.INP, ATMOS INPUT'
       *****************************************************************
       * GEOMETRY DATA BLOCK, LOADED BY INPGEO, STORED IN /GEOM/
       *
       * NUMBER OF RADIAL SPATIAL ELEMENTS
       *
    2  GENUMRAD001  6
       *
       *  SANDIA
       *
    3  GESPAEND001    0.1   0.2   0.4   0.6   0.9   1.1
       *****************************************************************
       * NUCLIDE DATA BLOCK, LOADED BY INPISO, STORED IN /ISOGRP/, /ISONAM/
       *
       * NUMBER OF NUCLIDES
       *
    4  ISNUMISO001 60
       *
       * NUMBER OF NUCLIDE GROUPS
       *
    5  ISMAXGRP001  9
       *
       * WET AND DRY DEPOSITION FLAGS FOR EACH NUCLIDE GROUP
       *
       *              WETDEP     DRYDEP
       *
    6  ISDEPFLA001    .FALSE.    .FALSE.
    7  ISDEPFLA002    .TRUE.     .TRUE.
    8  ISDEPFLA003    .TRUE.     .TRUE.
    9  ISDEPFLA004    .TRUE.     .TRUE.
   10  ISDEPFLA005    .TRUE.     .TRUE.
   11  ISDEPFLA006    .TRUE.     .TRUE.
   12  ISDEPFLA007    .TRUE.     .TRUE.
   13  ISDEPFLA008    .TRUE.     .TRUE.
   14  ISDEPFLA009    .TRUE.     .TRUE.
       *
       * NUCLIDE GROUP DATA FOR 9 NUCLIDE GROUPS
       *
       *              NUCNAM     PARENT   IGROUP       HAFLIF
       *
   15  ISOTPGRP001    CO-58      NONE       6        6.160E+06
   16  ISOTPGRP002    CO-60      NONE       6        1.660E+08
   17  ISOTPGRP003    KR-85      NONE       1        3.386E+08
   18  ISOTPGRP004    KR-85M     NONE       1        1.613E+04
   19  ISOTPGRP005    KR-87      NONE       1        4.540E+03
   20  ISOTPGRP006    KR-88      NONE       1        1.000E+04
   21  ISOTPGRP007    RB-86      NONE       3        1.611E+06
   22  ISOTPGRP008    SR-89      NONE       5        4.495E+06
   23  ISOTPGRP009    SR-90      NONE       5        8.865E+08
   24  ISOTPGRP010    SR-91      NONE       5        3.413E+04
   25  ISOTPGRP011    SR-92      NONE       5        9.756E+03     NEW
   26  ISOTPGRP012    Y-90       SR-90      7        2.307E+05
   27  ISOTPGRP013    Y-91       SR-91      7        5.080E+06
   28  ISOTPGRP014    Y-92       SR-92      7        1.274E+04     NEW
   29  ISOTPGRP015    Y-93       NONE       7        3.636E+04     NEW
   30  ISOTPGRP016    ZR-95      NONE       7        5.659E+06
   31  ISOTPGRP017    ZR-97      NONE       7        6.048E+04
   32  ISOTPGRP018    NB-95      ZR-95      7        3.033E+06
   33  ISOTPGRP019    MO-99      NONE       6        2.377E+05
   34  ISOTPGRP020    TC-99M     MO-99      6        2.167E+04
   35  ISOTPGRP021    RU-103     NONE       6        3.421E+06
   36  ISOTPGRP022    RU-105     NONE       6        1.598E+04
   37  ISOTPGRP023    RU-106     NONE       6        3.188E+07
   38  ISOTPGRP024    RH-105     RU-105     6        1.270E+05
   39  ISOTPGRP025    SB-127     NONE       4        3.283E+05
   40  ISOTPGRP026    SB-129     NONE       4        1.562E+04
   41  ISOTPGRP027    TE-127     SB-127     4        3.366E+04
   42  ISOTPGRP028    TE-127M    NONE       4        9.418E+06
   43  ISOTPGRP029    TE-129     SB-129     4        4.200E+03
   44  ISOTPGRP030    TE-129M    NONE       4        2.886E+06
   45  ISOTPGRP031    TE-131M    NONE       4        1.080E+05
   46  ISOTPGRP032    TE-132     NONE       4        2.808E+05
   47  ISOTPGRP033    I-131      TE-131M    2        6.947E+05
   48  ISOTPGRP034    I-132      TE-132     2        8.226E+03
   49  ISOTPGRP035    I-133      NONE       2        7.488E+04
   50  ISOTPGRP036    I-134      NONE       2        3.156E+03
   51  ISOTPGRP037    I-135      NONE       2        2.371E+04
   52  ISOTPGRP038    XE-133     I-133      1        4.571E+05
   53  ISOTPGRP039    XE-135     I-135      1        3.301E+04
   54  ISOTPGRP040    CS-134     NONE       3        6.501E+07
   55  ISOTPGRP041    CS-136     NONE       3        1.123E+06
   56  ISOTPGRP042    CS-137     NONE       3        9.495E+08
   57  ISOTPGRP043    BA-139     NONE       9        4.986E+03     NEW
   58  ISOTPGRP044    BA-140     NONE       9        1.105E+06
   59  ISOTPGRP045    LA-140     BA-140     7        1.448E+05
   60  ISOTPGRP046    LA-141     NONE       7        1.418E+04     NEW
   61  ISOTPGRP047    LA-142     NONE       7        5.724E+03     NEW
   62  ISOTPGRP048    CE-141     LA-141     8        2.811E+06  PARENT ADDED
   63  ISOTPGRP049    CE-143     NONE       8        1.188E+05
   64  ISOTPGRP050    CE-144     NONE       8        2.457E+07
   65  ISOTPGRP051    PR-143     CE-143     7        1.173E+06
   66  ISOTPGRP052    ND-147     NONE       7        9.495E+05
   67  ISOTPGRP053    NP-239     NONE       8        2.030E+05
   68  ISOTPGRP054    PU-238     CM-242     8        2.809E+09
   69  ISOTPGRP055    PU-239     NP-239     8        7.708E+11
   70  ISOTPGRP056    PU-240     CM-244     8        2.133E+11
   71  ISOTPGRP057    PU-241     NONE       8        4.608E+08
   72  ISOTPGRP058    AM-241     PU-241     7        1.366E+10
   73  ISOTPGRP059    CM-242     NONE       7        1.408E+07
   74  ISOTPGRP060    CM-244     NONE       7        5.712E+08
       *****************************************************************
       * WET DEPOSITION DATA BLOCK, LOADED BY INPWET, STORED IN /WETCON/
       *
       * WASHOUT COEFFICIENT NUMBER ONE, LINEAR FACTOR
       *
   75  WDCWASH1001  9.5E-5   (JON HELTON AFTER JONES, 1986)
       *
       * WASHOUT COEFFICIENT NUMBER TWO, EXPONENTIAL FACTOR
       *
```

T2 12-10-92 10:46a

```
76  WDCWASH2001  0.8      (JON HELTON AFTER JONES, 1986)
    ***************************************************************
    * DRY DEPOSITION DATA BLOCK, LOADED BY INPDRY, STORED IN /DRYCON/
    *
    * NUMBER OF PARTICLE SIZE GROUPS
    *
77  DDNPSGRP001  1
    *
    * DEPOSITION VELOCITY OF EACH PARTICLE SIZE GROUP (M/S)
    *
78  DDVDEPOS001  0.01   (VALUE SELECTED BY S. ACHARYA, NRC)
    ***************************************************************
    * DISPERSION PARAMETER DATA BLOCK, LOADED BY INPDIS, STORED IN /DISPY/,
    *
    * SIGMA = A X ** B  WHERE A AND B VALUES ARE FROM TADMOR AND GUR (1969)
    *
    * LINEAR TERM OF THE EXPRESSION FOR SIGMA-Y, 6 STABILITY CLASSES
    *
    * STABILITY CLASS: A         B         C         D         E         F
    *
79  DPCYSIGA001  0.3658   0.2751   0.2089   0.1474   0.1046   0.0722
    *
    * EXPONENTIAL TERM OF THE EXPRESSION FOR SIGMA-Y, 6 STABILITY CLASSES
    *
    * STABILITY CLASS: A         B         C         D         E         F
    *
80  DPCYSIGB001   .9031    .9031    .9031    .9031    .9031    .9031
    *
    * LINEAR TERM OF THE EXPRESSION FOR SIGMA-Z, 6 STABILITY CLASSES
    *
    * STABILITY CLASS: A         B         C         D         E         F
    *
81  DPCZSIGA001  2.5E-4   1.9E-3    .2       .3       .4       .2
    *
    * EXPONENTIAL TERM OF THE EXPRESSION FOR SIGMA-Z, 6 STABILITY CLASSES
    *
    * STABILITY CLASS; A         B         C         D         E         F
    *
82  DPCZSIGB001  2.125    1.6021    .8543    .6532    .6021    .6020
    *
    *  LINEAR SCALING FACTOR FOR SIGMA-Y FUNCTION, NORMALLY 1
    *
83  DPYSCALE001   1.
    *
    *  LINEAR SCALING FACTOR FOR SIGMA-Z FUNCTION,
    *  NORMALLY USED FOR SURFACE ROUGHNESS LENGTH CORRECTION.
    *  (Z1 / Z0) ** 0.2,    FROM CRAC2 WE HAVE  (10 CM / 3 CM) ** 0.2 = 1.27
    *
84  DPZSCALE001   1.27
    ***************************************************************
    * EXPANSION FACTOR DATA BLOCK, LOADED BY INPEXP, STORED IN /EXPAND/
    *
    * TIME BASE FOR EXPANSION FACTOR (SECONDS)
    *
85  EXTIMBAS001   3600.   (1 HOUR)
    *
    * BREAK POINT FOR FORMULA CHANGE (SECONDS)
    *
86  EXBRKPNT001   3600.   (1 HOUR)
    *
    * EXPONENTIAL EXPANSION FACTOR NUMBER 1
    *
87  EXXPFAC1001      0.2
    *
    * EXPONENTIAL EXPANSION FACTOR NUMBER 2
    *
```

```
88  EXXPFAC2001      0.25
    ***************************************************************
    * PLUME RISE DATA BLOCK, LOADED BY INPLRS, STORED IN /PLUMRS/
    *
    * SCALING FACTOR FOR THE CRITICAL WIND SPEED FOR ENTRAINMENT OF A BOUYAN
    * (USED BY FUNCTION CAUGHT)
    *
89  PRSCLCRW001   1.
    *
    * SCALING FACTOR FOR THE A-D STABILITY PLUME RISE FORMULA
    * (USED BY FUNCTION PLMRIS)
    *
90  PRSCLADP001   1.
    *
    * SCALING FACTOR FOR THE E-F STABILITY PLUME RISE FORMULA
    * (USED BY FUNCTION PLMRIS)
    *
91  PRSCLEFP001   1.
    ***************************************************************
    * WAKE EFFECTS DATA BLOCK, LOADED BY INPWAK, STORED IN /BDLWAK/
    *
    * BUILDING WIDTH (METERS)
    *
92  WEBUILDW001   1.
    *
    * BUILDING HEIGHT (METERS)
    *
93  WEBUILDH001   1.
    ***************************************************************
    * RELEASE DATA BLOCK, LOADED BY INPREL, STORED IN /ATNAM2/, /RRLREL/
    *
94  RDATNAM2001 'ACNR .....'
    *
    * TIME AFTER ACCIDENT INITIATION WHEN THE ACCIDENT REACHES GENERAL EMERG
    * CONDITIONS (AS DEFINED IN NUREG-0654), OR WHEN PLANT PERSONNEL CAN REL
    * PREDICT THAT GENERAL EMERGENCY CONDITIONS WILL BE ATTAINED
    *
95  RDOALARM001        900.
    *
    * NUMBER OF PLUME SEGMENTS THAT ARE RELEASED
    *
96  RDNUMREL001          1
    *
    * SELECTION OF RISK DOMINANT PLUME
    *
97  RDMAXRIS001          1
    *
    * REFERENCE TIME FOR DISPERSION AND RADIOACTIVE DECAY
    *
98  RDREFTIM001        0.00
    *
    * HEAT CONTENT OF THE RELEASE SEGMENTS (W)
    * A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
    *
99  RDPLHEAT001        0.0
    *
    * HEIGHT OF THE PLUME SEGMENTS AT RELEASE (M)
    * A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
    *
100 RDPLHITE001         0.
    *
    * DURATION OF THE PLUME SEGMENTS (S)
    * A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
    *
101 RDPLUDUR001       3600.
    *
```

```
    * TIME OF RELEASE FOR EACH PLUME (S AFTER SCRAM)
    * A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
    *
102 RDPDELAY001      0.
    *
    * PARTICLE SIZE DISTRIBUTION OF EACH NUCLIDE GROUP
    * YOU MUST SPECIFY A COLUMN OF DATA FOR EACH OF THE PARTICLE SIZE GROUPS
    *
103 RDPSDIST001      1.
104 RDPSDIST002      1.
105 RDPSDIST003      1.
106 RDPSDIST004      1.
107 RDPSDIST005      1.
108 RDPSDIST006      1.
109 RDPSDIST007      1.
110 RDPSDIST008      1.
111 RDPSDIST009      1.
    *
    * INVENTORY (Pu-239 only - 24.5 Ci)
    *
    *                NUCNAM      CORINV(BQ)
    *
112 RDCORINV001      CO-58       0.0E+00
113 RDCORINV002      CO-60       0.0E+00
114 RDCORINV003      KR-85       0.0E+00
115 RDCORINV004      KR-85M      0.0E+00
116 RDCORINV005      KR-87       0.0E+00
117 RDCORINV006      KR-88       0.0E+00
118 RDCORINV007      RB-86       0.0E+00
119 RDCORINV008      SR-89       0.0E+00
120 RDCORINV009      SR-90       0.0E+00
121 RDCORINV010      SR-91       0.0E+00
122 RDCORINV011      SR-92       0.0E+00
123 RDCORINV012      Y-90        0.0E+00
124 RDCORINV013      Y-91        0.0E+00
125 RDCORINV014      Y-92        0.0E+00
126 RDCORINV015      Y-93        0.0E+00
127 RDCORINV016      ZR-95       0.0E+00
128 RDCORINV017      ZR-97       0.0E+00
129 RDCORINV018      NB-95       0.0E+00
130 RDCORINV019      MO-99       0.0E+00
131 RDCORINV020      TC-99M      0.0E+00
132 RDCORINV021      RU-103      0.0E+00
133 RDCORINV022      RU-105      0.0E+00
134 RDCORINV023      RU-106      0.0E+00
135 RDCORINV024      RH-105      0.0E+00
136 RDCORINV025      SB-127      0.0E+00
137 RDCORINV026      SB-129      0.0E+00
138 RDCORINV027      TE-127      0.0E+00
139 RDCORINV028      TE-127M     0.0E+00
140 RDCORINV029      TE-129      0.0E+00
141 RDCORINV030      TE-129M     0.0E+00
142 RDCORINV031      TE-131M     0.0E+00
143 RDCORINV032      TE-132      0.0E+00
144 RDCORINV033      I-131       0.0E+00
145 RDCORINV034      I-132       0.0E+00
146 RDCORINV035      I-133       0.0E+00
147 RDCORINV036      I-134       0.0E+00
148 RDCORINV037      I-135       0.0E+00
149 RDCORINV038      XE-133      0.0E+00
150 RDCORINV039      XE-135      0.0E+00
151 RDCORINV040      CS-134      0.0E+00
152 RDCORINV041      CS-136      0.0E+00
153 RDCORINV042      CS-137      0.0E+00
154 RDCORINV043      BA-139      0.0E+00
155 RDCORINV044      BA-140      0.0E+00
```



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156 RDCORINV045      LA-140      0.0E+00
157 RDCORINV046      LA-141      0.0E+00
158 RDCORINV047      LA-142      0.0E+00
159 RDCORINV048      CE-141      0.0E+00
160 RDCORINV049      CE-143      0.0E+00
161 RDCORINV050      CE-144      0.0E+00
162 RDCORINV051      PR-143      0.0E+00
163 RDCORINV052      ND-147      0.0E+00
164 RDCORINV053      NP-239      0.0E+00
165 RDCORINV054      PU-238      0.0E+00
166 RDCORINV055      PU-239      9.065E+11
167 RDCORINV056      PU-240      0.0E+00
168 RDCORINV057      PU-241      0.0E+00
169 RDCORINV058      AM-241      0.0E+00
170 RDCORINV059      CM-242      0.0E+00
171 RDCORINV060      CM-244      0.0E+00
    *
    *  SCALING FACTOR = RESPIRABLE FACTOR (0.5) * FRACTION OF SEALED SOURCE
    *
172 RDCORSCA001   5.0E-02 * UNITS
    *
    * RELEASE FRACTIONS FOR ISOTOPE GROUPS IN RELEASE
    *
    *  ISOTOPE GROUPS:
    *
    *           XE/KR    I     CS     TE     SR     RU     LA     CE     BA
    *
173 RDRELFRC001 1.0E+0 1.0E+0 1.0E+0 1.0E+0 1.0E+0 1.0E+0 1.0E+0 3.2E-4 1.0E
    ****************************************************************************
    * OUTPUT CONTROL DATA BLOCK, LOADED BY INPOPT, STORED IN /STOPNE/, /ATMO
    *
    * FLAG TO INDICATE THAT THIS IS THE LAST PROGRAM IN THE SERIES TO BE RUN
    *
174 OCENDAT1001   .FALSE. (SET THIS VALUE TO .TRUE. TO SKIP EARLY AND CHRONC)
    *
175 OCIDEBUG001   1
    *
    * NAME OF THE NUCLIDE TO BE LISTED ON THE DISPERSION LISTINGS
    *
176 OCNUCOUT001   PU-239
    ****************************************************************************
    * METEOROLOGICAL SAMPLING DATA BLOCK
    *
    * METEOROLOGICAL SAMPLING OPTION CODE:
    *
    * METCOD = 1, USER SPECIFIED DAY AND HOUR IN THE YEAR (FROM MET FILE),
    *          2, WEATHER CATEGORY BIN SAMPLING,
    *          3, 120 HOURS OF WEATHER SPECIFIED ON THE ATMOS USER INPUT FIL
    *          4, CONSTANT MET (BOUNDARY WEATHER USED FROM THE START),
    *          5, STRATIFIED RANDOM SAMPLES FOR EACH DAY OF THE YEAR.
    *
177 M1METCOD001   4    (BOUNDARY WEATHER USED FROM THE START)
    *
    * LAST SPATIAL INTERVAL FOR MEASURED WEATHER
    *
178 M2LIMSPA001   0
    *
    * BOUNDARY WEATHER MIXING LAYER HEIGHT
    *
179 M2BNDMXH001   1000.  (METERS)
    *
    * BOUNDARY WEATHER STABILITY CLASS INDEX
    *
180 M2IBDSTB001   6      (F-STABILITY)
    *
    * BOUNDARY WEATHER RAIN RATE
```

```
      *
  181 M2BNDRAN001  0.      (MM/HR)
      *
      * BOUNDARY WEATHER WIND SPEED
      *
  182 M2BNDWND001  1.      (M/S)
      *
      * START DAY IN THE YEAR FOR THE SINGLE WEATHER SEQUENCE
      *
  183 M3ISTRDY001  157     (START TIME FOR PEAK ECONOMIC COST OF SAMPLE PROBLEM
      *
      * START HOUR IN THE DAY FOR THE SINGLE WEATHER SEQUENCE
      *
  184 M3ISTRHR001  10      (START TIME FOR PEAK ECONOMIC COST OF SAMPLE PROBLEM
      *
******** TERMINATOR RECORD ENCOUNTERED -- END OF BASE CASE USER INPUT ********

USER INPUT PROCESSING SUMMARY - BASE CASE

NUMBER OF RECORDS READ                          =  391
NUMBER OF BLANK OR COMMENT RECORDS READ         =  206
NUMBER OF TERMINATOR RECORDS                    =    1
NUMBER OF RECORDS PROCESSED                     =  184
     NUMBER OF PROCESSED RECORDS DUPLICATED     =    0
     NUMBER OF PROCESSED RECORDS SORTED         =  184
******************************************************************************

1 RELEASED INVENTORY OF ALL PLUMES
 CO-58      0.00E+00
 CO-60      0.00E+00
 KR-85      0.00E+00
 KR-85M     0.00E+00
 KR-87      0.00E+00
 KR-88      0.00E+00
 RB-86      0.00E+00
 SR-89      0.00E+00
 SR-90      0.00E+00
 SR-91      0.00E+00
 SR-92      0.00E+00
 Y-90       0.00E+00
 Y-91       0.00E+00
 Y-92       0.00E+00
 Y-93       0.00E+00
 ZR-95      0.00E+00
 ZR-97      0.00E+00
 NB-95      0.00E+00
 MO-99      0.00E+00
 TC-99M     0.00E+00
 RU-103     0.00E+00
 RU-105     0.00E+00
 RU-106     0.00E+00
 RH-105     0.00E+00
 SB-127     0.00E+00
 SB-129     0.00E+00
 TE-127     0.00E+00
 TE-127M    0.00E+00
 TE-129     0.00E+00
 TE-129M    0.00E+00
 TE-131M    0.00E+00
 TE-132     0.00E+00
 I-131      0.00E+00
 I-132      0.00E+00
 I-133      0.00E+00
 I-134      0.00E+00
 I-135      0.00E+00
 XE-133     0.00E+00
 XE-135     0.00E+00
 CS-134     0.00E+00
 CS-136     0.00E+00
 CS-137     0.00E+00
 BA-139     0.00E+00
 BA-140     0.00E+00
 LA-140     0.00E+00
 LA-141     0.00E+00
 LA-142     0.00E+00
 CE-141     0.00E+00
 CE-143     0.00E+00
 CE-144     0.00E+00
 PR-143     0.00E+00
 ND-147     0.00E+00
 NP-239     0.00E+00
 PU-238     0.00E+00
 PU-239     1.45E+07
 PU-240     0.00E+00
 PU-241     0.00E+00
 AM-241     0.00E+00
 CM-242     0.00E+00
 CM-244     0.00E+00

USER INPUT IS READ FROM UNIT 25
RECORD IDENTIFIER FIELDS  11 CHARACTERS LONG ARE EXPECTED.
THE FIRST 100 COLUMNS OF EACH INPUT RECORD ARE PROCESSED.
THE MAXIMUM NUMBER OF IDENTIFIER RECORDS THAT MAY BE SAVED AS THE BASE CASE IS

RECORD
NUMBER                              RECORD

        * MACCS early input file, CNSAC facility
        *
    1   MIEANAM1001  'Maximum possible fire scenario'
        *
        * FLAG TO INDICATE THAT THIS IS THE LAST PROGRAM IN THE SERIES TO BE RUN
        *
    2   MIENDAT2001  .TRUE.    (SET THIS VALUE TO .TRUE. TO SKIP CHRONC)
        *
        * DISPERSION MODEL OPTION CODE:  1  *  STRAIGHT LINE
        *                                2  *  WIND-SHIFT WITH ROTATION
        *                                3  *  WIND-SHIFT WITHOUT ROTATION
        *
    3   MIIPLUME001  1     (STRAIGHT LINE PLUME)
        *
        * NUMBER OF FINE GRID SUBDIVISIONS USED BY THE MODEL
        *
    4   MINUMFIN001  7     (3, 5 OR 7 ALLOWED)
        *
        * LEVEL OF DEBUG OUTPUT REQUIRED, NORMAL RUNS SHOULD SPECIFY ZERO
        *
    5   MIIPRINT001  0     (TURN OFF THE DEBUG PRINT)
        *
        * LOGICAL FLAG SIGNIFYING THAT THE BREAKDOWN OF RISK BY WEATHER CATEGORY
        * BIN ARE TO BE PRESENTED TO SHOW THEIR RELATIVE CONTRIBUTION TO THE MEA
        *
        *             RISBIN
        *
    6   MIRISCAT001   .FALSE.
        *
        * FLAG INDICATING IF WIND-ROSES FROM ATMOS ARE TO BE OVERRIDDEN
        *
    7   MIOVRRID001   .FALSE.   (USE THE WIND ROSE CALCULATED FOR EACH WEATHER BIN
```

```
   ******************************************************************
   * POPULATION DISTRIBUTION DATA BLOCK, LOADED BY INPOPU, STORED IN /POPDA
   *
 8 PDPOPFLG001  UNIFORM
 9 PDIBEGIN001  1   (SPATIAL INTERVAL AT WHICH POPULATION BEGINS)
10 PDPOPDEN001  1000. (POPULATION DENSITY (PEOPLE PER SQUARE KILOMETER))
   ******************************************************************
   * ORGAN DEFINITION DATA BLOCK, LOADED BY INORGA, STORED IN /EARDOV/ AND
   *
   * NUMBER OF ORGANS DEFINED FOR HEALTH EFFECTS
   *
11 OONUMORG001   5
   *
   * NAMES OF THE ORGANS DEFINED FOR HEALTH EFFECTS
   *
12 OOORGNAM001 'NULL', 'EDEWBODY', 'LUNGS', 'RED MARR', 'BONE SUR'
   ******************************************************************
   * SHIELDING AND EXPOSURE FACTORS, LOADED BY INDFAC, STORED IN /EADFAC/
   *
   * THREE VALUES OF EACH PROTECTION FACTOR ARE SUPPLIED,
   * ONE FOR EACH TYPE OF ACTIVITY:
   *
   * ACTIVITY TYPE:
   *     1 - EVACUEES WHILE MOVING
   *     2 - NORMAL ACTIVITY IN SHELTERING AND EVACUATION ZONE
   *     3 - SHELTERED ACTIVITY
   *
   * CLOUD SHIELDING FACTOR
   *
   *    SITE         GG   PB   SEQ  SUR  ZION
   *    SHELTERING  0.7  0.5  0.65 0.6  0.5
   *
   *             EVACUEES  NORMAL  SHELTER
   *
13 SECSFACT001     1.0      1.0      1.0   * NO REDUCTION FACTORS
   *
   * PROTECTION FACTOR FOR INHALATION
   *
14 SEPROTIN001     1.0      1.0      1.0
   *
   * BREATHING RATE (CUBIC METERS PER SECOND)
   *
15 SEBRRATE001  3.47E-4  3.47E-4  3.47E-4
   *
   * SKIN PROTECTION FACTOR
   *
16 SESKPFAC001  1.0      1.0      1.0
   *
   * GROUND SHIELDING FACTOR
   *
   *    SITE         GG   PB   SEQ  SUR  ZION
   *    SHELTERING  0.25 0.1  0.2  0.2  0.1
   *
17 SEGSHFAC001     1.0    1.0    1.0
   *
   * RESUSPENSION INHALATION MODEL CONCENTRATION COEFFICIENT (/METER)
   *
   *   RESCON = 1.E-4 IS APPROPRIATE FOR MECHANICAL RESUSPENSION BY VEHICLE
   *   RESHAF = 2.11 DAYS CAUSES 1.E-4 TO DECAY IN ONE WEEK TO 1.E-5. THE V
   *   OF RESCON USED IN THE FIRST TERM OF THE LONG-TERM RESUSPENSION EQUAT
   *   USED IN CHRONC.
   *
18 SERESCON001   1.E-4     (RESUSPENSION IS TURNED ON)
   *
   * RESUSPENSION CONCENTRATION COEFFICIENT HALF-LIFE (SEC)
   *
19 SERESHAF001   1.82E5    (2.11 DAYS)
   ******************************************************************
   * EVACUATION ZONE DATA BLOCK, LOADED BY EVNETW, STORED IN /NETWOR/, /EOP
   *
   * SPECIFIC DESCRIPTION OF THE EMERGENCY RESPONSE SCENARIO BEING USED
   *
20 EZEANNO2001  "NO EVACUATION"
   *
   * THE TYPE OF WEIGHTING TO BE APPLIED TO THE EMERGENCY RESPONSE SCENARIO
   * YOU MUST SUPPLY A VALUE OF "TIME" OR "PEOPLE"
   *
21 EZWTNAME001  "PEOPLE"
   *
   * WEIGHTING FRACTION APPLICABLE TO THIS SCENARIO
   *
22 EZWTFRAC001  0.0
   *
   * LAST RING IN THE MOVEMENT ZONE
   *
23 EZLASMOV001     0     (NO EVACTION)
   *
   ******************************************************************
   * SHELTER AND RELOCATION ZONE DATA BLOCK, LOADED BY INPEMR,
   *                                  STORED IN /INPSRZ/, /RELOCA/
   *
   * TIME TO TAKE SHELTER IN THE INNER SHELTER ZONE (SECONDS FROM OALARM)
   *
24 SRTTOSH1001     0.     (THERE IS NO INNER SHELTER ZONE)
   *
   * SHELTER DURATION IN THE INNER SHELTER ZONE (SECONDS FROM TAKING SHELTE
   *
25 SRSHELT1001     0.     (THERE IS NO INNER SHELTER ZONE)
   *
   * LAST RING OF THE OUTER SHELTER ZONE
   *
26 SRLASHE2001     0      (THERE IS NO OUTER SHELTER ZONE)
   *
   * TIME TO TAKE SHELTER IN THE OUTER SHELTER ZONE (SECONDS FROM OALARM)
   *
27 SRTTOSH2001     0.     (THERE IS NO OUTER SHELTER ZONE)
   *
   * SHELTER DURATION IN THE OUTER SHELTER ZONE (SECONDS FROM TAKING SHELTE
   *
28 SRSHELT2001     0.     (THERE IS NO OUTER SHELTER ZONE)
   *
   * DURATION OF THE EMERGENCY PHASE (SECONDS FROM PLUME ARRIVAL)
   *
29 SRENDEMP001   86400.   (ONE DAY)
   *
   * CRITICAL ORGAN FOR RELOCATION DECISIONS
   *
30 SRCRIORG001  "EDEWBODY"
   *
   * HOT SPOT RELOCATION TIME (SECONDS FROM PLUME ARRIVAL)
   *
31 SRTIMHOT001  7200.    (NO RELOCATION)
   *
   * NORMAL RELOCATION TIME (SECONDS FROM PLUME ARRIVAL)
   *
32 SRTIMNRM001  7200.    (NO RELOCATION)
   *
   * HOT SPOT RELOCATION DOSE CRITERION THRESHOLD (SIEVERTS)
   *
33 SRDOSHOT001  0.5    (50 REM DOSE TO WHOLE BODY IN 1 WEEK TRIGGERS RELOCA
   *
   * NORMAL RELOCATION DOSE CRITERION THRESHOLD (SIEVERTS)
```

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*
34 SHDOSNWB001 0.25  (25 REM DOSE TO WHOLE BODY IN 1 WEEK TRIGGERS RELOCA
----------------------------------------------------------------------
* EARLY FATALITY MODEL PARAMETERS, LOADED BY INEFAT, STORED IN /EFATAL/
*
* NUMBER OF EARLY FATALITY EFFECTS
*
35 EFNUMEFA001  0
*
----------------------------------------------------------------------
* EARLY INJURY MODEL PARAMETERS, LOADED BY INEINJ, STORED IN /EINJUR/
*
* NUMBER OF EARLY INJURY EFFECTS
*
36 EINUMEIN001  0
*
----------------------------------------------------------------------
* ACUTE EXPOSURE CANCER PARAMETERS, LOADED BY INACAN STORED IN /ACANCR/.
*
* NUMBER OF ACUTE EXPOSURE CANCER EFFECTS
*
37 LCNUMACA001   3
*
* THRESHOLD DOSE FOR WHICH DDREFA WILL BE APPLIED
*
38 LCDDTHRE001  1.0
*
* DOSE THRESHOLD FOR LINEAR DOSE RESPONSE (SV)
*
39 LCACTHRE001  0.5
*
*            ACNAME      ORGNAM   ACSUSC DDREFA DDREFB  CFRISK   CIRISK  0
*
40 LCANCERS001 "LEUKEMIA"  "RED MARR"  1.0   1.0   0.0   4.9E-3    0.0
41 LCANCERS002 "BONE"      "BONE SUR"  1.0   1.0   0.0   6.5E-4    0.0
42 LCANCERS003 "LUNG"      "LUNGS"     1.0   1.0   0.0   7.8E-3    0.0
----------------------------------------------------------------------
* RESULT 1 OPTIONS BLOCK, LOADED BY INOUT1, STORED IN /OUTPT1/
* TOTAL NUMBER OF A GIVEN EFFECT (LATENT CANCER, EARLY DEATH, EARLY INJU
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
43 TYPE1NUMBER     4
*
44 TYPE1OUT001      "CAN FAT/TOTAL"             1  6
45 TYPE1OUT002      "CAN FAT/LUNG"              1  6
46 TYPE1OUT003      "CAN FAT/LEUKEMIA"          1  6
47 TYPE1OUT004      "CAN FAT/BONE"              1  6
----------------------------------------------------------------------
* RESULT 2 OPTIONS BLOCK, LOADED BY INOUT2, STORED IN /OUTPT2/
* FURTHEST DISTANCE AT WHICH A GIVEN RISK OF EARLY DEATH IS EXCEEDED.
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
48 TYPE2NUMBER  0
*
----------------------------------------------------------------------
* RESULT 3 OPTIONS BLOCK, LOADED BY INOUT3, STORED IN /OUTPT3/
* NUMBER OF PEOPLE WHOSE DOSE TO A GIVEN ORGAN EXCEEDS A GIVEN THRESHOLD
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
49 TYPE3NUMBER  0
*
----------------------------------------------------------------------
* RESULT 4 OPTIONS BLOCK, LOADED BY INOUT4, STORED IN /OUTPT4/
```



```
* 360 DEGREE AVERAGE RISK OF A GIVEN EFFECT AT A GIVEN DISTANCE.
*
* POSSIBLE TYPES OF EFFECTS ARE:
*
*    "ERL FAT/TOTAL"
*    "ERL INJ/INJURY NAME"
*    "CAN FAT/CANCER NAME"
*    "CAN FAT/TOTAL"
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
50 TYPE4NUMBER  0
*
----------------------------------------------------------------------
* RESULT 5 OPTIONS BLOCK, LOADED BY INOUT5, STORED IN /OUTPT5/
*
* TOTAL POPULATION DOSE TO A GIVEN ORGAN BETWEEN TWO DISTANCES.
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
51 TYPE5NUMBER     4
*
*               ORGAN       I1DIS5     I2DIS5
*
52 TYPE5OUT001 "[illegible]"   1          6          (0-1 [illegible])
53 TYPE5OUT002 "LUNGS"         1          6          (0-1 [illegible])
54 TYPE5OUT003 "RED MARR"      1          6          (0-1 [illegible])
55 TYPE5OUT004 "BONE SUR"      1          6          (0-1 [illegible])
----------------------------------------------------------------------
* RESULT 6 OPTIONS BLOCK, LOADED BY INOUT6, STORED IN /OUTPT6/
*
* CENTERLINE DOSE TO AN ORGAN VS DIST BY PATHWAY, PATHWAY NAMES ARE AS F
*
*  PATHWAY NAME:
*     "CLD"     - CLOUDSHINE
*     "GRD"     - GROUNDSHINE
*     "INH ACU" - "ACUTE DOSE EQUIVALENT" FROM DIRECT INHALATION OF THE C
*     "INH LIF" - "LIFETIME DOSE COMMITMENT" FROM DIRECT INHALATION OF TH
*     "RES ACU" - "ACUTE DOSE EQUIVALENT" FROM RESUSPENSION INHALATION
*     "RES LIF" - "LIFETIME DOSE COMMITMENT" FROM RESUSPENSION INHALATION
*     "TOT ACU" - "ACUTE DOSE EQUIVALENT" FROM ALL PATHWAYS
*     "TOT LIF" - "LIFETIME DOSE COMMITMENT" FROM ALL PATHWAYS
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
56 TYPE6NUMBER      4
*
*               ORGAN         PATHWAY      I1DIS6   I2DIS6
*
57 TYPE6OUT001 "LUNGS"        "TOT LIF"      1         6  [illegible]   (0-1 [illegible])
58 TYPE6OUT002 "BONE SUR"     "TOT LIF"      1         6  [illegible]   (0-1 [illegible])
59 TYPE6OUT003 "[illegible]"  "TOT LIF"      1         6  [illegible]   (0-1 [illegible])
60 TYPE6OUT004 "RED MARR"     "TOT LIF"      1         6  [illegible]   (0-1 [illegible])
----------------------------------------------------------------------
* RESULT 7 OPTIONS BLOCK, LOADED BY INOUT7, STORED IN /OUTPT7/
*
* CENTERLINE RISK OF A GIVEN EFFECT VS DISTANCE
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
61 TYPE7NUMBER    1
*
*                   NAME              I1DIS7       I2DIS7
*
62 TYPE7OUT001      "CAN FAT/TOTAL"     1            6          (0-1 [illegible])
----------------------------------------------------------------------
```

```
      * RESULT 8 OPTIONS BLOCK, LOADED BY [illegible], STORED IN /[illegible]
      *
      * POPULATION WEIGHTED FATALITY RISK BETWEEN 2 DISTANCES
      *
      * NUMBER OF DESIRED RESULTS OF THIS TYPE
      *
   65 TYPENUMBER    0
      *
      *
******* TERMINATOR RECORD ENCOUNTERED -- END OF BASE CASE USER INPUT *******

USER INPUT PROCESSING SUMMARY - BASE CASE

NUMBER OF RECORDS READ                          =  305
NUMBER OF BLANK OR COMMENT RECORDS READ         =  241
NUMBER OF TERMINATOR RECORDS                    =    1
NUMBER OF RECORDS PROCESSED                     =   63
    NUMBER OF PROCESSED RECORDS DUPLICATED      =    0
    NUMBER OF PROCESSED RECORDS STORED          =   63
--------------------------------------------------------------------
```

```
[illegible] FROM A [illegible] FILE WITH THE [illegible]:
[illegible] File [illegible]: Changed by [illegible], [illegible]
[illegible] added with [illegible] Version 1.5.11.1

[illegible]

CALCULATING A [illegible] POPULATION [illegible]

1 THIS [illegible] ALLOWS THE [illegible] OF UP TO 3[illegible] RESULTS

YOU HAVE [illegible] 3[illegible] RESULTS FROM "EARLY" [illegible]:

    4 RESULTS OF TYPE 1
    [illegible] RESULTS OF TYPE 2
    [illegible] RESULTS OF TYPE 3
    [illegible] RESULTS OF TYPE 4
    4 RESULTS OF TYPE 5
   2[illegible] RESULTS OF TYPE 6
    6 RESULTS OF TYPE 7
    [illegible] RESULTS OF TYPE 8
1        [illegible]      [illegible]      [illegible]      [illegible]      [illegible]

           1        157        10          0   1.[illegible]
1
[illegible]     RESULTS FOR [illegible]
```

| | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5.[illegible] | 6.[illegible] | 6.[illegible] | 5.5[illegible] | 1.[illegible] | 0.[illegible] | 1.[illegible] | 2.[illegible] | 2.[illegible] | 121 | 121 | 1.[illegible] | 0.0 | [illegible] | [illegible] |
| 2 | 1.5[illegible] | [illegible] | [illegible] | 9.[illegible] | 1.[illegible] | 0.[illegible] | 1.[illegible] | 6.[illegible] | 5.1[illegible] | 121 | 121 | 1.[illegible] | 0.0 | 1[illegible] | [illegible] |
| 3 | 3.[illegible] | 2.[illegible] | 2.[illegible] | 3.2[illegible] | 1.[illegible] | 0.[illegible] | [illegible] | 1.2[illegible] | 7.[illegible] | 121 | 121 | 1.[illegible] | 0.0 | [illegible] | [illegible] |
| 4 | 5.[illegible] | 9.[illegible] | 9.[illegible] | 1.5[illegible] | 1.[illegible] | 0.[illegible] | 7.1[illegible] | 1.[illegible] | 1.[illegible] | 121 | 121 | 1.[illegible] | 0.0 | [illegible] | [illegible] |
| 5 | 7.5[illegible] | 4.[illegible] | 4.[illegible] | [illegible] | 1.[illegible] | 0.[illegible] | 6.1[illegible] | 2.[illegible] | 1.3[illegible] | 121 | 121 | 1.[illegible] | 0.0 | 7[illegible] | [illegible] |
| 6 | 1.[illegible] | 2.[illegible] | 2.[illegible] | 5.2[illegible] | 1.[illegible] | 0.[illegible] | 5.1[illegible] | 3.7[illegible] | 1.[illegible] | 121 | 121 | 1.[illegible] | 0.0 | 1[illegible] | [illegible] |

```
[illegible], TOTAL [illegible]= 9.775[illegible]
1 DATE AND TIME OF RUN = [illegible] 12/[illegible]   09:42:22   [illegible] VERSION 1.5.11.1, [illegible], 5/2[illegible]
  "[illegible]" DESCRIPTION = [illegible], [illegible]
  "EARLY" DESCRIPTION = [illegible] possible fire scenario

SOURCE TERM 1 OF 1:
   [illegible] -----

RESULTS FOR A SINGLE EMERGENCY RESPONSE COHORT WITHOUT ANY WEIGHTING FRACTIONS BEING APPLIED

   COHORT 1 = [illegible]
```

| 12/[illegible] 09:42:22 PAGE 1 | | | [illegible] NON-ZERO | MEAN | 50th | QUANTILES 90th | 95th | 99th | 99.9th | PEAK CONS | PEAK PROB | PEAK TRIAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HEALTH EFFECTS CASES | | | | | | | | | | | | |
| [illegible] FAT/TOTAL | | 0-1.1 [illegible] | 1.[illegible] | 1.1[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.1[illegible] | 1.[illegible] | 1 |
| [illegible] FAT/LUNG | | 0-1.1 [illegible] | 1.[illegible] | 9.1[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 9.1[illegible] | 1.[illegible] | 1 |
| [illegible] FAT/[illegible] | | 0-1.1 [illegible] | 1.[illegible] | 1.1[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.1[illegible] | 1.[illegible] | 1 |
| [illegible] FAT/BONE | | 0-1.1 [illegible] | 1.[illegible] | 1.3[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.3[illegible] | 1.[illegible] | 1 |
| POPULATION DOSE (SV) | | | | | | | | | | | | |
| [illegible] | TOT LIF | 0-1.1 [illegible] | 1.[illegible] | 3.[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 3.[illegible] | 1.[illegible] | 1 |
| LUNGS | TOT LIF | 0-1.1 [illegible] | 1.[illegible] | 1.1[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.1[illegible] | 1.[illegible] | 1 |
| RED [illegible] | TOT LIF | 0-1.1 [illegible] | 1.[illegible] | 2.4[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 2.4[illegible] | 1.[illegible] | 1 |
| BONE SUR | TOT LIF | 0-1.1 [illegible] | 1.[illegible] | 2.[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 2.[illegible] | 1.[illegible] | 1 |
| CENTERLINE DOSE AT SOME DISTANCES (SV) | | | | | | | | | | | | |
| LUNGS | TOT LIF | 0-0.1 [illegible] | 1.[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.[illegible] | 1 |
| LUNGS | TOT LIF | 0.1-0.2 [illegible] | 1.[illegible] | 1.[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.[illegible] | 1.[illegible] | 1 |
| LUNGS | TOT LIF | 0.2-0.4 [illegible] | 1.[illegible] | 3.[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 3.[illegible] | 1.[illegible] | 1 |
| LUNGS | TOT LIF | 0.4-0.6 [illegible] | 1.[illegible] | 1.[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.[illegible] | 1.[illegible] | 1 |
| LUNGS | TOT LIF | 0.6-0.9 [illegible] | 1.[illegible] | 5.5[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 5.5[illegible] | 1.[illegible] | 1 |
| LUNGS | TOT LIF | 0.9-1.1 [illegible] | 1.[illegible] | 3.1[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 3.1[illegible] | 1.[illegible] | 1 |

[illegible] 12-[illegible] [illegible]    Page 1 of 2

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BONE SUR | TOT LIF | 0-0.1 | [illegible] | 1.0000 | 2.08E-01 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 2.08E-01 | 1.00E+00 | 1 |
| BONE SUR | TOT LIF | 0.1-0.2 | [illegible] | 1.0000 | 2.63E-02 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 2.63E-02 | 1.00E+00 | 1 |
| BONE SUR | TOT LIF | 0.2-0.4 | [illegible] | 1.0000 | 7.84E-03 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 7.84E-03 | 1.00E+00 | 1 |
| BONE SUR | TOT LIF | 0.4-0.6 | [illegible] | 1.0000 | 3.08E-03 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 3.08E-03 | 1.00E+00 | 1 |
| BONE SUR | TOT LIF | 0.6-0.9 | [illegible] | 1.0000 | 1.41E-03 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 1.41E-03 | 1.00E+00 | 1 |
| BONE SUR | TOT LIF | 0.9-1.1 | [illegible] | 1.0000 | 7.91E-04 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 7.91E-04 | 1.00E+00 | 1 |
| ENDOSTEUM | TOT LIF | 0-0.1 | [illegible] | 1.0000 | 2.11E-02 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 2.11E-02 | 1.00E+00 | 1 |
| ENDOSTEUM | TOT LIF | 0.1-0.2 | [illegible] | 1.0000 | 2.44E-03 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 2.44E-03 | 1.00E+00 | 1 |
| ENDOSTEUM | TOT LIF | 0.2-0.4 | [illegible] | 1.0000 | 7.91E-04 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 7.91E-04 | 1.00E+00 | 1 |
| ENDOSTEUM | TOT LIF | 0.4-0.6 | [illegible] | 1.0000 | 3.08E-04 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 3.08E-04 | 1.00E+00 | 1 |
| ENDOSTEUM | TOT LIF | 0.6-0.9 | [illegible] | 1.0000 | 1.43E-04 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 1.43E-04 | 1.00E+00 | 1 |
| ENDOSTEUM | TOT LIF | 0.9-1.1 | [illegible] | 1.0000 | 8.0[illegible]E-05 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 8.0[illegible]E-05 | 1.00E+00 | 1 |
| RED MARR | TOT LIF | 0-0.1 | [illegible] | 1.0000 | 1.67E-02 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 1.67E-02 | 1.00E+00 | 1 |
| RED MARR | TOT LIF | 0.1-0.2 | [illegible] | 1.0000 | 2.11E-03 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 2.11E-03 | 1.00E+00 | 1 |
| RED MARR | TOT LIF | 0.2-0.4 | [illegible] | 1.0000 | 6.33E-04 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 6.33E-04 | 1.00E+00 | 1 |
| RED MARR | TOT LIF | 0.4-0.6 | [illegible] | 1.0000 | 2.44E-04 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 2.44E-04 | 1.00E+00 | 1 |
| RED MARR | TOT LIF | 0.6-0.9 | [illegible] | 1.0000 | 1.13E-04 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 1.13E-04 | 1.00E+00 | 1 |
| RED MARR | TOT LIF | 0.9-1.1 | [illegible] | 1.0000 | 6.34E-05 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 6.34E-05 | 1.00E+00 | 1 |

```
READING FROM A DOSE CONVERSION FILE WITH THE FOLLOWING HEADER:
MACCS File DOSDATA.INP: Changed by D. CHANIN25-JAN-92, 09:53:47
Seven new organs added with MACCS Version 1.5.11.1

NO EVACUATION REQUESTED

 CALCULATING A UNIFORM POPULATION DISTRIBUTION

1 THIS PROGRAM CURRENTLY ALLOWS THE GENERATION OF UP TO  394 RESULTS

 YOU HAVE REQUESTED  38 RESULTS FROM "EARLY" COMPOSED OF:

    4 RESULTS OF TYPE 1
    0 RESULTS OF TYPE 2
    0 RESULTS OF TYPE 3
    0 RESULTS OF TYPE 4
    4 RESULTS OF TYPE 5
   24 RESULTS OF TYPE 6
    6 RESULTS OF TYPE 7
    0 RESULTS OF TYPE 8
1       TRIAL        DAY        HOUR        DIR      PROBET

           1         157         10           0   1.00E+00
1
 ATMOSPHERIC RESULTS FOR CO-60
     DISTANCE GL AIRCON    GRNCON    GL X/Q  WETREN  DRYREN    REMRAY     PLSIGY     PLSIGZ  WEATHER  WTFCTR  AMGHT    TIMCEN  TIMDUR

  1  5.00E+01  5.33E+01  5.20E-01  5.54E-02  1.0000  0.7066  1.13E+03  2.50E+00  2.30E+00  121 121  1.000     0.0       50.   3600.
  2  1.50E+02  6.72E+00  6.70E-02  9.00E-03  1.0000  0.8571  7.97E+02  6.70E+00  5.17E+00  121 121  1.000     0.0      150.   3600.
  3  3.00E+02  2.02E+00  2.01E-02  3.25E-03  1.0000  0.8152  6.83E+02  1.25E+01  7.81E+00  121 121  1.000     0.0      300.   3600.
  4  5.00E+02  7.77E-01  7.75E-03  1.30E-03  1.0000  0.8613  5.57E+02  1.99E+01  1.07E+01  121 121  1.000     0.0      500.   3600.
  5  7.50E+02  3.60E-01  3.59E-03  8.17E-04  1.0000  0.8380  4.80E+02  2.80E+01  1.36E+01  121 121  1.000     0.0      750.   3600.
  6  1.00E+03  2.03E-01  2.02E-03  5.20E-04  1.0000  0.9065  4.02E+02  3.71E+01  1.63E+01  121 121  1.000     0.0     1000.   3600.
 IN EGEOM, TOTAL DEPOSITED=  7.6024E+02
1  DATE AND TIME OF RUN = MACCS  12/10/92   10:29:40   MACCS VERSION 1.5.11.1, D. CHANIN, 5/26/92
   "ATMOS"  DESCRIPTION = CHIA.INP, ATMOS INPUT
   "EARLY"  DESCRIPTION = Maximum possible fire scenario

 SOURCE TERM  1 OF  1:
     ACRR .....

 RESULTS FOR A SINGLE EMERGENCY RESPONSE COHORT WITHOUT ANY WEIGHTING FACTIONS BEING APPLIED

     COHORT 1 = NO EVACUATION

 12/10/92   10:29:40    PAGE   1          PROB                                QUANTILES                                       PEAK       PEAK  PEAK
                                        NON-ZERO    MEAN        50TH       90TH       95TH       99TH       99.9TH       CONS       PROB  TRIAL
 HEALTH EFFECTS CASES
  CAN FAT/TOTAL                 0-1.1 KM   1.0000  8.04E-11 NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  8.04E-11  1.00E+00   1
  CAN FAT/LUNG                  0-1.1 KM   1.0000  7.73E-11 NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  7.73E-11  1.00E+00   1
  CAN FAT/LEUKEMIA              0-1.1 KM   1.0000  2.94E-12 NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  2.94E-12  1.00E+00   1
  CAN FAT/BONE                  0-1.1 KM   1.0000  2.27E-13 NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  2.27E-13  1.00E+00   1

 POPULATION DOSE (SV)
  EDEWBODY     TOT LIF          0-1.1 KM   1.0000  1.82E-09 NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  1.82E-09  1.00E+00   1
  LUNGS        TOT LIF          0-1.1 KM   1.0000  9.91E-09 NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  9.91E-09  1.00E+00   1
  RED MARR     TOT LIF          0-1.1 KM   1.0000  6.01E-10 NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  6.01E-10  1.00E+00   1
  BONE SUR     TOT LIF          0-1.1 KM   1.0000  5.04E-10 NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  5.04E-10  1.00E+00   1

 CENTERLINE DOSE AT SOME DISTANCES (SV)
  LUNGS        TOT LIF          0-0.1 KM   1.0000  6.90E-09 NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  6.90E-09  1.00E+00   1
  LUNGS        TOT LIF        0.1-0.2 KM   1.0000  8.71E-10 NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  8.71E-10  1.00E+00   1
  LUNGS        TOT LIF        0.2-0.4 KM   1.0000  2.61E-10 NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  2.61E-10  1.00E+00   1
  LUNGS        TOT LIF        0.4-0.6 KM   1.0000  1.01E-10 NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  1.01E-10  1.00E+00   1
  LUNGS        TOT LIF        0.6-0.9 KM   1.0000  4.67E-11 NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  4.67E-11  1.00E+00   1
  LUNGS        TOT LIF        0.9-1.1 KM   1.0000  2.63E-11 NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  NOT-FOUND  2.63E-11  1.00E+00   1
```

OUT.CO 12-10-92 10:33a                                                                                Page 1 of 2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BONE SUR | TOT LIF | 0-0.1 | KM | 1.0000 | 3.50E-10 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 3.50E-10 | 1.00E+00 | 1 |
| BONE SUR | TOT LIF | 0.1-0.2 | KM | 1.0000 | 4.43E-11 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 4.43E-11 | 1.00E+00 | 1 |
| BONE SUR | TOT LIF | 0.2-0.4 | KM | 1.0000 | 1.33E-11 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 1.33E-11 | 1.00E+00 | 1 |
| BONE SUR | TOT LIF | 0.4-0.6 | KM | 1.0000 | 5.13E-12 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 5.13E-12 | 1.00E+00 | 1 |
| BONE SUR | TOT LIF | 0.6-0.9 | KM | 1.0000 | 2.30E-12 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 2.30E-12 | 1.00E+00 | 1 |
| BONE SUR | TOT LIF | 0.9-1.1 | KM | 1.0000 | 1.34E-12 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 1.34E-12 | 1.00E+00 | 1 |
| EDEWBODY | TOT LIF | 0-0.1 | KM | 1.0000 | 1.26E-09 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 1.26E-09 | 1.00E+00 | 1 |
| EDEWBODY | TOT LIF | 0.1-0.2 | KM | 1.0000 | 1.60E-10 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 1.60E-10 | 1.00E+00 | 1 |
| EDEWBODY | TOT LIF | 0.2-0.4 | KM | 1.0000 | 4.79E-11 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 4.79E-11 | 1.00E+00 | 1 |
| EDEWBODY | TOT LIF | 0.4-0.6 | KM | 1.0000 | 1.85E-11 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 1.85E-11 | 1.00E+00 | 1 |
| EDEWBODY | TOT LIF | 0.6-0.9 | KM | 1.0000 | 8.57E-12 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 8.57E-12 | 1.00E+00 | 1 |
| EDEWBODY | TOT LIF | 0.9-1.1 | KM | 1.0000 | 4.82E-12 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 4.82E-12 | 1.00E+00 | 1 |
| RED MARR | TOT LIF | 0-0.1 | KM | 1.0000 | 4.18E-10 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 4.18E-10 | 1.00E+00 | 1 |
| RED MARR | TOT LIF | 0.1-0.2 | KM | 1.0000 | 5.28E-11 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 5.28E-11 | 1.00E+00 | 1 |
| RED MARR | TOT LIF | 0.2-0.4 | KM | 1.0000 | 1.58E-11 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 1.58E-11 | 1.00E+00 | 1 |
| RED MARR | TOT LIF | 0.4-0.6 | KM | 1.0000 | 6.11E-12 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 6.11E-12 | 1.00E+00 | 1 |
| RED MARR | TOT LIF | 0.6-0.9 | KM | 1.0000 | 2.83E-12 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 2.83E-12 | 1.00E+00 | 1 |
| RED MARR | TOT LIF | 0.9-1.1 | KM | 1.0000 | 1.60E-12 | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | NOT-FOUND | 1.60E-12 | 1.00E+00 | 1 |

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