PCSA TOOL VERSION 3.0
USER GUIDE

Prepared for

U.S. Nuclear Regulatory Commission
Contract NRC–02–02–012

Prepared by

T. Maxwell
B. Dasgupta
G. Adams
R. Benke
N. Eisenberg

Center for Nuclear Waste Regulatory Analyses
San Antonio, Texas

January 2005

PREVIOUS REPORT IN SERIES

Name	Date
Development of a Tool and Review Methodology for Assessment of Preclosure Safety Analysis—Progress Report	September 2000
PCSA Tool Development—Progress Report	September 2001
PCSA Tool Development—Progress Report II	September 2002
PCSA Tool Version 2.0 User Guide	June 2003

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ACKNOWLEDGMENTS

This report was prepared to document work performed by the Center for Nuclear Waste Regulatory Analyses (CNWRA) for the U.S. Nuclear Regulatory Commission (NRC) under Contract No. NRC–02–02–012. The activities reported here were performed on behalf of the NRC Office of Nuclear Material Safety and Safeguards, Division of High-Level Waste Repository Safety. The views expressed in this manual are those of the authors and do not necessarily reflect the views or regulatory position of NRC.

The authors thank A. Lozano for technical reviews and B. Sagar for programmatic review.

The authors are also thankful to A. Ramos for typing the user guide and A. Woods and C. Cudd for providing editorial services in the preparation of the final document.

QUALITY OF DATA, ANALYSES, AND COMPUTER CODES

DATA: No CNWRA-generated original data are contained in the PCSA Tool. Data used in the PCSA Tool are primarily equipment failure rate actuarial data from several sources. Each data source is cited in the PCSA Tool database.

ANALYSES AND CODES: The PCSA Tool Version 3.0 has been developed following CNWRA Technical Operating Procedure (TOP)–018, which implements the requirements of the CNWRA Quality Assurance Manual. The PCSA Tool uses Microsoft® products and was developed to run on a personal computer using the Windows® NT operating system. Hereafter, the terms Microsoft and Windows will be used without the registered trademark symbol. The PCSA Tool Version 3.0 was developed using Visual Basic 6.0, Microsoft Access 97 SR–2, SAPHIRE Version 6.80 (Idaho National Engineering and Environmental Laboratory, 1998), RSAC Version 6.2 (Wenzel, 1994), MELCOR Version 1.8.5 (Gauntt, et al., 2000), InstallShield DevStudio Version 9.0, and a suite of utility codes. No other versions of the listed previous codes were used in this document. SAPHIRE is developed, supported, and distributed by Idaho National Engineering and Environmental Laboratory. RSAC is distributed by Radiation Safety Information Computational Center, Oak Ridge National Laboratory. MELCOR is developed, supported, and distributed by Sandia National Laboratories. InstallShield DevStudio Version 9.0 is distributed by InstallShield Software Corporation. The suite of utility codes consists of PCSA_LHS, PCSA_LHSINP, PCSA_PROB, PCSA_RSACRD, PCSA_IETCCDF, and PCSA_ToTRISK. These utility codes were developed at CNWRA using the Lahey LF95 FORTRAN Compiler. Visual Basic 6.0, Microsoft Access 97, and InstallShield packages are commercial “off-the-shelf” products and, hence, do not need to be put under CNWRA Configuration Control. The acquired computer codes SAPHIRE, RSAC, and MELCOR, which will not be modified, are under CNWRA Configuration Control.

InstallShield DevStudio Version 9.0 is used to create a PCSA Tool installation setup for Windows 2000 for distribution to the NRC and CNWRA staff. The setup distribution will install SAPHIRE, RSAC, and MELCOR codes and the CNWRA-developed applications. Microsoft Access software will not be required to be installed on the user’s computer.

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1 INTRODUCTION

1.1 Purpose

The preclosure safety analysis (PCSA) Tool was developed to enable the U.S. Nuclear Regulatory Commission (NRC) and the Center for Nuclear Waste Regulatory Analyses (CNWRA) staffs to conduct an independent analysis and review of the U.S. Department of Energy (DOE) preclosure safety analysis for a proposed repository at Yucca Mountain, Nevada. As part of any license application for construction authorization and a subsequent license update to receive and possess waste at the proposed repository, 10 CFR Part 63 (Code of Federal Regulations, 2001) requires DOE to demonstrate, through a preclosure safety analysis, the facility would comply with the preclosure performance objectives for the period until permanent closure. The PCSA Tool, through confirmatory analyses, will be used to identify potential gaps in the DOE safety analysis; assess the DOE compliance with regulatory performance objectives; evaluate the safety significance of structures, systems, and components, and gain risk insight. In addition, the PCSA Tool can be used to support staff in inspection activities and assess regulatory safety during operations. The PCSA Tool is a Windows-based software package that features a graphical user interface (forms and tables) that presents data from the databases, software packages, and utility tools. This user guide contains information about operations of PCSA Tool Version 3.0 for conducting independent preclosure safety analyses.

1.2 Background

The proposed geologic repository at Yucca Mountain will be designed for the permanent disposal of approximately 70,000 metric tons of spent nuclear fuel and high-level waste. During the preclosure period, the proposed facility will receive and handle casks containing the waste in sealed disposal canisters or in the form of spent nuclear fuel assemblies. Using a combination of manual and remote operations, the waste will be transferred into disposal waste packages and transported underground for emplacement into drifts. The risk-informed, performance-based regulation 10 CFR Part 63 provides the general scope, requirements, and objectives of the preclosure safety analysis. To ensure safety of the public and workers during the operational phase of the repository until permanent closure, 10 CFR Part 63 requires demonstration of compliance with the regulatory dose limits through a preclosure safety analysis. The requirements for preclosure safety analysis are specified in 10 CFR 63.112 and performance objectives in 10 CFR 63.111(a,b). An important purpose of the preclosure safety analysis is to identify structures, systems, and components important to safety.

The Yucca Mountain Review Plan (NRC, 2003) will be used by the staff to review any license application for construction authorization and, if a construction authorization is granted, any license to receive and possess nuclear waste. The NRC (2003) implements the requirements of 10 CFR Part 63 and outlines a risk-informed, performance-based review philosophy that requires DOE to demonstrate, through its preclosure safety analysis, the repository will be designed, constructed, and operated to meet the specified performance objectives throughout the preclosure period. Review of the preclosure safety analysis is addressed in Section 2.1.1 (NRC, 2003), which has eight subsections. Each subsection provides guidance (review methods and acceptance criteria) on what information staff is to review, the review basis, how the review is to be accomplished, what demonstrates compliance with regulations and examples of potential conclusions regarding the applicable sections in 10 CFR Part 63. For reviewing the

preclosure safety analysis, NRC (2003) follows a sequence of evaluations that involves assessment of the (i) site description; (ii) description and design of structures, systems, and components, equipment, and operational process activities; (iii) identification of hazards and initiating events; (iv) identification of event sequences; and (v) consequence analysis for evaluation of

- Compliance demonstration for Category 1 and 2 event sequences
- Identification of structures, systems, and components important to safety
- Design of structures, systems, and components important to safety
- Satisfaction of the as low as is reasonably achievable requirements

The PCSA Tool, which implements the review methodology of NRC (2003), provides risk-informed review capabilities to facilitate staff identification of safety-related structures, systems, and components for detailed review, and staff determination of whether the DOE preclosure safety analysis demonstrates compliance with the performance objectives in 10 CFR Part 63. The sequence of evaluation is depicted in Figure 1.2-1 where associated preclosure safety analysis (NRC, 2003) sections and areas of the PCSA Tool activities in the overall review process are indicated. The preclosure review methodology and function of the PCSA Tool are discussed in detail in Dasgupta, et al. (2000, 2001a,b, 2002, 2003) and in Benke, et al. (2002, 2004). This user guide steps through the preclosure safety analysis process and describes the functions of the tool to enable the user to operate PCSA Tool Version 3.0.

1.3 Scope and Content

This PCSA Tool Version 3.0 User Guide provides procedures for input, operation, and reporting of output. This guide also provides a general description of how to use the PCSA Tool to review and conduct confirmatory analyses for determining compliance with the regulatory requirements for preclosure safety analysis outlined in NRC (2003).

This user guide is intended to provide both first-time and experienced users immediate access to the tool while providing brief explanations of the options inherent in the PCSA Tool. The broad spectrum of the analytical capabilities of the tool is described in Dasgupta, et al. (2002, 2003). This user guide consists of the following sections:

Chapter 1: Introduction—states the purpose and background of the PCSA Tool development including necessary information on system requirements, software used, installation, and user assistance.

Chapter 2: Overview of the PCSA Tool Design and Operations—contains a general description of the computational approach and the tool menu structure and modules. This chapter also describes the data flow and operations in the PCSA Tool.

Chapter 3: Reference for Menu Functions—describes the functions of each menu, submenu, and buttons to store and retrieve data from the database and to conduct analyses. The subsections in this chapter are organized by the menus in the main menu bar.

Chapter 4: References—provides a list of the references used in preparing this user guide.

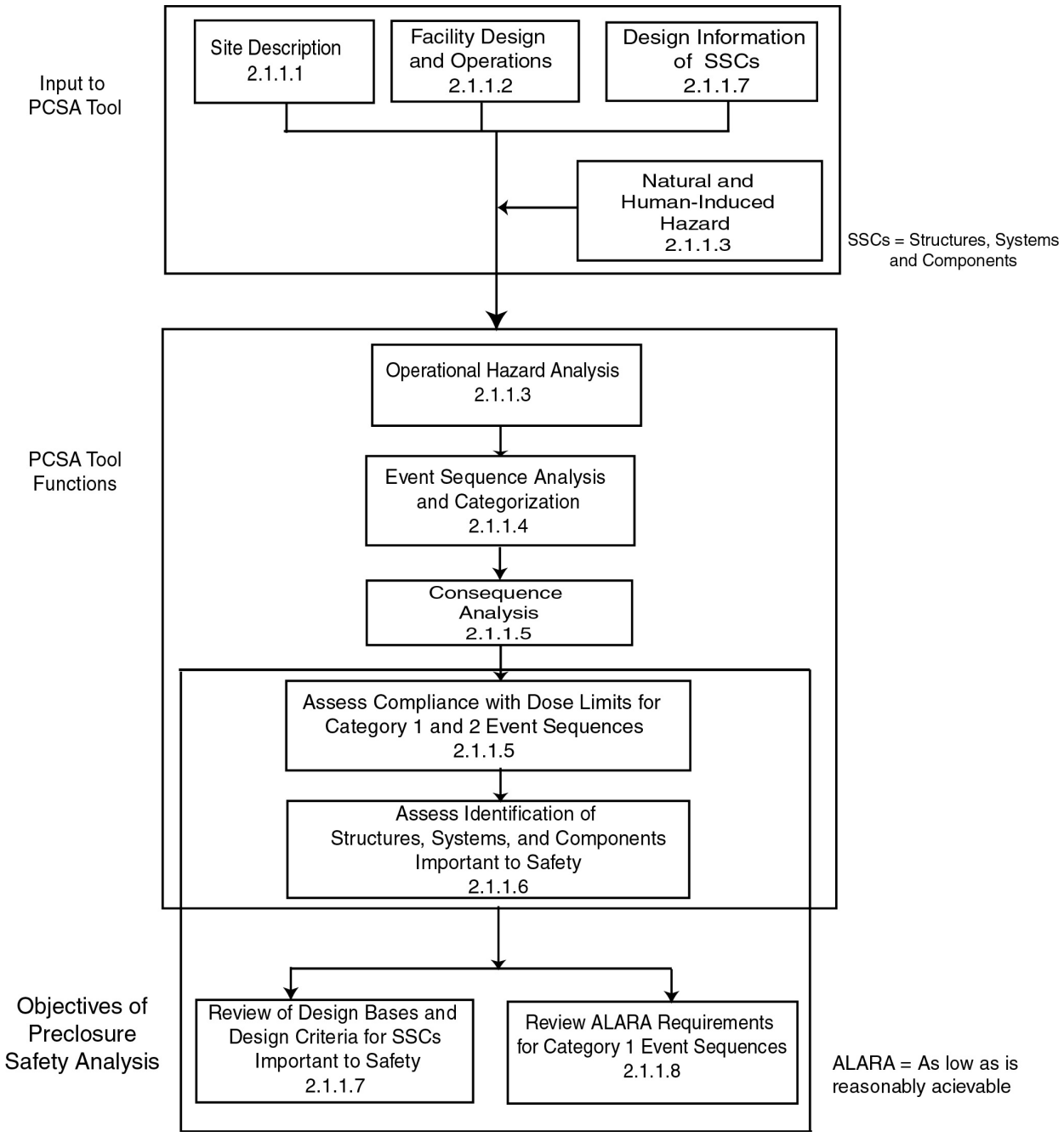


Figure 1.2-1. Preclosure Review Methodology Using Yucca Mountain Review Plan and PCSA Tool Activities

1.4 System Requirements

The PCSA Tool has been developed to operate on an IBM-compatible personal computer with a Pentium II-266 MHz. The operating system must be Windows NT 4.0/Windows 2000/ Windows XP. The estimated disk space requirement is 250 MB maximum. The program is currently developed on a Pentium II–266 MHz computer with 256 MB of random access memory. The memory size of the PCSA Tool Version 3.0 executable is 3.76 MB. Visual Basic, the programming language for the tool, does not need to be installed on the computer for the executable to run.

1.5 Software and Graphics Devices

PCSA Tool Version 3.0 has been developed using the following software: Visual Basic 6.0, Microsoft Access 97 SR–2, SAPHIRE Version 6.80, RSAC Version 6.2, MELCOR Version 1.8.5, InstallShield DevStudio Version 9.0, Crystal Reports Developer Edition 9, and a suite of utility codes. SAPHIRE is developed, supported, and distributed by Idaho National Engineering and Environmental Laboratory, and RSAC is distributed by Radiation Safety Information Computational Center, Oak Ridge National Laboratory. MELCOR is developed, supported, and distributed by Sandia National Laboratories. InstallShield DevStudio 9.0 is distributed by InstallShield Software Corporation. Crystal Reports Developer Edition 9 is distributed by Crystal Decisions Inc., Palo Alto, California 94301-2413. The suite of utility codes, consisting of PCSA_LHS, PCSA_LHSINP, PCSA_PROB, PCSA_RSACRD, PCSA_IETCCDF, and PCSA_TOTRISK have been developed at CNWRA using the Lahey LF95 FORTRAN Compiler.

The tool currently provides graphics and reporting capabilities using the Crystal Reports. Additionally, fault tree and event tree models are graphically displayed using features in the SAPHIRE code.

1.6 Installation Guidelines

A setup package, InstallShield DevStudio 9.0, was used to create a PCSA Tool installation setup for Windows NT/Windows 2000/Windows XP on a compact disk for distribution to prospective users. The setup distribution will also install the application packages SAPHIRE, RSAC, and MELCOR codes and the CNWRA-developed applications. The Microsoft Access database software is not required to be resident in the user's computer. The user may read through the detailed instructions for installation in Readme.txt provided on the installation disk.

1.7 Installation Test

After the installation is completed, the user can run the PCSA Tool from the desktop by clicking the PCSA Tool icon. The tool installation can be tested by opening the project file PCSAdemo.mdb.

1.8 Software Validation

To comply with the requirements of CNWRA Technical Operating Procedure–018, PCSA Tool Version 3.0 has been validated.[1] The analyses software, SAPHIRE, RSAC, and MELCOR, were validated independently.

1.9 Assistance for PCSA Tool Users

Typographical Conventions

The following typographical conventions have been adopted in this user guide:

- Menu: Bold, Italic, "hot-key" Underlined
- Submenu: Italic, "hot-key" Underlined
- Action Commands: Bold
- Data Entry Fields: Underlined
- Window Title: Bold MS Sans Serif
- Notes: Denoted by Arrow, Italic

Training: Periodic training for new NRC and CNWRA staff and retraining for additional NRC and CNWRA staff can be provided on request.

Assistance: Telephone assistance and email response can be obtained from

B. Dasgupta	bdasgupta@swri.org	210.522.6815
R. Benke	rbenke@swri.org	210.522.5250
G. Adams	gadams@swri.org	210.522.4957

[1]Adams, G. and T. Maxwell. "Software Validation Test Report. Summary for PCSA Tool Version 3.0.0." San Antonio, Texas: CNWRA. 2004.

2 OVERVIEW OF PCSA TOOL DESIGN AND OPERATIONS

2.1 Computational Approach

The PCSA Tool computer code combines the useful components of the integrated safety analysis methodologies used in the chemical industry and the probabilistic risk assessment capabilities and tools used in the safety assessment of nuclear power reactors. The PCSA Tool has been designed to (i) enter and retrieve information in a database, (ii) perform calculations using off-the-shelf and specially designed software, and (iii) document the review results. The executive module of the PCSA Tool interfaces with the databases and analytical tools.

The structure of the PCSA Tool is schematically illustrated in Figure 2.1-1. The figure shows that the graphical user interface, developed using Visual Basic 6.0, controls the functions of the tool by independently linking to databases and other software packages. The project database and fixed database were created using Microsoft Access database software. The equipment failure rate, human error, and equipment failure mode checklist databases are considered fixed because these databases can only be viewed through the graphical user interface and cannot be modified by the user. The project database, the workbench for the tool, has been designed to perform specific data management tasks that allow safety analyses to be conducted in a systematic manner. The input data and output data to and from other software packages are also managed by this database. As seen in Figure 2.1-1, the project data are handled through several tables in the Microsoft Access database for (i) entering or gaining access to data, (ii) sorting and filtering data, and (iii) creating reports.

The model analysis in the PCSA Tool is conducted using the SAPHIRE, RSAC, and MELCOR codes, which are based on mathematical models described in Russel, et al. (1993), Wenzel (1994), and Gauntt, et al. (2000), respectively. The SAPHIRE software conducts fault tree and event tree analyses, and the RSAC software performs dose calculations from the atmospheric release of radiological material. The Worker Dose evaluation is built into the RSAC code, and the PCSA Tool offers three types of Worker Dose calculations: Worker Indoors, Worker in the remediation pool area, Worker Outdoors. MELCOR is used to estimate the building discharge fraction (i.e., the fraction of radionuclides released into the building air that is transported through the building ventilation and discharged into the atmosphere).

2.2 PCSA Tool Modules

The PCSA Tool structure is modeled after the preclosure safety analysis review methodology as shown in Figure 1.2-1. Activity for each section is divided into several modules, and the PCSA Tool functions through these modules. The main modules parallel the review methodology, and each module has submodules, as shown in Figure 2.2-1(a,b). The modules in the PCSA Tool allow the staff to perform independent review analyses and to store data and results of the review in a structured and systematic manner. Results of the review are abstracted, as appropriate, for use in other modules of the PCSA Tool. The PCSA Tool modules and data flow processes are described below. Further details about each of the modules can be obtained from Dasgupta, et al. (2002).

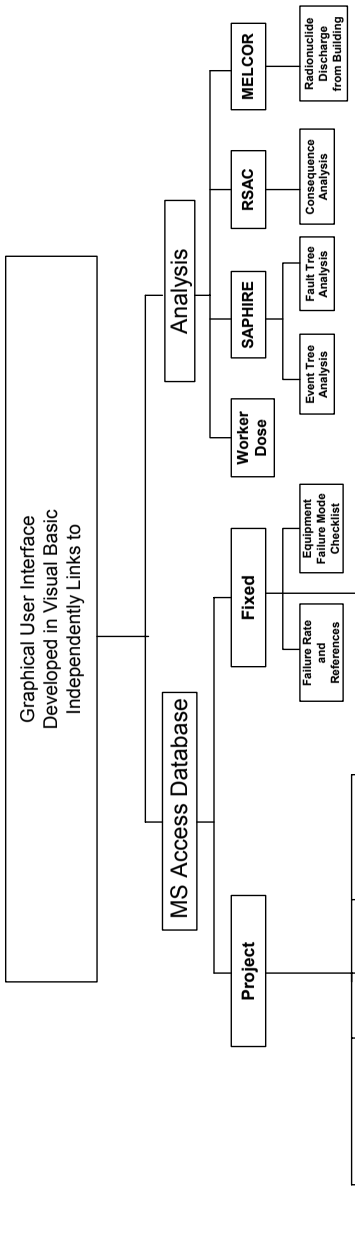


Figure 2.1-1. PCSA Tool Structure

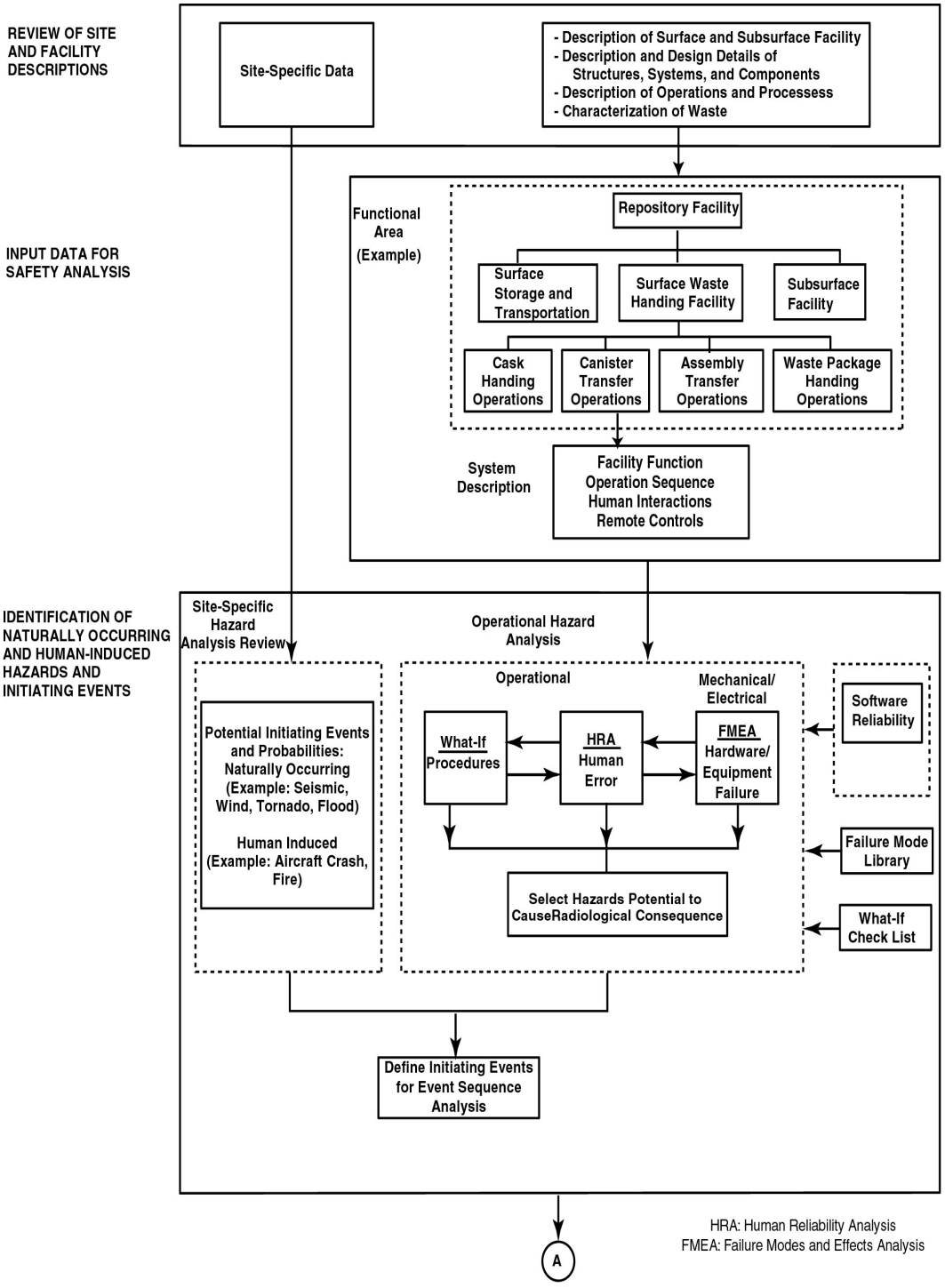


Figure 2.2-1(a). PCSA Tool Modules and Data Flow Diagram

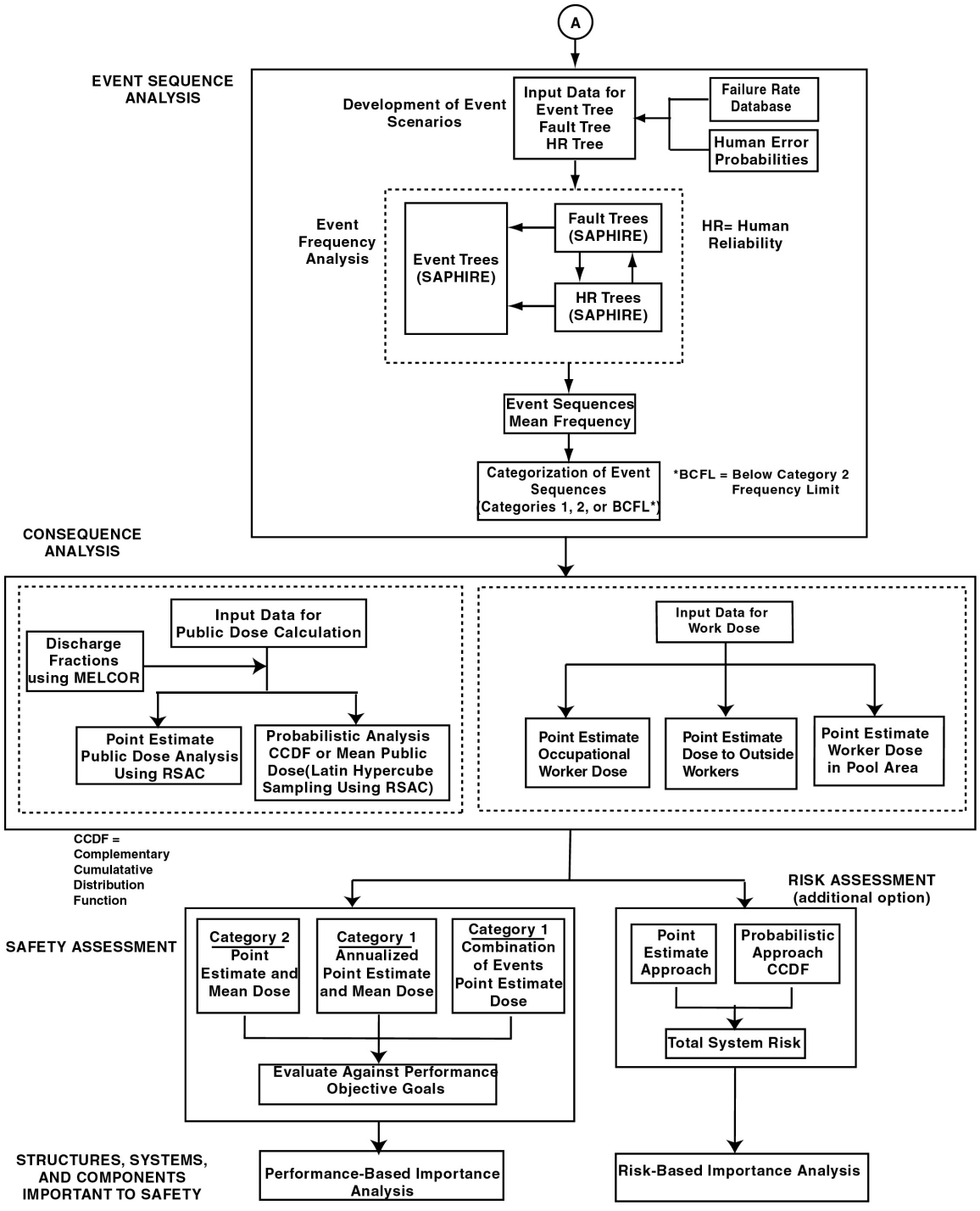


Figure 2.2-1(b). PCSA Tool Modules and Data Flow Diagram

2.2.1 Review of Site and Facility Description

This section, which addresses the first three boxes in Figure 1.2-1, does not have a corresponding module in the tool. Staff will identify and verify sufficient information is available to review and perform independent preclosure safety analysis. Site-specific data refer primarily to meteorology, geology, and human activities. The facility data include description and design details of structures, systems, and components; characterization of waste and source terms; and description of geologic repository operations area operational processes and procedures with an adequate understanding of the component and facility functions and sequence of operations.

2.2.2 Input Data for Safety Analysis

2.2.2.1 Functional Area

The facility and operations in the geologic repository operations area can be divided into areas by specific function or by physical layout of the facility or by nature of process. In this module, the functional area is identified to define the physical boundary of the safety analysis. The tool has been designed to develop a project tree by dividing the facility into major functional areas, then dividing the functional areas into several subareas, if required. For example, as shown in Figure 2.2-1(a), the canister transfer operation is a subfunctional area to a top level functional area Surface Waste Handling Facility. The canister transfer can be further subdivided into three subfunctional areas [not shown in Figure 2.2-1 (a)]. Functional areas must be identified before using the tool. The tool allows dividing a facility into 26 (A–Z) top level functional areas. Each functional area can be divided into three further sublevels, and each sublevel can be divided into nine functional areas. The tool has the potential to create 18,954 functional areas. The tool assigns an identification number to a functional area to help in systematizing the data entry and data retrieval in the project database.

2.2.2.2 System

Information required for safety analysis in a functional area is compiled in the System Description and structures, systems, and components submodules.

2.2.2.2.1 System Description

The system description of each functional area is input into this submodule. The PCSA Tool allows for extensive description and systematic analysis of operational hazards, systems, and repository operations for both surface and subsurface, and nuclear material (e.g., inventories of casks and canisters) handled in the functional area of the operations is also identified and documented.

2.2.2.2.2 Structures, Systems, and Components

The structures, systems, and components submodule stores the design information on structures, systems, and components and their functions, human actions, remote system and controls, and software systems used pertaining to a specific functional area.

2.2.3 Naturally Occurring and Human-Induced Hazards and Initiating Events

This section addresses two code submodules: (i) site-specific, naturally occurring, and human-induced hazard analysis; and (ii) operational hazard analysis, as shown in Figure 2.2-1(a). The end result of the module is to identify the initiating events that may lead to a potential radiological dose to the public or workers.

2.2.3.1 Site-Specific Hazard Analysis Review

The naturally occurring events and human-induced events common to all functional areas in the facility are identified in this submodule. The naturally occurring events consist of seismic, tornado, wind, flood, and others. Site-specific, human-induced events include aircraft crash, fire, and others. The U.S. Department of Energy (DOE) justification and analyses to include or exclude hazards from a generic list of hazards will be reviewed, and, if required, independent analyses will be made outside the PCSA Tool. The module in the PCSA Tool will record the outcome of the staff review and identify the site-specific events, including frequency of occurrence, that may initiate event sequences in the facility.

2.2.3.2 Operational Hazard Analysis

Events resulting from the facility operations are analyzed for each functional area in this submodule. In addition, the failure checklist database is a submodule that provides input to this module.

The PCSA Tool offers four qualitative hazard analysis methods to identify operational hazards that may result in radiological dose to the public and workers: what-if analysis, failure modes and effects analysis, energy method, and human reliability analysis. The what-if analysis can be used for identifying process hazards, the failure modes and effects analysis addresses hardware and equipment failures, the energy method seeks to find possible release of energy (e.g., kinetic, chemical, or thermal) from the system that may result in radiological consequences, and the human reliability analysis determines the possible human errors from human activities and human interaction with other systems. Details for each of these methodologies can be found in Dasgupta, et al. (2002).

2.2.3.3 Initiating Events

In this submodule, initiating events that have the potential for radiological consequences are identified. The initiating events are selected from naturally occurring or human-induced hazard analysis or operational hazard analysis. The PCSA Tool further allows documentation of estimation of frequencies for the initiating events and consideration of uncertainties associated with the estimated frequencies. The database on failure rate from actuarial data can be used to evaluate frequencies associated with the failure of components. In addition, fault tree analysis and human reliability analysis using the SAPHIRE software can be used to evaluate frequencies for events initiated from failure of a system or human action. To consider events identified by DOE, the PCSA Tool allows such events to carry forward (flag) the information for subsequent analyses in the PCSA Tool. All initiating events are assigned a unique identification number to track the event in subsequent modules.

2.2.4 Event Sequence Analysis

This section addresses code submodules development of an event scenario and event frequency analysis as shown in Figure 2.2-1(b).

2.2.4.1 Event Scenarios

In this submodule, the event scenarios are developed by first identifying an initiating event from the site-specific and operational hazards analyses, then propagating the consequences of the initiating event through a series of safety-related systems or operations failures. Each event scenario is analyzed using the event tree method (NRC, 1994) to estimate the event sequence frequencies. The success of the event tree analysis technique is based on three basic presumptions: (i) all system events have been anticipated, (ii) all consequences of these events have been explored, and (iii) the probabilities of failure for all events have been correctly estimated, including consideration of uncertainties. The tool allows the user to systematically record each event scenario and the associated data.

If the system represents a single component or piece of equipment whose failure is modeled in the event tree, the component failure rate can be estimated directly from actuarial data if available. For multicomponent or complex systems, fault trees are used to find failure probabilities for each node in the event tree. A fault tree is a graphical tool used to depict possible ways that an undesired system state (top event) could occur. Depending on the nature of the subsystem, the fault tree may model failure of electrical systems, mechanical systems, human actions, or combinations of these events. Basic data for each fault tree top event can be recorded in the PCSA Tool database.

Every event scenario is given a unique identification. There is no limit to the number of event scenarios that can be developed in a functional area. The user may postulate alternate event scenarios for a given initiating event, however, the user may flag an event scenario to be used for subsequent analyses (e.g., safety assessment/risk assessment). The flag can be changed at any time to provide the user with the capability to study the effects on safety assessment using alternate event scenarios.

Information generated from this module would be used to model event trees and fault trees in SAPHIRE software; however, that data cannot be directly used as SAPHIRE input.

2.2.4.2 Failure Rate Database and Human Error Probability Generator

The PCSA Tool contains a comprehensive library of failure rates of equipment from actuarial data. The data are organized and categorized in an industry standard taxonomical structure. The data on a particular component can be searched with the help of a taxonomic tree structure or a built-in search capability. Each failure rate datum lists the unit associated with it (e.g., per demand or per hour). The primary and secondary references for the data source and any statistical information available on the data are also provided. The PCSA Tool provides a generator to estimate human error probability by traversing a logic tree to select the appropriate human error probability and performance-shaping factor. The technique for human error rate prediction methodology developed by Swain and Guttman (1983) for evaluating human error probability was implemented in the PCSA Tool.

2.2.4.3 Event Frequency Analysis

Event trees and fault trees are analyzed using the stand-alone software, SAPHIRE Version 6.80 (Idaho National Engineering and Environmental Laboratory, 1998). The SAPHIRE software is a collection of programs that allows the user to model event trees and fault trees; define event sequences and basic event failure data; solve system fault trees and event sequences; quantify cutsets; and perform uncertainty, sensitivity, and importance analyses. The system failure response is analyzed by a fault tree-linking technique, whereby the fault tree logic is combined with the event tree logic resulting in a logic expression for each sequence in the event tree. The event tree and fault trees are modeled using a graphic editor. The code requires failure probabilities of the basic events as input to the model. The user can specify a point estimate or distribution of basic event probabilities as input. The SAPHIRE program generates reports and graphics. Relevant information can be abstracted and stored in the PCSA Tool project database. The user must be familiar with the operations of the SAPHIRE software package to model and analyze event trees and fault trees.

2.2.4.4 Event Sequences and Categorization

Results from the event tree analysis from the SAPHIRE runs are stored in this submodule. All event sequences are given unique identification numbers. The frequency and end state (i.e., qualitative assessment of consequence) for each event sequence are entered.

Based on the frequency of occurrences, event sequences are categorized as Category 1 or Category 2. Based on the definitions from 10 CFR 63.2, Category 1 event sequences are those natural and human-induced event sequences expected to occur one or more times before permanent closure. Category 2 event sequences are other natural and human-induced event sequences that have at least 1 chance in 10,000 of occurring before permanent closure. In this submodule, the event sequence frequencies are automatically categorized as Category 1, Category 2, or below category frequency limit (BCFL) based on the preclosure period assigned to the initiating events. BCFL are those with frequencies of occurrence less than the Category 2 frequency limit.

2.2.5 Analysis of Consequence

The consequence analysis module calculates the radiological dose to the members of the public and workers. This section addresses the two main code submodules: public dose and worker dose. These modules are supplied information through an input data module. Point estimate or probabilistic calculations can be performed for the public dose determination. Point estimate calculations of the worker dose are also available.

2.2.5.1 Input Data

This module prepares data required for public dose calculations by deterministic and probabilistic approaches. Dose calculation requires the inventory of radionuclides, meteorological data, and other parameters. For probabilistic analysis, the distributions of sampled parameters are provided in this module.

2.2.5.2 Public Dose

The point estimate calculations of public dose are performed using RSAC software. The probabilistic calculations are based on Latin Hypercube Sampling of RSAC input parameters. RSAC is executed once for each sampled set of input parameters to determine the dose from that realization. The results from the simulations and dose calculations are processed and displayed in this module. The tool provides a separate module for generating input data to calculate building discharge fractions using the MELCOR software. The building discharge fraction serves as input data in the public dose calculation using RSAC.

2.2.5.3 Worker Dose

The worker dose option provides the capability to incorporate three types of worker dose: (1) normal operation dose, (2) accident dose to workers outside buildings, and (3) accident dose to workers inside buildings.

2.2.5.3.1 Normal Operation Dose

The normal operation dose option performs a spreadsheet calculation to estimate dose to the facility workers. This calculation is limited to underwater-handling events, with workers present above the pool. A single screen provides the user interface for the input and output of the worker dose calculations.

2.2.5.3.2 Accident Dose Outside

The accident dose outside option performs an analysis for workers exposed to a contaminated plume of air released from the ventilation system of a building. The source of released radionuclides may be damaged PWR spent nuclear fuel, BWR spent nuclear fuel, or a user-specified source. The HEPA filtration system integrated in the building's ventilation system may be assumed to operate properly or fail. The exposed workers may be on the building releasing the plume or not on the building, but downwind. Wind flow around the building sets up three aerodynamic zones: (1) cavity zone, (2) wake zone, and (3) displacement zone. The dose to downwind workers depends on which aerodynamic zone they are in, which depends on a number of physical factors including the horizontal distance of the worker from the source, the height of the release, and the building dimensions. The usual air dispersion models are modified to account for the highly modified aerodynamic conditions downwind of the building.

2.2.5.3.3 Accident Dose Inside

The accident dose inside option performs an analysis for workers exposed to accidental releases of radionuclides inside buildings. For accidents resulting in releases under dry conditions, worker dose is modeled as resulting from the leakage of contaminated air from a hot cell into an adjoining room. The source of released radionuclides may be damaged PWR spent nuclear fuel, BWR spent nuclear fuel, or a user-specified source. Several physical parameters, such as the room volume, ventilation rate in the worker's room, leakage rate, and time spent by worker in the adjacent room, determine the dose. For accidents resulting in releases under wet conditions, worker dose is modeled as resulting from the release of gases from a spent nuclear fuel pool directly to the room where the worker is located. The pool option performs a spreadsheet calculation to estimate dose to the facility workers. This calculation is limited to

underwater-handling events, with workers present above the pool. A single screen provides the user interface for the input and output of the worker dose calculations.

2.2.6 Safety Assessment

The safety assessment module integrates and analyzes the results obtained in the various tasks for safety assessment. This integration includes, among other things, tabulation of frequencies for event sequences and consequences. The results are analyzed to assess safety by comparing the dose with performance objectives for the Categories 1 and 2 event sequences stipulated in 10 CFR 63.111. For Category 1 event sequences, the two approaches for safety assessment used in this module are annualized dose and combination of events. For Category 2 event sequences, each event sequence is compared with Category 2 dose limits.

2.2.7 Risk Assessment

The risk assessment module evaluates aggregate risk from a potential repository during the preclosure period. Estimation of aggregate risk is not required by the U.S. Nuclear Regulatory Commission (NRC) regulation in 10 CFR Part 63 and will not be used directly in compliance determination. However, estimation of aggregate risk is incorporated in the PCSA Tool for gaining risk insights. Additionally, the risk assessment can be used also to evaluate the reliance on structures, systems, and components important to safety.

2.2.8 Structures, Systems, and Components Important to Safety

The structures, systems, and components important to safety will be identified using a performance-based importance analysis. This module is not yet fully developed. The approach and current state of development are discussed in Dasgupta, et al. (2002, Chapter 9).

2.3 PCSA Tool Menu Structure

The structure of the menus in the context of the PCSA Tool functions is described in this section. When the program is first executed, a startup title form is displayed to the user with an artistic rendering of the proposed Yucca Mountain repository (CRWMS M&O, 1996). The user can open or create projects from the startup page. The tool creates and opens project database files with the extension .mdb. Project files must be stored in an already established directory Project. In the PCSA Tool, the term project represents a single specific database. The project files for SAPHIRE analysis are managed by the SAPHIRE software. It is, however, recommended that these files be saved in an established directory, Saphire Projects.

After selecting a file or creating a new file, the PCSA Tool opens the main tool window with a menu bar at the top of the window. The menu bar lists various functions and categories into which the tool allows entry of data or further actions. The overall menu and submenu structure is shown in Figure 2.3-1. By clicking on the various options, the user is able to navigate through various programs, forms, tables, and reports. The user can then enter data into the selected table or form and recall the data at a later time. The forms and tables provide further actions through button controls. A typical example of the structure of action buttons is shown in Figure 2.3-2.

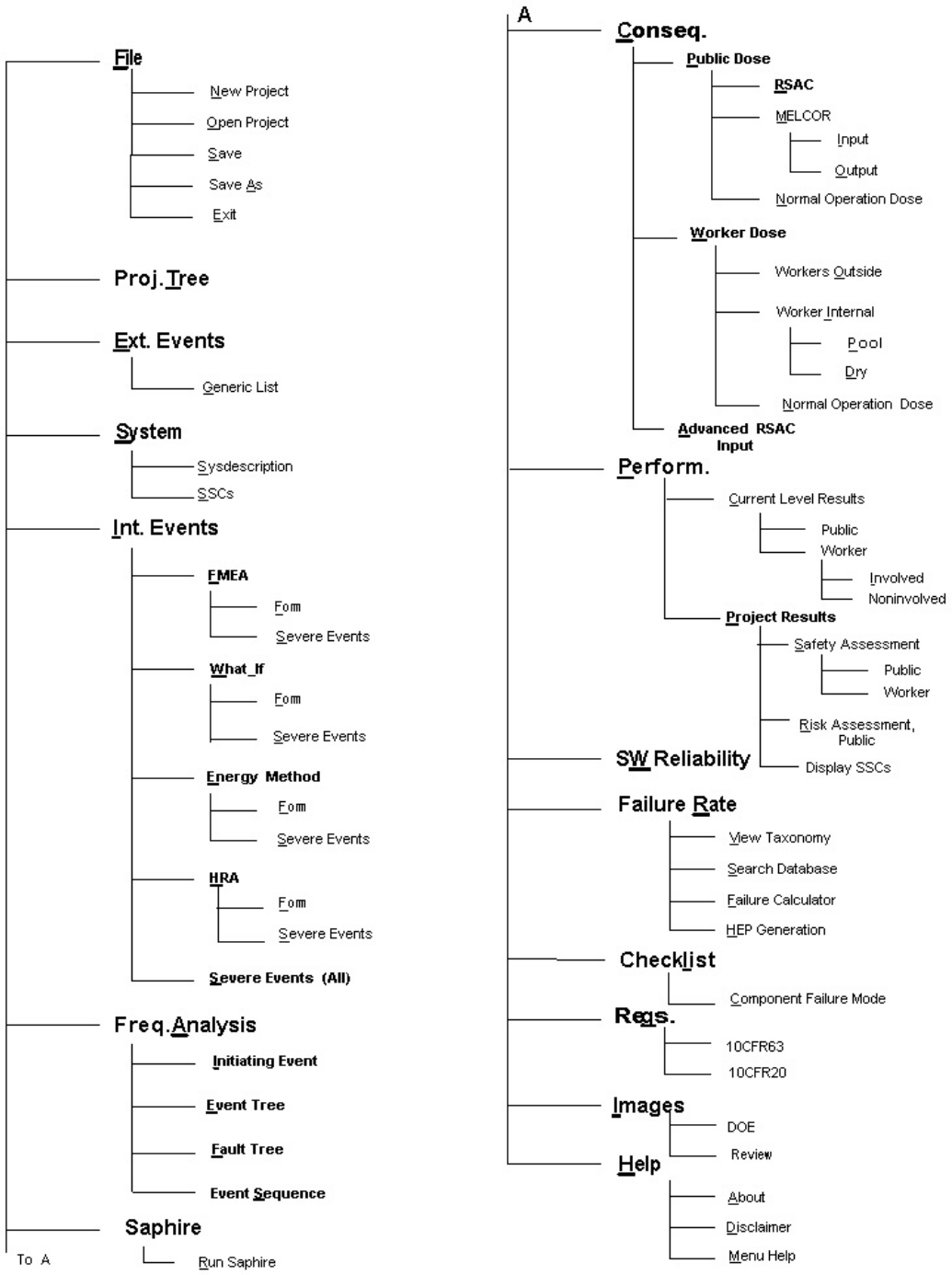


Figure 2.3-1. Tree Diagram Showing Layout of Menus and Submenus

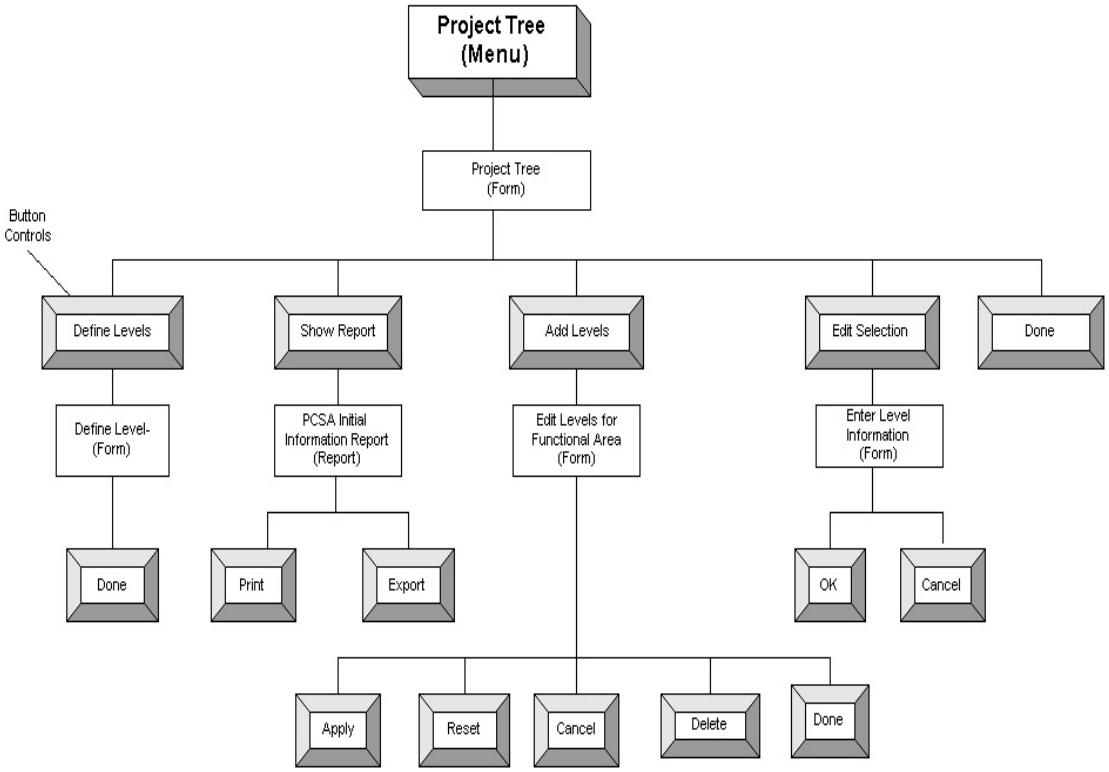


Figure 2.3-2. Example of Typical Action Buttons for Each Menu

3 REFERENCE FOR MENU FUNCTIONS

3.1 Getting Started

When the PCSA Tool Version 3.0 software is first executed from the desktop, a startup title page is displayed to the user (Figure 3.1-1). The startup page displays five buttons: **About PCSA**, **Disclaimer**, **Open Project**, **Create Project**, and **Exit**. The **About PCSA** button describes the tool and the project. The **Open Project** button will open an existing project, and the **Create Project** button will enable the user to create a new project. Selecting either **Open Project** or **Create Project** will open a dialog box as shown in Figure 3.1-2. The dialog box has features similar to other standard Windows application packages (e.g., searching a project file, or saving a project file in the directory structure). The PCSA Tool will create and open database files with the extension .mdb.

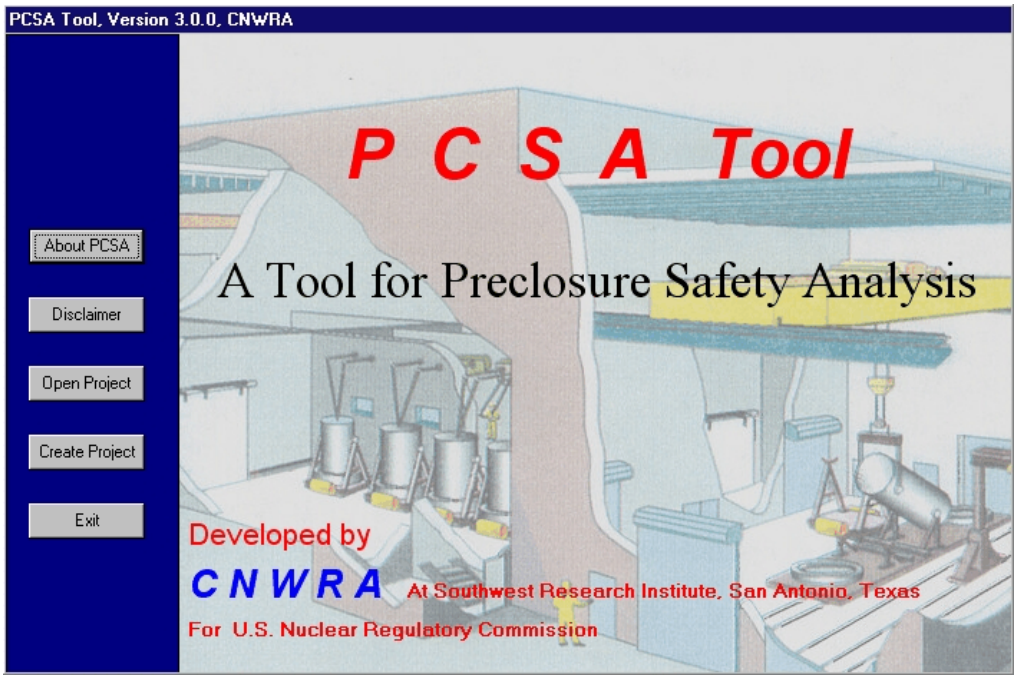


Figure 3.1-1. Display of Startup Screen Window PCSA Tool

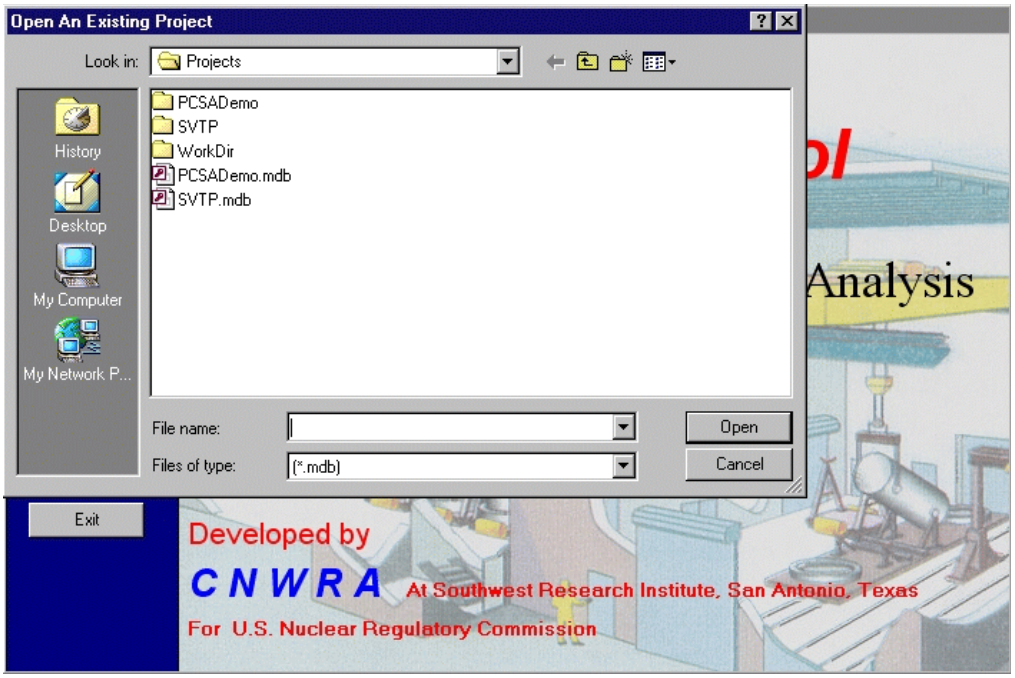


Figure 3.1-2. Open Project Dialog Box to Open an Existing Project

Action Commands

About PCSA: Displays pertinent information about PCSA Tool.

Disclaimer: Displays PCSA Tool disclaimer statement.

Open Project: Opens a dialog box showing existing database files in the Project directory. The user can select and open a database.

Create Project: Opens a dialog box showing existing database files in the Projects directory. The user can create a new database file with the extension .mdb.

Exit: Allows the user to exit the PCSA Tool.

⇛ *Note: Create Project also creates a directory under the same name as the database file. The newly created directory will have a RASCRuns subdirectory. Users sharing the project database must have a corresponding subdirectory structure and the associated file in their computers.*

3.2 File

Once the database has been selected, the PCSA Tool displays the main form as shown in Figure 3.2-1 with the main menu bar at the top of the screen. The first menu is the **File** menu. The submenus under the **File** menu are described below.

Open Project: The program will default back to the opening title screen as illustrated in Figure 3.1-1. The **Open Project** button will allow the user to select an existing file. When opening a new project, the **System Log** window, shown in Figure 3.2-2, may appear displaying the Tool User, Date and Time, and Description of changes made since the Tool was last accessed. It will only be displayed if log entries had been made in previous sessions; otherwise, the main form shown in Figure 3.2-1 will be displayed.

New Project: The program will default back to the opening title screen as illustrated in Figure 3.1-1. The **Create Project** button will allow the user to type in the name of a new file.

Save: Saves the information in the current project database. The user must be aware that any entered information resides in a temporary database until saved.

Save As: Saves the information as a new project database. The user must be aware that the current database does not default to the newly saved file. To access the newly saved file, the user must exit the current database and open the newly saved database.

Exit: The tool will prompt the user to save any information entered in the current session before quitting the program. If any changes have been made and the user chooses to save the file, the **System Log Entry** window will appear as shown in Figure 3.2-3. If log entries had been made in previous sessions, the user must make a log entry; otherwise the log entry is optional. Afterward, the user selects **Close** to close the **System Log Entry** window and the tool.

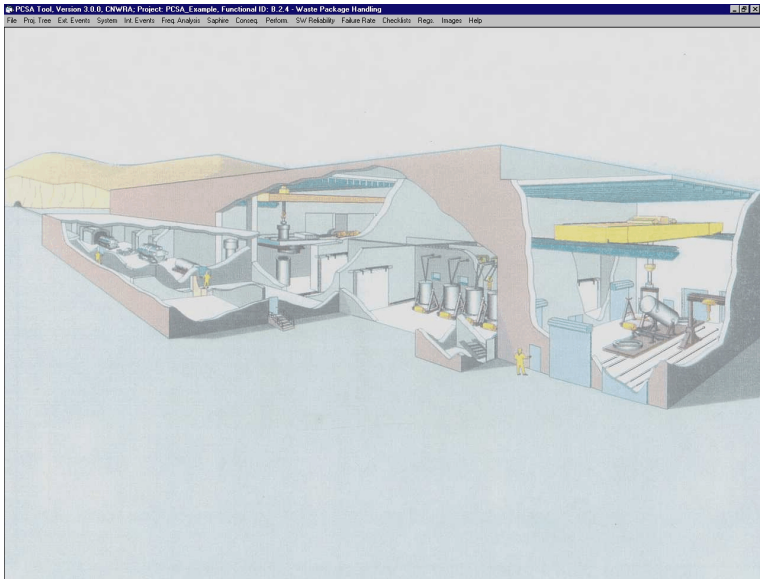


Figure 3.2-1. PCSA Tool Showing Menu Bar

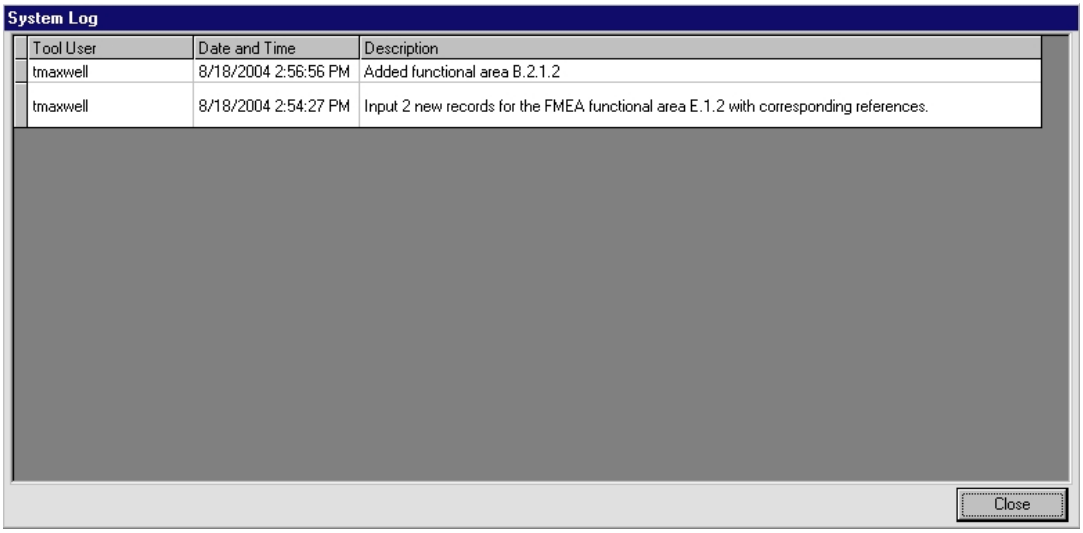


Figure 3.2-2. System Log Showing Database Changes

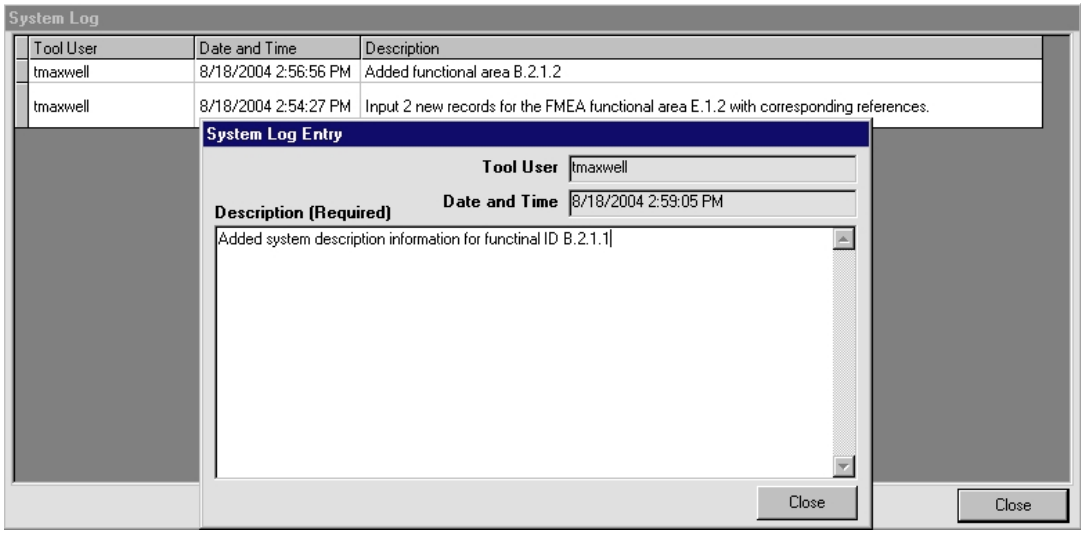


Figure 3.2-3. System Log Entry

3.3 *Proj. Tree*

There are two Project Tree (*Proj. Tree*) phases. The first is creating a project tree, while the second is modifying a project tree, which will be discussed in Section 3.3.3.

3.3.1 *Creating a Project Tree (Proj. Tree)*

When starting a new project, the Create Levels for Functional Area window illustrated in Figure 3.3.1-1, will be displayed with four columns to select the level that will identify a functional area with a Functional ID. The Project Tree assigns an alpha-numeric identification to a functional area that helps systematize data entry and data retrieval in the project database.

The levels are constructed by clicking on the appropriate letter and the sublevel numbers. The tree structure may be viewed using the **View Tree** button. The first column provides options A through Z, and each of the remaining three columns provide options 1 through 9. The Functional ID selection is oriented so the alpha-numeric combination is selected in a set order. With the selection of a level, the user builds a Functional ID, which is displayed in the current selection window. The user can either add the Functional ID to the table on the right using **Apply** or clear the selection with **Reset**. To delete a Functional ID, the user must highlight the Functional ID in the table and select **Delete**. The Functional IDs will be placed in order automatically even if an ID is not entered in the correct sequence. For example, if A.1 is inserted after A.2, A.1 will still be placed before A.2. When the desired number of Functional IDs have been created, select **Done** to advance to the main project screen.

The following list includes basic Project Tree steps:

(1) Plan: Know how many levels the functional area requires and how many sublevels are needed for each level. It is important to plan the project tree structure in advance, because the tool allows limited capability to delete a Functional ID. See the following note.

(2) Input the Levels: Input the alpha-numeric Functional ID using the columns provided, as shown in Figure 3.3.1-1, and select **Apply**.

(3) Generate the Project Tree: When the entries are complete, select **Done** to advance to the main project screen. An entry may be deleted after **Apply** has been selected using the **Delete** command.

(4) Describe the Functional Areas: Provide a description of each functional area at each level and sublevel, by selecting ***Proj. Tree*** from the top tool bar (see Section 3.3.2).

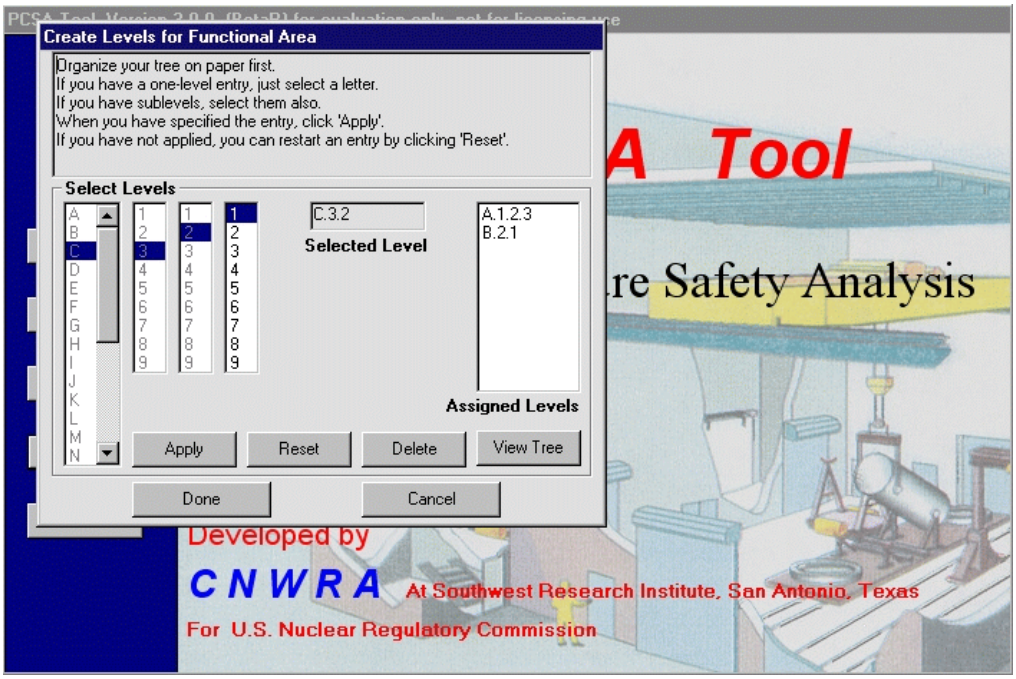


Figure 3.3.1-1. Create Levels for Functional Area Window

Action Commands

Apply:	Adds the chosen Functional ID into the Functional Area ID tables.
Reset:	Clears the Functional ID in the current selection window (Note, **Reset** does not erase the Functional ID in the Functional ID table).
Delete:	Erases a Functional ID entry selected from the Assigned Levels table.
View Tree:	Allows the user to see the project tree as it would appear in the project.
Done:	Allows the user to proceed into project with a created project tree.
Cancel:	Sends the user back to the opening screen without saving the project tree. The user will be warned with the message “This action will destroy your tree. Do you wish to continue?” before canceling.

⇛ *Note:* ***Delete*** *is allowed in the Project Tree as long as no data have been entered in another form or table.*

⇛ *Note: The user is advised to use caution while creating the Project Tree because the tool offers limited flexibility in deleting a Functional ID that has been incorrectly or inadvertently applied. The user must note that a Functional ID already selected (using **Apply** button) cannot be further subdivided. To subdivide the functional area, the user must delete the Functional ID and recreate with the desired sublevels. Another note of caution, the Functional ID can only be deleted if there are no data entered in the database under this Functional ID. It is recommended that the user make several trials to become familiar with building a project tree and understand the limitations before embarking on developing a bigger tree for a project.*

3.3.2 *Functional Area Descriptions*

After the **Project Tree** has been created, click on the ***Proj. Tree*** menu from the top menu bar to display the **Project Tree** window. Selecting a base level will display the **Functional Area Descriptions** window shown in Figure 3.3.2-1, which allows the user to input descriptions of each area. At the bottom of the window, the Remarks field allows the user to enter information without any character limitations.

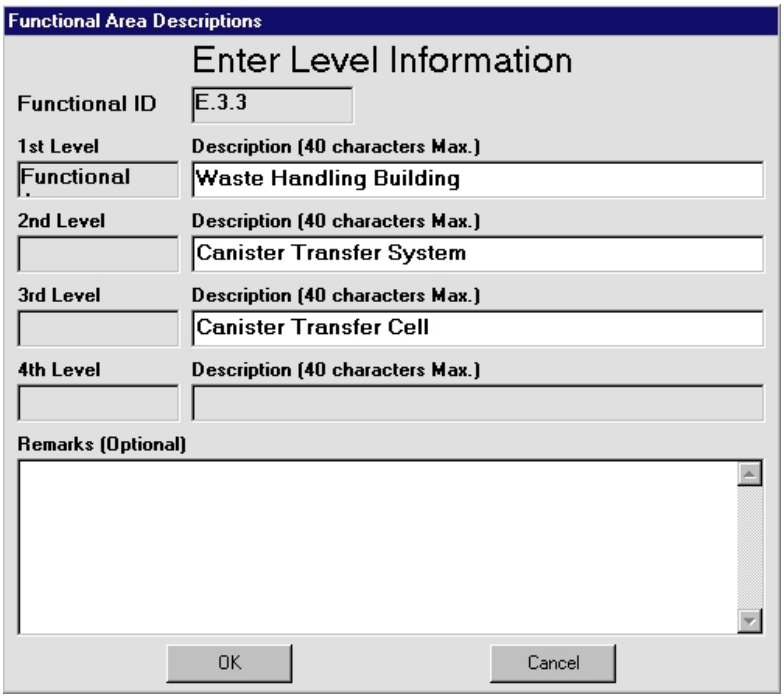


Figure 3.3.2-1. Functional Area Descriptions Menu

Action Commands

OK:	Accepts any additions or changes made by the user and closes the **Functional Area Descriptions** window.
Cancel:	Closes the **Functional Area Descriptions** window without retaining any input made by the user.

3.3.3 *Modifying a Project Tree*

The project tree can be modified at any time. The ***Proj. Tree*** menu can be selected from the top menu bar to display the **Project Tree** window. The **Project Tree** window opens with the first level shown, while the sublevels are displayed by expanding on each node, as shown in Figure 3.3.3-1.

To add a functional area, the **Add Level** button can be used. The **Add Level** button displays the **Edit Levels for Functional Area** window, shown in Figure 3.3.3-2, and the functions of the buttons in that dialog box are shown on page 3-5.

The user can delete the functional area at the end of a branch if there are no data associated with the functional area.

3.3.4 *Selecting a Functional Area*

The ***Proj. Tree*** menu prompts a **Project Tree** window that displays an expandable and collapsible tree view of the functional area, as shown in Figure 3.3.3-1. The Project Tree is used to show and develop the organization of functional areas as a tree structure. This window helps to manage data from the facility hazard analysis in a systematic manner. The data for each node of the tree can be expanded to three levels, allowing three levels of subsections for each functional area. When the lowest level of a functional area is selected and the **Done** button is clicked, a graphical user interface activates the ***System***, ***Int. Event***, and ***Freq. Analysis*** menus (see Figure 3.2-1), and the *Current Level Results* submenu under the ***Perform.*** menu.

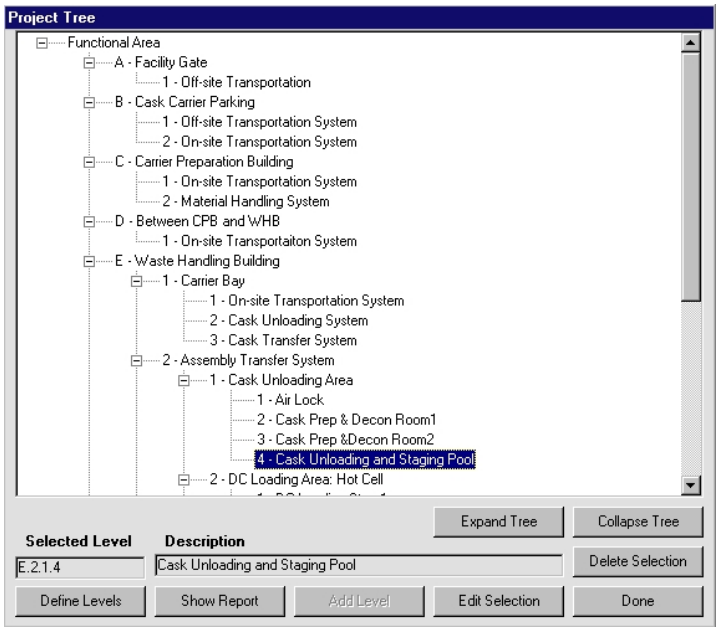


Figure 3.3.3-1. Project Tree Functional Areas Expanded to Third Level under Node E

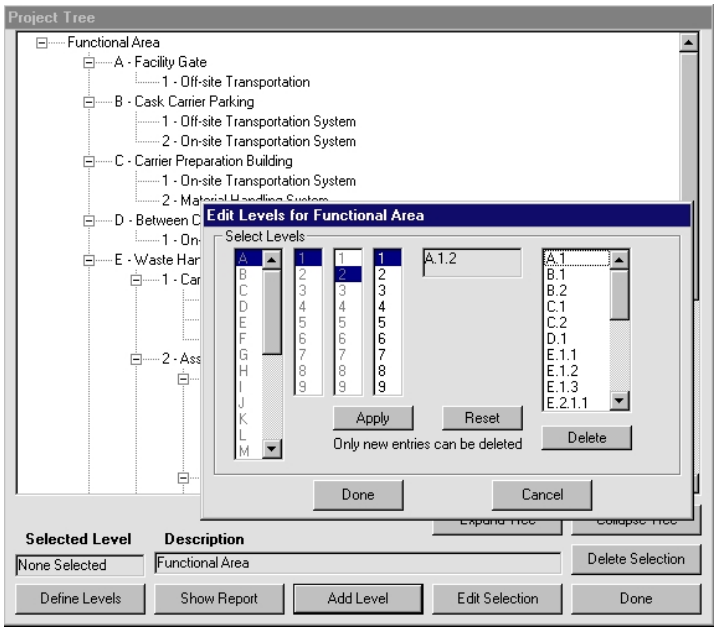


Figure 3.3.3-2. Edit Levels for Functional Area Window

Action Commands

Expand Tree:	Displays the Project Tree fully expanded to all nodes and subsections.
Collapse Tree:	Displays the Project Tree with all nodes collapsed except the node containing the last level selected. In this cases, the last node selected is collapsed to its selected level.
Delete Selection:	Allows the user to delete a base level of Functional Area ID. Deletion is allowed only if no data exist in the database corresponding to the Functional ID.
Define Levels:	Allows the user to define levels to each functional area. The drop-down list can be used to define the label. The user can type in the desired label.
Show Report:	Displays the Project Tree in report format.
Add Level:	Allows the user to add a level to the **Project Tree**. Selecting **Add Level** will display a dialog box similar to that shown in Figure 3.3.3-2.
Edit Selection:	Allows the user to modify a functional area.
Done:	Exits the **Project Tree** window retaining any changes made by **Add Level** and **Edit Selection**. If a functional area is selected, the **Done** button activates ***System***, ***Int. Event***, and ***Freq. Analysis*** menus and *Current Level Results* submenu under the ***Perform***. menu.

⇛ *Note: If a Functional ID has not been selected, some project options will not be available.*

3.4 *Ext. Events*

The ***Ext. Events*** menu contains a submenu, *Generic List*, that leads to a database with tables containing a generic list of naturally occurring and human-induced external events. The event screening process is based on an in-depth review of U.S. Department of Energy (DOE) reports or an independent analysis. The outcome of the review for each category can be stored in the database.

3.4.1 *Generic List*

The **Naturally Occurring and Human-Induced Events** window as shown in Figure 3.4.1-1 is accessed by selecting ***Ext. Events*** from the main menu and opening the *Generic List* submenu. The table shows the four screening criteria: Potential exists for event to be applicable, Rate of process high enough to affect facility, Consequence of an event significantly high to affect facility, and Event Frequency (per year). To consider an event applicable to the repository site, the outcome for the first three screening categories should be Y (yes), and the frequency of occurrence of the event should be greater than the Category 2 frequency limit. A potential initiating event is indicated by Y in the Applicability of the Event to the Site column, while N indicates a negative outcome. Applicability of the Event to the Site is automatically determined by the program for an event being evaluated based on the user input.

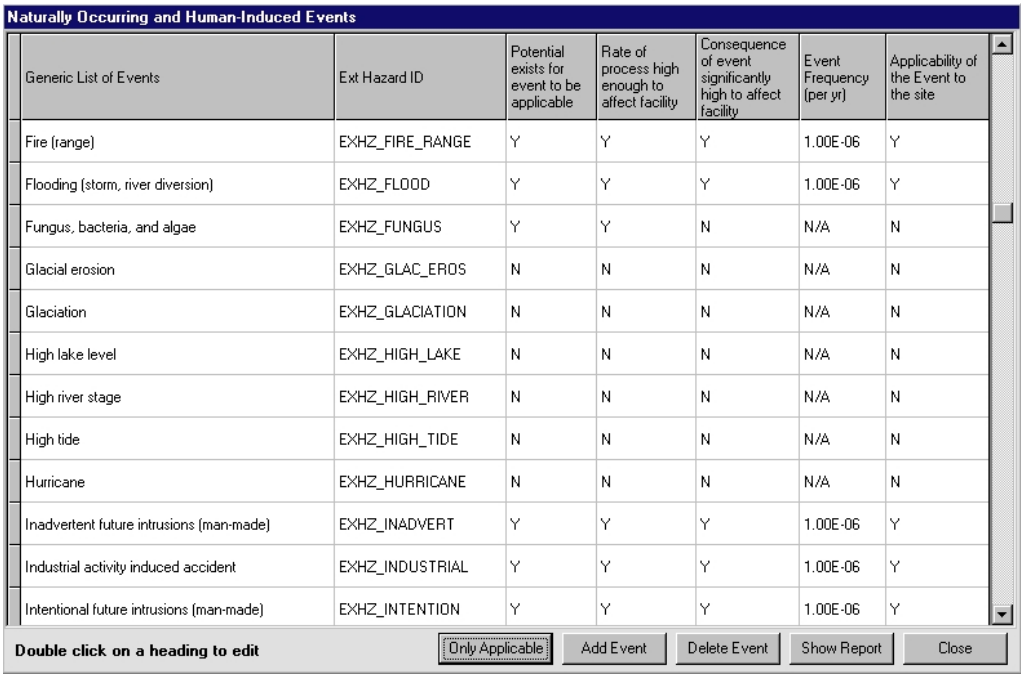


Figure 3.4.1-1. A Site-Specific Hazard Analysis Database

Action Commands

Only Applicable:	Displays the list of potential initiating events. To return to the main list, select **Show All**.
Add Event:	Adds another event to the Generic List of Events. The Tool will prompt the user with a text box titled **Add Event**.
Delete Event:	Erases the event selected by the user.
Show Report:	Displays the information in report format.
Close:	Closes the menu and returns the user to the main project screen.

3.4.2 *Editing and Creating Event*

The event screening process will be based on an in-depth review of DOE reports. The outcome of the review for each screening criterion can be stored in the database by double-clicking on an event in the Generic List of Events column, which will launch an **Events** window similar to that in Figure 3.4.2-1. The fields provided in the form allow the reviewer to provide comments about the DOE Definition of events, Required Condition for the events, and brief discussions about corresponding screening criteria. In general, decisions about screening criteria will be made based on DOE document reviews, and the review finding may be provided in the corresponding text fields to support the decision made. The tool provides text fields to record the review outcome of DOE documents for four screening criteria: Potential exists for event to be applicable to the site, Rate of process high enough to affect the facility during preclosure period, Consequence of significantly high to affect the facility during preclosure period, and Event Frequency (per yr). Accept a screening criterion by selecting the **Yes** button, which automatically updates the corresponding criterion in the Generic List of Events field in Figure 3.4.1-1. Furthermore, the events form has Additional Discussion and DOE References text fields for storing more information. If there is an independent report generated from the review, the report file can also be linked to the database by providing the name and path of the directory structure.

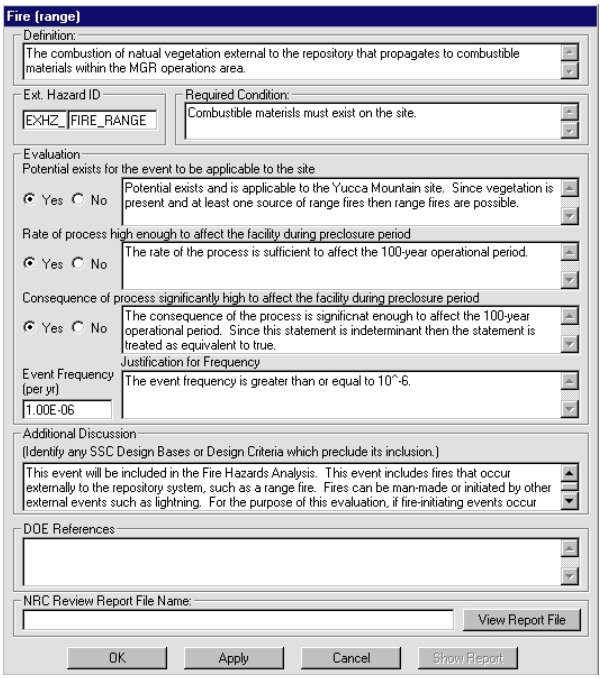


Figure 3.4.2-1. Form to Store Staff Review Results for a Site-Specific Hazard

Action Commands

OK: Accepts the information input by the user and returns the user to the *Generic List* submenu.

Apply: Accepts the information input by the user without returning to the main project screen.

Cancel: Does not accept the information input by the user and returns the user to the main project screen.

Show Report: Displays the information in report format.

View Report File: Displays the referenced report in NRC Review Report File Name text field, provided it exists in the specified location in the /Documents subdirectory and the computer has an appropriate viewer compatible with the report file format.

⇛ *Note: The report file's extension (.wpd, .doc, and such) must be registered on the computer for the* **View Report File** *feature to work.*

3.5 System

3.5.1 System Description

The System Description window is opened in the PCSA Tool by clicking on the *System Description* submenu item under the ***System*** menu. The **System Description** window, shown in Figures 3.5.1-1 through 3.5.1-9, can be used only when a functional area is selected from the ***Proj. Tree*** menu. The **System Description** window provides the following nine input folders: Function, Operation Sequence, Waste Characterization, Human Actions, Shielding, Software System, Fire Hazards, General, and Assumptions.

The following Action Commands, as shown in Figures 3.5.1-1 through 3.5.1-9, are used within separate tabs of the **System Description** window.

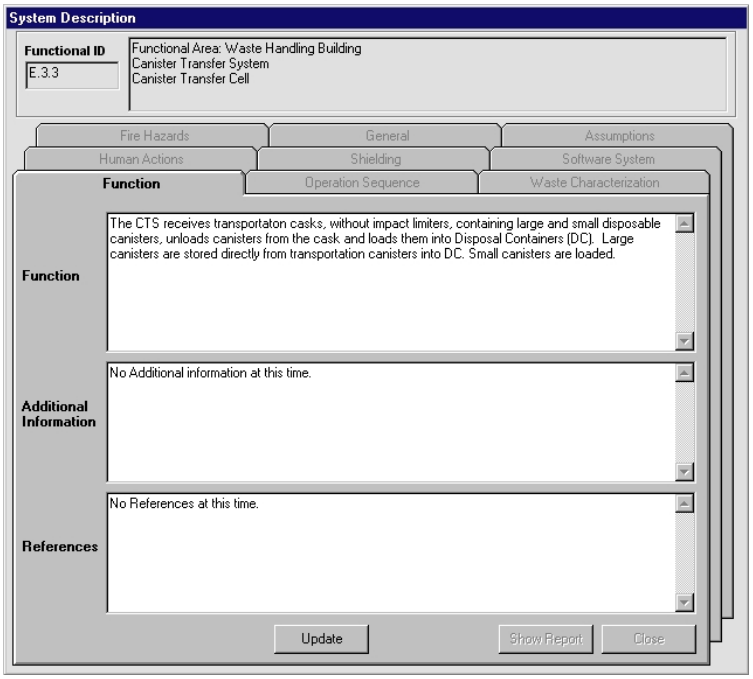


Figure 3.5.1-1. Function Input Folder

Action Commands

Add Record: Activates a dialog box and allows the user to add information in the current window.

Edit Record: Activates a dialog box and allows the user to change information in the current window.

Delete Record: Allows the user to delete information in the current window.

Edit:	Allows the user to change information within the window.
Update:	Activated after **Add Record**, **Edit Record**, or **Edit** is selected. Accepts the user's changes.
Cancel:	Disregards the current record. This command is only provided when the dialog box is active.
Show Report:	Displays the information in the current window in report format.
Close:	Closes the **System Description** window. This command is not provided when the dialog box is active.

A description of each folder tab is provided next.

3.5.1.1 *Function*

Function: Provide a brief description of the functions of the system or process being analyzed in the current functional area.

Additional Information: Enter any additional information.

References: Enter reference information in which the function is discussed.

3.5.1.2 *Operation Sequence*

Item No.: An item or serial number is automatically assigned to each operation sequence.

Detailed Operations Sequence: Enter a step-by-step sequence of operations in the functional area.

Duration of Operation: Enter time of system operation.

Additional Information: Enter any additional information pertinent to the operation.

DOE Reports and References: Enter DOE reports and references from which the data were obtained.

Lift Height: Enter lift height data. Activated if "Lift Height Data Available" is checked.

Distance Traveled: Enter distance traveled data. Activated if "Distance Traveled Data Available" is checked.

Speed of Travel: Enter speed of travel data. Activated if "Speed of Travel Data Available" is checked.

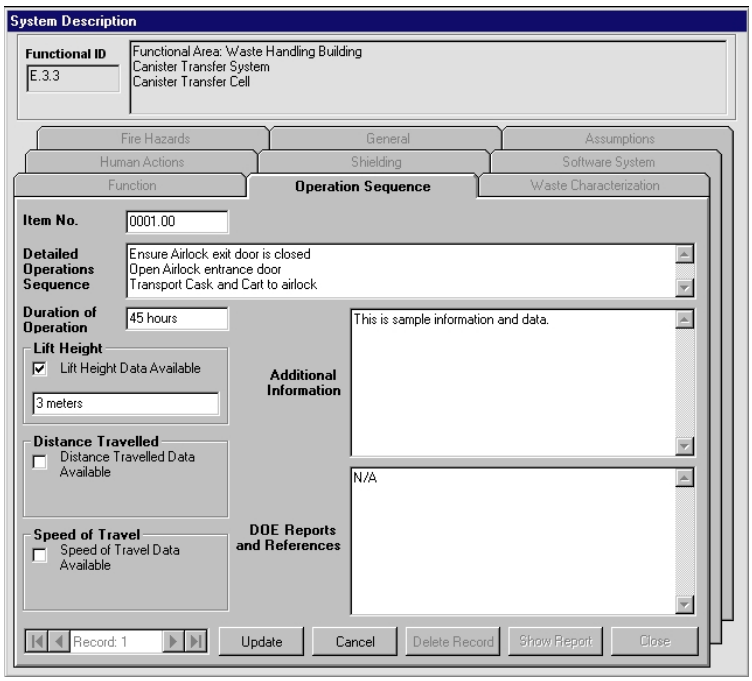


Figure 3.5.1-2. Operation Sequence Input Folder Tab

3.5.1.3 *Waste Characterization*

Item No: An item number is automatically assigned to the current record.

Description of Waste: Describe the nuclear waste characteristics associated with the current system.

Heat Generation Rate: Enter the heat generation rate in Watts.

External Dose Rate: Enter the external dose rate.

References: Enter references for the data entered in the current record.

Material Type: Enter the type of waste.

Material Container: Enter waste container information.

Material Amount: Enter the amount of waste.

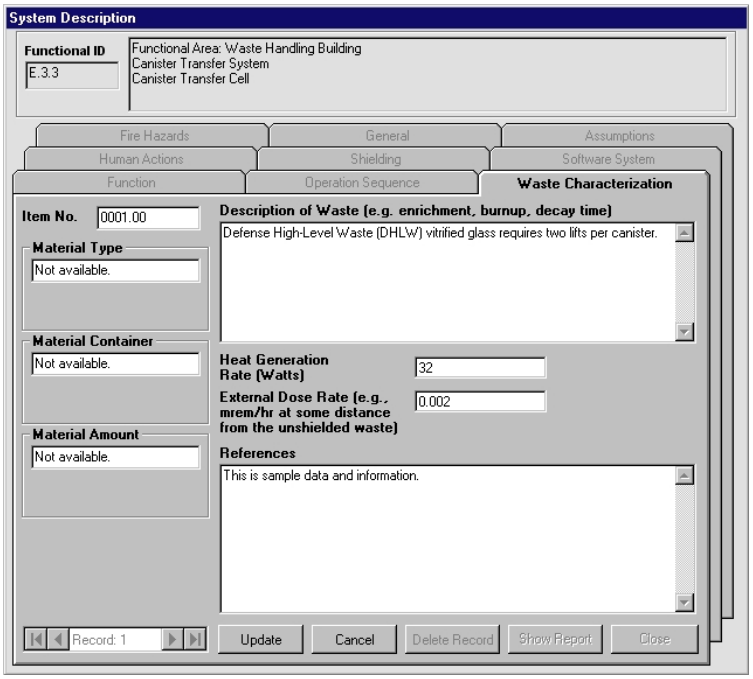


Figure 3.5.1-3. Waste Characterization Input Folder Tab

3.5.1.4 *Human Actions*

Maintenance and Standby: Enter the maintenance and standby actions. Several records may be added.

Operational: Enter the operational actions. Several records may be added.

References: Enter references pertaining to the data entered for the current record.

Additional Information: Enter any additional information.

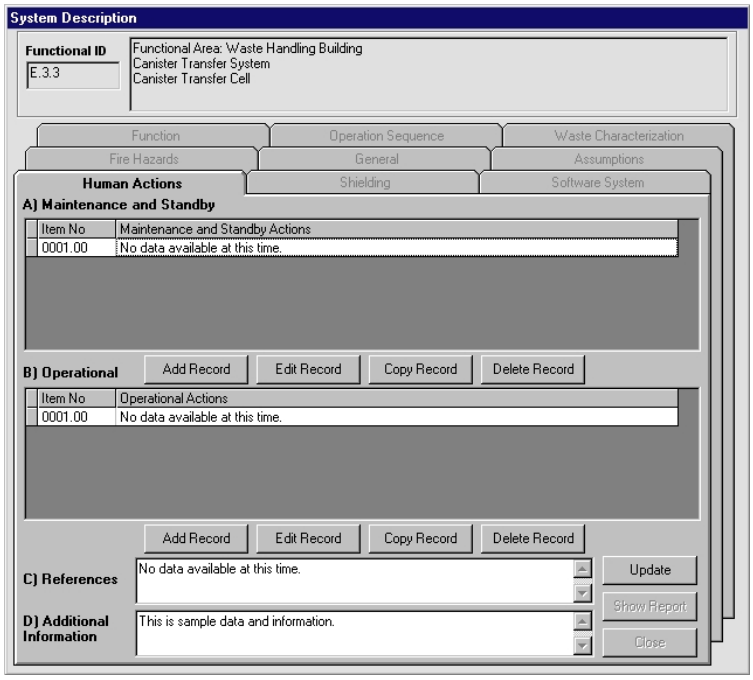


Figure 3.5.1-4. Human Actions Input Folder Tab

3.5.1.5 *Shielding*

Item No: An item number is automatically assigned to the current record.

Source Geometry: Enter the geometry of the source.

Additional Information: Enter any additional information.

Worker Location Relative to Sources: Enter the location of the worker relative to the sources.

Shield Locations Relative to Sources: Enter shield locations relative to the sources.

References: Enter references for the data entered in the current record.

Shield Material: Enter the material type of the shield.

Shield Composition: Enter the composition of the shield material.

Shield Density: Enter the density of the shield.

Shield Thickness: Enter the thickness of the shield.

Images: User may view various images by double-clicking on a record.

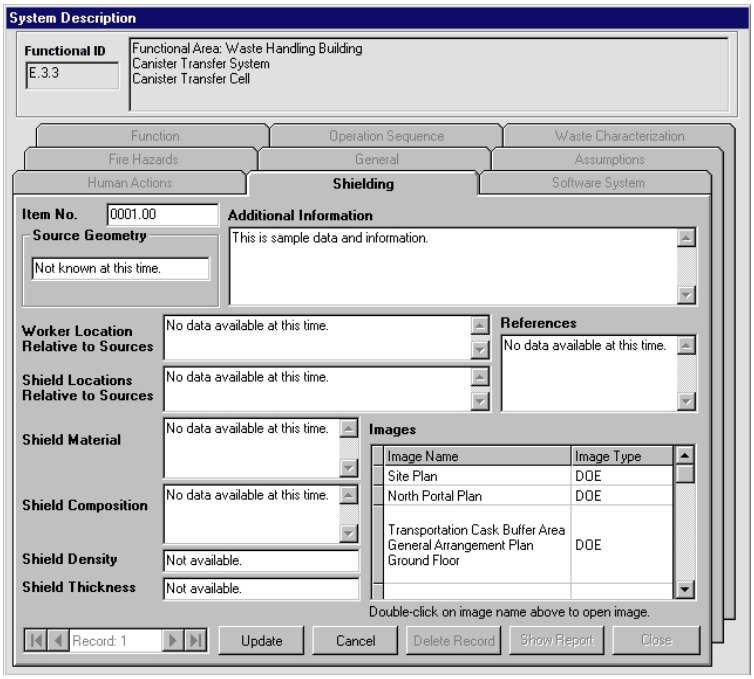


Figure 3.5.1-5. Shielding Input Folder

3.5.1.6 *Software System*

Software System Used: Enter multiple software systems used, if applicable.

References: Enter references for the software systems listed.

Additional Information: Enter any additional information.

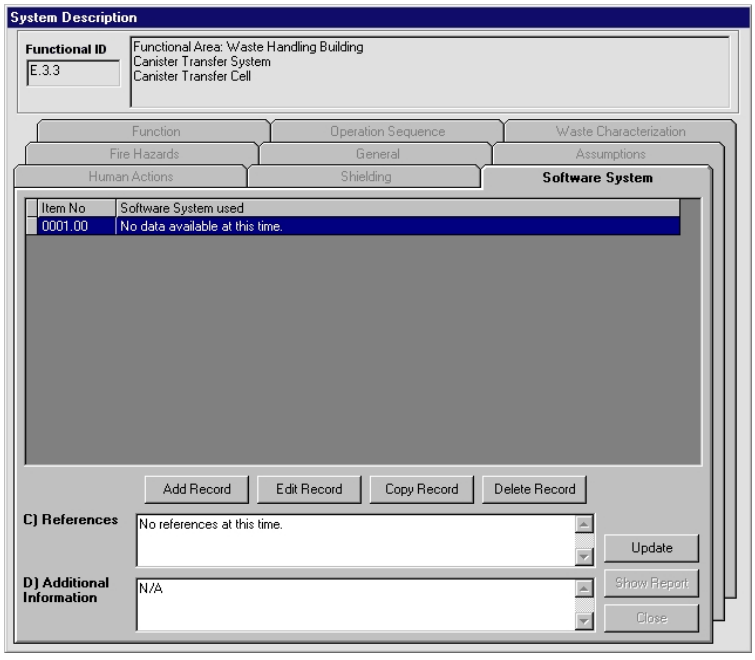


Figure 3.5.1-6. Software System Input Folder Tab

3.5.1.7 *Fire Hazards*

Item No: An item number is automatically assigned to the current record.

Presence of Combustible Material: Select "Yes" or "No." If "Yes" is selected, the user will be prompted to identify the combustible materials that are present.

Location and Description of the Combustible Material: Enter the location and description of the combustible material.

Additional Information: Enter any additional information.

DOE Reports and References: Enter DOE reports and references from which the data were obtained.

Function: Enter the function of the combustible material for the identified hazard.

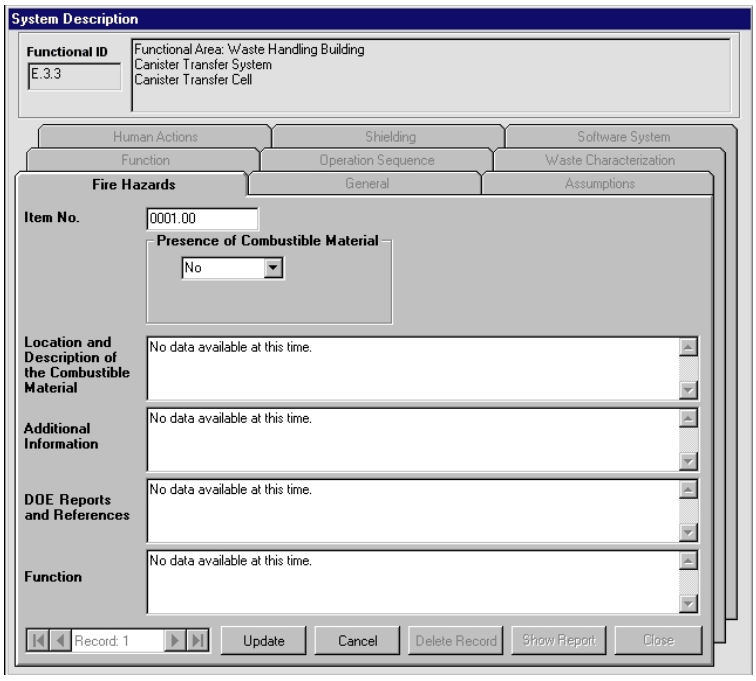


Figure 3.5.1-7. Fire Hazards Input Folder Tab

3.5.1.8 *General*

There is presence of neutron moderators for criticality: Select the checkbox if there is presence of neutron moderators for criticality for the current functional area.

Radiation Area Designation: Enter a radiation area designation or select from the three possible radiation area designations provided.

Ventilation Flow Rate: Enter the ventilation flow rate in the functional area.

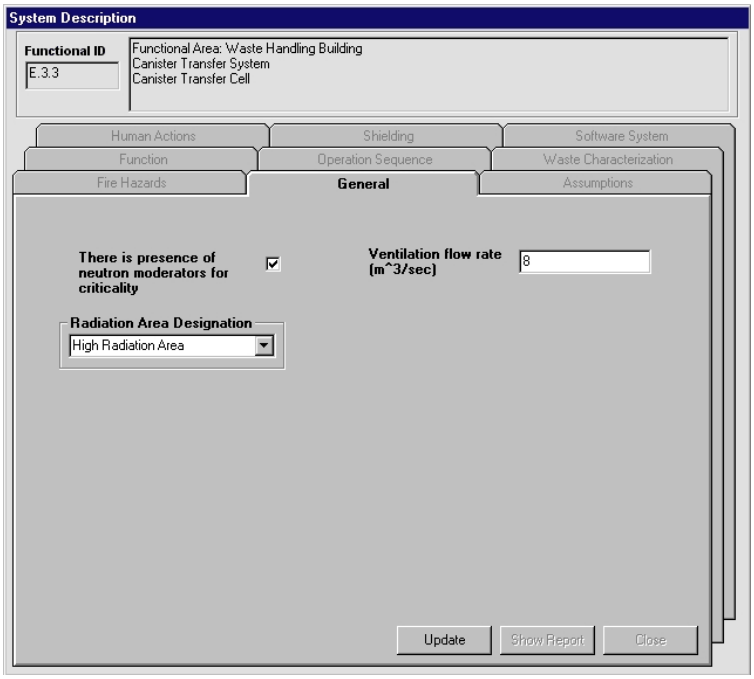


Figure 3.5.1-8. General Input Folder Tab

3.5.1.9 *Assumptions*

Assumptions: Enter multiple assumptions if appropriate. Assumptions are characterized by an item number, which is automatically generated. Additional information pertaining to an assumption may also be entered.

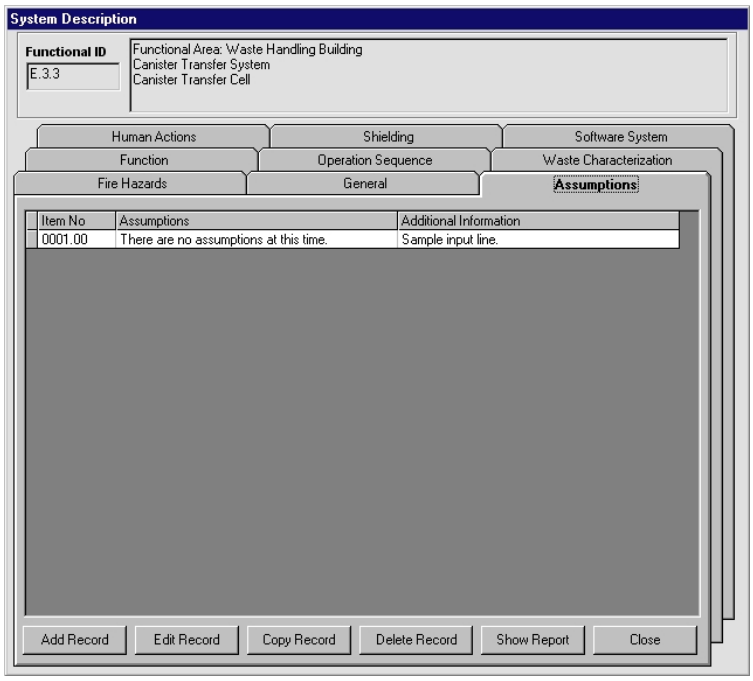


Figure 3.5.1-9. Assumptions Input Folder Tab

3.5.2 Structures, Systems, and Components

The **Structures, Systems, and Components Data** window, is opened in the PCSA Tool by clicking on the *Structures Systems and Components* submenu item under the ***System*** menu. The **Structures, Systems, and Components Data** window, shown in Figures 3.5.2-1 and 3.5.2-2, can be used only when a functional area is selected from the ***Proj. Tree*** menu. The **Structures, Systems, and Components Data** window provides two input folder tabs.

The following **Action Commands** correspond to Figures 3.5.2-1 and 3.5.2-2.

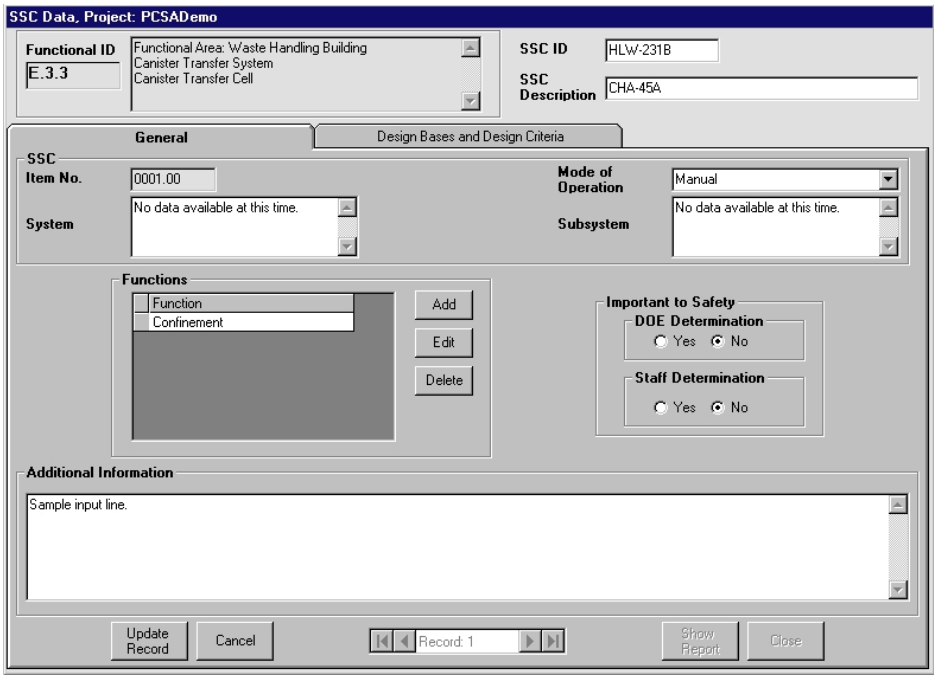


Figure 3.5.2-1. Structures, Systems, and Components General Input Folder Tab

Action Commands

Add Record: Allows the user to add information in the current window. May also activate a dialog box to allow the user to add information.

Edit Record: Allows the user to change information in the current window. May also activate a dialog box to allow the user to change information.

Delete Record: Allows the user to delete the current record.

Copy Record: Allows the user to make a new record by copying an existing record.

Add: Activates a specific dialog box and allows the user to add information.

Edit: Activates a specific dialog box and allows the user to change information.

Delete: Allows the user to delete information.

Update: Accepts the user's changes. Activated after **Add Record** or **Edit Record** is selected.

Apply: Applies the user's changes to the current record.

Cancel: Disregards changes made to the current record.

Show Report: Displays the information in the current window in report format.

Close: Closes the **Structures, Systems, and Components Data** window.

3.5.2.1 *General*

Structures, Systems, and Components ID: Enter an identification for the current Structure, System, or Component.

Structures, Systems, and Components Description: Enter a description for the current structures, systems, and components.

Item No: An item number is automatically assigned to the current record.

System: Enter a description for the system.

Mode of Operation: Enter a mode of operation or select one from the drop-down menu.

Subsystem: Enter subsystem information pertaining to the structures, systems, and components.

Functions: An structures, systems, and components ID must be entered before "Functions" can be selected from the drop-down menu. The user may add a function or select from those provided in the drop-down menu.

DOE Determination: Select "Yes" or "No" to denote whether or not DOE identified the structures, systems, and components as important to safety.

Staff Determination: Select "Yes" or "No" to denote whether or not the staff identified the structures, systems, and components as important to safety.

Additional Information: Enter any additional information.

3.5.2.2 *Design Bases and Design Criteria*

Design Bases and Design Criteria: Enter multiple design bases and design criteria. An item number is automatically assigned. In addition, a design review comment and additional information may be entered to characterize the design bases or design criteria.

Functions: Add a function description to the current design basis or design criteria if applicable.

Hazards: Associate hazards with the current design basis or design criteria if applicable.

Initiating Events: Associate an initiating event with the current design basis or design criteria if applicable.

Event Tree: Associate an event tree (event scenario) with the current design basis or design criteria if applicable.

3.6 *Int. Events*

The Internal Events (***Int. Events***) menu is located in the main menu bar of the PCSA Tool (see Figure 3.2-1). *FMEA*, *What If*, *Energy Method*, *HRA,* and *Severe Events (All)* are submenus of the ***Int. Events*** menu.

3.6.1 *FMEA*

Under the ***Int. Events*** menu, the Failure Modes and Effects Analysis (*FMEA*) is a submenu that leads to the *Form* and *Severe Events* submenus. When the *Form* submenu is selected, the tool launches an **FMEA Form** window. Text fields for data entry and action commands in the **FMEA Form** are shown in Figure 3.6.1-1. At the top, the form also displays information related to the functional area being analyzed. The **FMEA Form** fills only one row of a record in an **FMEA Table** window. There is no restriction for the amount of information that can be stored in each text field. The **FMEA Table** is accessed from the **FMEA Form** by selecting the FMEA Table button. The FMEA Table displays data in tabular format. Rows can be inserted between records by incrementing item numbers in decimals. For example, to insert a row between row 3 and 4, the item number may be specified as 3.6. Additional edit features (Copy, Edit, Paste) can be accessed by right clicking on the mouse. The **FMEA Table** is displayed in Figure 3.6.1-2. The data can be entered in the **FMEA Form** or **FMEA Table**, and the user can use both forms interchangeably. The descriptions of individual data entry fields shown in Figure 3.6.1-1 are presented next.

Functional ID: Displays the identification number of the functional area along with the description of the functional area selected from the Project Tree.

Item No: An item number is automatically assigned to the current record.

Component Description: Enter the components of the system or process being analyzed.

Failure Mode: Describe briefly the type of failure associated with the component. A list of failure modes for limited number of components can be obtained from the ***Checklist*** menu.

Cause of Failure: Describe the reason for failure.

Effect of Failure: Describe the effect of the failure.

Preventative and Mitigative Features: Describe safeguards and controls, if any, against the type of failure.

Additional Information: Enter additional information.

Severe Events: Select “Yes” or “No” and enter justification for selection. Each potential failure that may result in a radioactive dose to the public or workers is judged according to severity on a qualitative basis, and entered as “Yes” or “No” in the Severe Event field.

Justification: Enter the rationale for selecting the “Yes” or the “No” button. If the decision is based on certain calculations, the user can record this in the Justification box.

Effect on Other Functional Areas: Select "Yes" or "No" and enter an explanation for the selection.

Explanation: Enter an explanation for selecting the "Yes" or the "No" button.

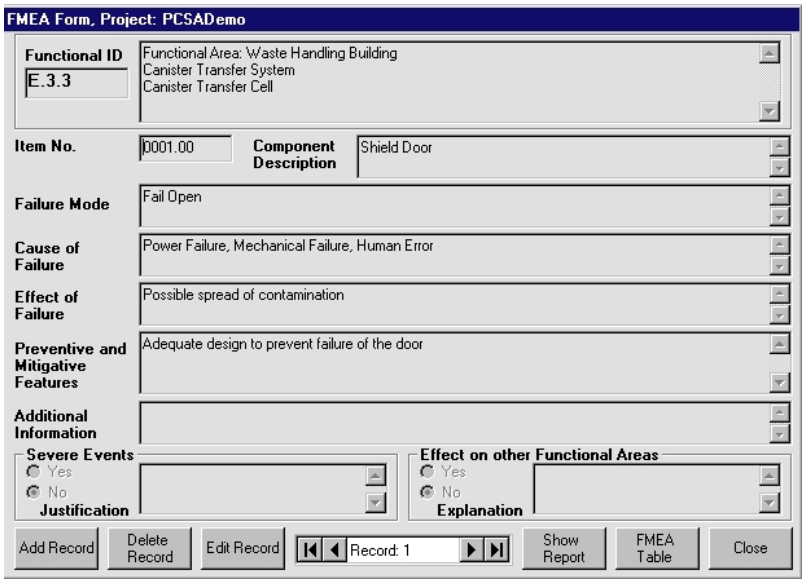
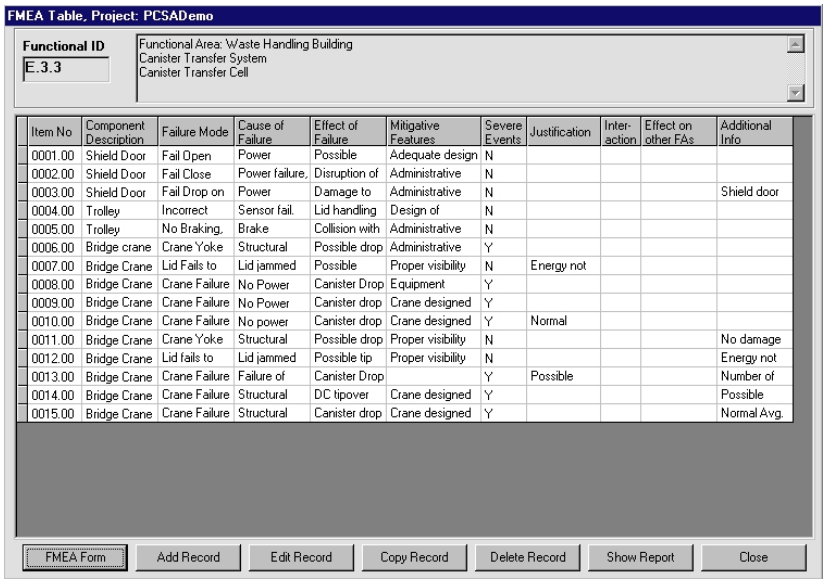


Figure 3.6.1-1. Example of Failure Modes and Effects Analysis (FMEA) Form



Item No	Component Description	Failure Mode	Cause of Failure	Effect of Failure	Mitigative Features	Severe Events	Justification	Inter-action	Effect on other FAs	Additional Info
0001.00	Shield Door	Fail Open	Power	Possible	Adequate design	N				
0002.00	Shield Door	Fail Close	Power failure,	Disruption of	Administrative	N				
0003.00	Shield Door	Fail Drop on	Power	Damage to	Administrative	N				Shield door
0004.00	Trolley	Incorrect	Sensor fail.	Lid handling	Design of	N				
0005.00	Trolley	No Braking,	Brake	Collision with	Administrative	N				
0006.00	Bridge crane	Crane Yoke	Structural	Possible drop	Administrative	Y				
0007.00	Bridge Crane	Lid Fails to	Lid jammed	Possible	Proper visibility	N	Energy not			
0008.00	Bridge Crane	Crane Failure	No Power	Canister Drop	Equipment	Y				
0009.00	Bridge Crane	Crane Failure	No Power	Canister drop	Crane designed	Y				
0010.00	Bridge Crane	Crane Failure	No power	Canister drop	Crane designed	Y	Normal			
0011.00	Bridge Crane	Crane Yoke	Structural	Possible drop	Proper visibility	N				No damage
0012.00	Bridge Crane	Lid fails to	Lid jammed	Possible tip	Proper visibility	N				Energy not
0013.00	Bridge Crane	Crane Failure	Failure of	Canister Drop		Y	Possible			Number of
0014.00	Bridge Crane	Crane Failure	Structural	DC tipover	Crane designed	Y				Possible
0015.00	Bridge Crane	Crane Failure	Structural	Canister drop	Crane designed	Y				Normal Avg.

Figure 3.6.1-2. Example of Failure Modes and Effects Analysis Table

Action Commands (Figures 3.6.1-1 and 3.6.1-2)

Add Record:	Activates the text boxes and allows the user to add a record (Form). Activates a new record by inputting a row (Table).
Delete Record:	Deletes the record currently displayed in the **FMEA Form** and the row that is currently selected in the **FMEA Table**. The user will be prompted "Are you sure you want to delete record?" after **Delete Record** is selected (Form/Table).
Edit Record:	Allows the user to modify any data entry fields (Form). Allows the user to modify a selected cell (Table).
Show Report:	Displays the information in a report format (Form/Table).
FMEA Form/ FMEA Table:	Allows the user to toggle between **FMEA Form** and **FMEA Table** windows.
Close:	Returns to the main project screen after saving changes made. However, **Close** does not save changes to the project database. To save changes to the database, the user must save the information through the ***File*** menu → *Save* submenu (Form/Table).
Cancel:	Returns the user to the default form display screen without saving the information (FMEA Form/Table). The **Cancel** option is displayed only after **Add Record** or **Edit Record** is selected.
Update Record:	Applies and saves any new information or changes made with the **Add Record** and **Edit Record** commands (FMEA Form). The Update Record option appears only after **Add Record** or **Edit Record** is selected.
Copy Record:	Copies the information of the entire row into another row (Table).

3.6.1.1 *Severe Events*

When the *Severe Events* option is selected from the *FMEA* submenu, the **Severe Events List** for '**FMEA**' window is displayed containing the events filtered by "Yes" in the Severe Events field in the **FMEA Table** window. As shown in Figure 3.6.1-3, the table also displays Failure Mode, Cause of Failure, Effect of Failure, Mitigative Features, and Justification from the **FMEA Table** window, and Remarks. The user can enter any additional information in the Remarks column. It is recommended that the user note whether this hazard was included or excluded based on further action taken in this analysis. The tool also generates a report from the severe events list.

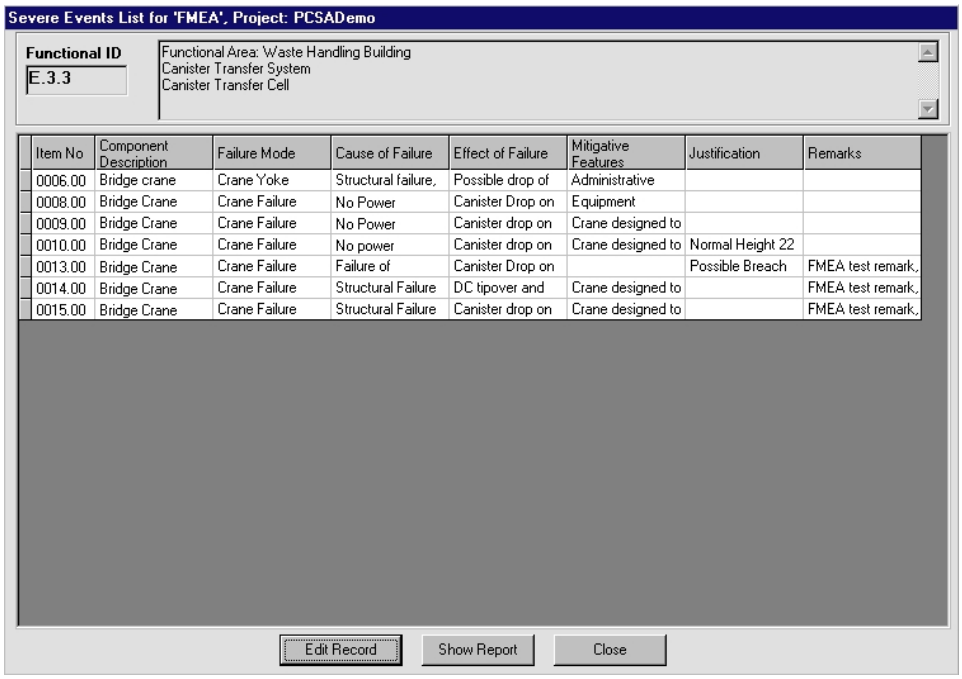


Figure 3.6.1-3. Severe Events List Window

Action Commands

Edit Record: Allows the user to edit only the Remarks field.

Show Report: Generates a report on ***Severe Events*** for display and printing.

Close: Closes the window, accepting any changes made to the Remarks field.

3.6.2 *What If*

The tool functions for a *What-If* analysis are similar to the *FMEA*. The analysis is performed by entering data into the database through a **What If Form** or **What If Table**. A *What-If* analysis would identify potential initiating events from human interactions. A similar process, *What-If*, is used to filter the severe events. An example of a *What-If* analysis applied to the offsite transportation system in Functional Area B.1 is presented in Figure 3.6.2-1. The descriptions of individual data entry fields shown in Figure 3.6.2-1 are presented next.

Functional ID: Displays identification number of the functional area along with the description of the functional area selected from the Project Tree.

Item No.: An item or serial number is automatically assigned to that current record.

What If: Identify possible event by posing questions with regard to each operation sequence (e.g., What if a specific component failure or process upset or human error occurs?).

Causes: Identify the cause(s) of such an event.

Consequences: Speculate on potential consequences to the event.

Preventative and Mitigative Features: Identify any safeguard(s) to mitigate the event.

Additional Information: Store additional information.

Severe Events: Select “Yes” or “No” with justification for selection. Each potential failure that may result in a radioactive dose to the public or workers is judged according to severity on a qualitative basis and entered as “Yes” or “No” in the Severe Events field.

Justification: Enter the rationale for selecting the “Yes” or the “No” button. If the decision is based on certain calculations, the user can record this in the Justification box.

Effect on Other Functional Areas: Select “Yes” or “No” and enter an explanation for the selection.

Explanation: Enter an explanation for selecting the “Yes” or the “No” button.

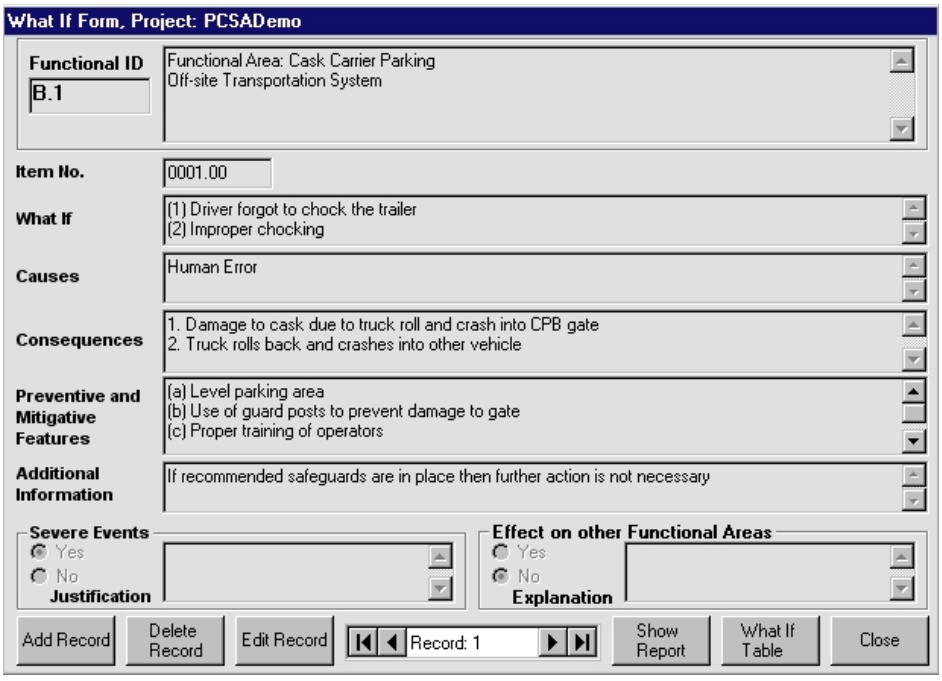


Figure 3.6.2-1. Example of a What-If Analysis Form Window

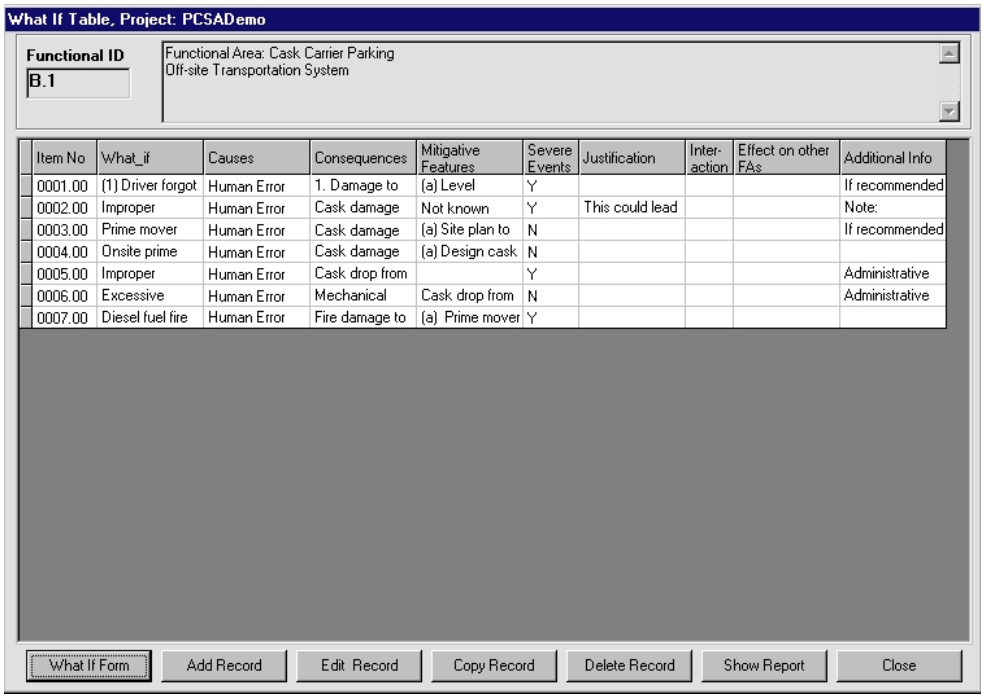


Figure 3.6.2-2. Example of a What-If Analysis Table Window

Action Commands (Figures 3.6.2-1 and 3.6.2-2)

Add Record:	Activates the text boxes and allows the user to add a record (Form). Activates a new record by inputting a row (Table).
Delete Record:	Deletes the record currently displayed in the **What If Form** and the row that is currently selected in the **What If Table**. The user will be prompted "Are you sure you want to delete record?" after **Delete Record** is selected (Form or Table).
Edit Record:	Allows the user to modify any data entry fields (Form). Allows the user to modify a selected cell (Table).
Show Report:	Displays the information in a report format (Form and Table).
What If Form/ What If Table:	Allows the user to toggle between **What If Form** and **What If Table** windows.
Close:	Returns to the main project screen after saving changes made. However, **Close** does not save changes to the project database. To save changes in the database, the user must save the information through the ***File*** menu → *Save* submenu (Form or Table).
Cancel:	Returns the user to the default form display screen without saving the information (Form or Table). The **Cancel** option is displayed only after **Add Record** or **Edit Record** is selected.
Update Record:	Applies and saves any new information or changes made with the **Add Record** and **Edit Record** commands (Form). The Update Record option appears only after **Add Record** or **Edit Record** is selected.
Copy Record:	Copies the information of the entire row into another row (Table).

3.6.2.1 *Severe Events*

When the *Severe Events* option is selected from the *What-If* submenu, a table screen is displayed that contains the events filtered by "Yes" in the Severe Events field in the **What-If Table**.

3.6.3 *Energy Method*

Located under the ***Int. Events*** menu in the main menu bar, the *Energy Method* (Figure 3.6.3-1) is initiated by selecting the *Form* option. The **Energy Method Form** allows the user to employ checklists to identify the hazards in the system. The **Energy Method Table** is accessed within the **Energy Analysis Form**. Adopting the DOE approach (CRWMS M&O, 1999), the events have been categorized as collision/crushing, chemical contamination/flooding,

explosion/implosion, fire, radiation/magnetic/electrical/fissile, and thermal. When a category is selected from the drop-down list in the form, the checklist and the applicability guidelines appear. The checklist helps identify the energy in the system that can potentially interact with the waste form. The checklists, developed by DOE, contain a series of questions for each generic hazard. The descriptions of individual data entry fields shown in Figure 3.6.3-1 are presented next.

Functional ID: Displays the identification number of the functional area along with the description of the functional area selected from the Project Tree.

Event Category: Choose an event category from the drop-down list.

Generic Event and Applicability Guidelines: Displays the checklist to identify potential hazards applicable to the event category. This text field cannot be edited.

Item No.: An item number is automatically assigned to the current record.

Event Name: Provide a brief description of the event.

Cause of Event: Describe the cause of the event.

Preventative and Mitigative Features: Describe safeguards and controls, if any, against the type of failure.

Additional Information: Enter additional information.

Severe Events: Select “Yes” or “No” with justification for selection. Each potential failure that may result in a radioactive dose to the public or workers is judged according to severity on a qualitative basis and entered as “Yes” or “No” in the Severe Events field.

Justification: Enter the rationale for selecting the “Yes” or the “No” button. If the decision is based on certain calculations, the user can record this in the Justification box.

Effect on Other Functional Areas: Select “Yes” or “No” and enter an explanation for the selection.

Explanation: Enter an explanation for selecting the “Yes” or the “No” button.

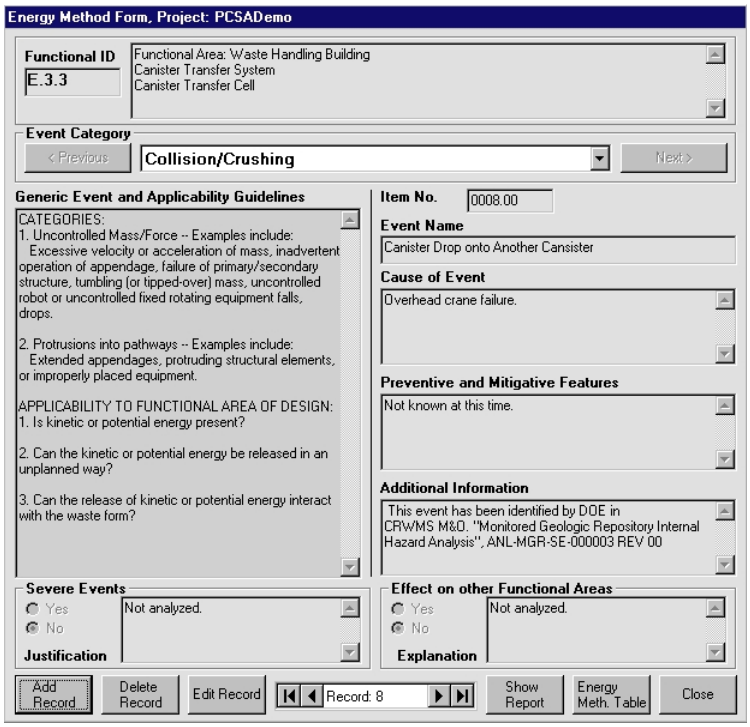


Figure 3.6.3-1. Example of an Energy Method Form Window

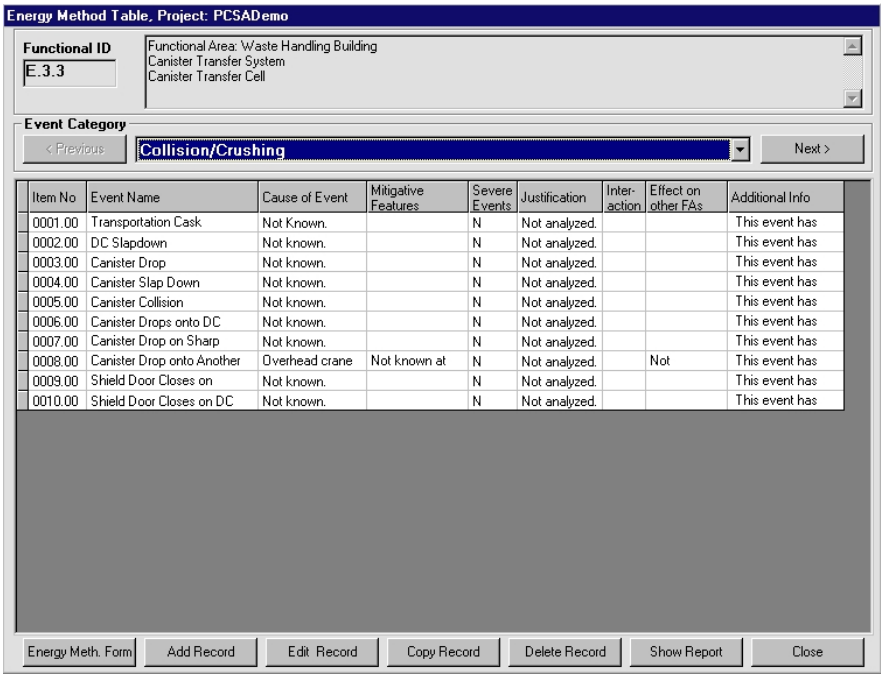


Figure 3.6.3-2. Example of an Energy Method Table Window

Action Commands (Figures 3.6.3-1 and 3.6.3-2)

Add Record:	Activates the text boxes and allows the user to add a record (Form). Activates a new record by inputting a row (Table).
Delete Record:	Deletes the record currently displayed in the **Energy Method Form** and the row currently selected in the **Energy Method Table**. The user will be prompted "Are you sure you want to delete record?" after **Delete Record** is selected (Form or Table).
Edit Record:	Allows the user to modify any data entry fields (Form). Allows the user to modify a selected cell (Table).
Show Report:	Displays the information in a report format (Form/Table).
Energy Meth. Form/ Energy Meth. Table:	Allows the user to toggle between **Energy Meth. Form** and **Energy Meth. Table** windows.
Close:	Returns to the main project screen after saving the changes. However, **Close** does not save changes to the project database. To save changes in the database, the user must save the information through the ***File*** menu → *Save* submenu (Form/Table).
Cancel:	Returns the user to the default form display screen without saving the information (Form/Table). The **Cancel** option is displayed only after **Add Record** or **Edit Record** is selected.
Update Record:	Applies and saves any new information or changes made with the **Add Record** and **Edit Record** commands (Form). The Update Record option appears only after **Add Record** or **Edit Record** is selected.
Copy Record:	Copies the information of the entire row into another row (Table).

3.6.3.1 *Severe Events*

When the *Severe Events* option is selected from the *Energy Method* submenu, a window is displayed containing the events filtered by "Yes" in the Severe Events field in the **Energy Method Table**.

3.6.4 *HRA*

The Human Reliability Analysis (*HRA*) feature can only be used when a functional area is selected from the ***Proj. Tree*** menu. The *HRA* submenu is selected from the ***Int. Events*** menu in the main menu bar of the PCSA Tool. *Form* and *Severe Events* are options of the *HRA* submenu.

The *Form* option launches the **Human Reliability Analysis Form** window (Figure 3.6.4-1). The **Human Reliability Analysis Table**, which shows the same information arranged in a tabular fashion, is accessed within the **Human Reliability Analysis Form**. The data can be entered using *Form* or *Table*, and the user can use both forms interchangeably. The descriptions of individual data entry fields shown in Figure 3.6.4-1 are presented next. More information about the data entry fields can be obtained from Dasgupta, et al. (2002).

Functional ID: Displays the identification number of the functional area along with the description of the functional area selected from the Project Tree.

Item No.: An item number is automatically assigned to the current record.

Category: Indicate the appropriate human action category. The main categories are: Type A—Maintenance and Standby Human Events, Type B—Operational Human Events (two subcategories), Type C—Responsive Human Events (three subcategories).

Human Action: Enter one of the Human Actions now listed in the System Description template. It is a description of the human action that may lead to error.

Human Failure Event: Enter the types of errors possible for a single human action. For example, a task might be omitted, a valve might be turned in the wrong direction, or a valve might be turned too far in the correct direction.

Performance Shaping Factors: Indicate any performance shaping factors that would influence the human error probability (e.g., training, stress level, use/no use of checklist, repetitiveness of action).

Recovery Action: Indicate what actions could be taken to recover from the error. For example, a supervisor checking after maintenance might discover and correct an inappropriately closed valve.

Effect of Failure: Enter the effect of the failure for Type A Human Actions, the effect of failures is always enabling of another initiating event; for Type B Human Actions, the effect of failures could be enabling, but is more likely to produce an initiating event itself. For example, actions during maintenance could close a valve that permits makeup water to be pumped into the assembly storage pool; a leak from the pool develops because of a mechanical failure, makeup water would not be available and the assemblies could become uncovered in time.

Preventative and Mitigative Features: Enter features that could prevent or irritigate an event. Features could be either human-action oriented (e.g., use a checklist or provide written instructions) or hardware oriented (e.g., use interlocks or stops to prevent incorrect assembly or excessive travel).

Additional Information: Enter additional information.

Severe Events: Indicate if the event is severe by selecting the “Yes” or “No” radio button.

Justification: Provide a justification for either choice.

Effect on Other Functional Areas: Select "Yes" or "No."

Explanation: Enter an explanation for selecting the "Yes" or the "No" button.

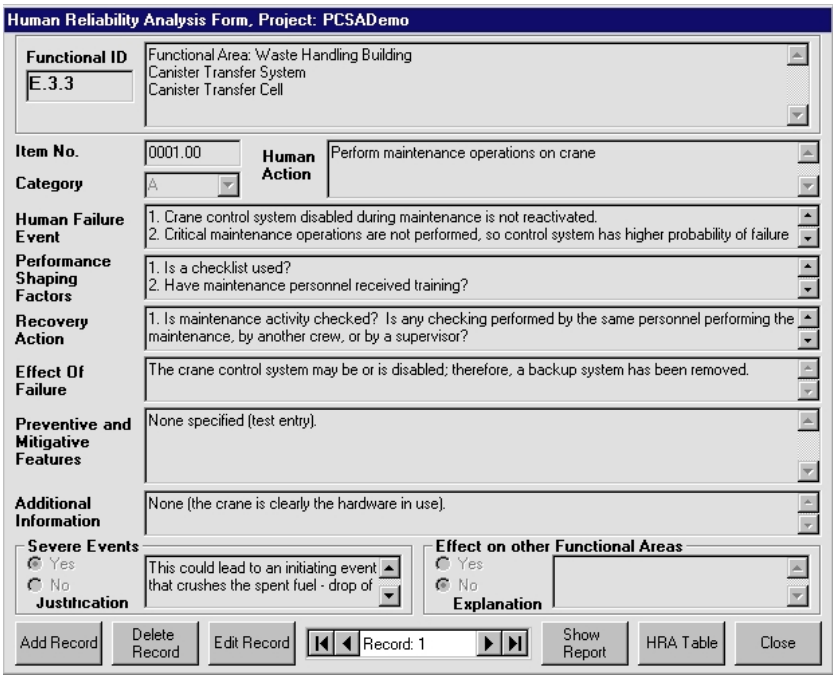


Figure 3.6.4-1. Example of a Human Reliability Analysis Form Window

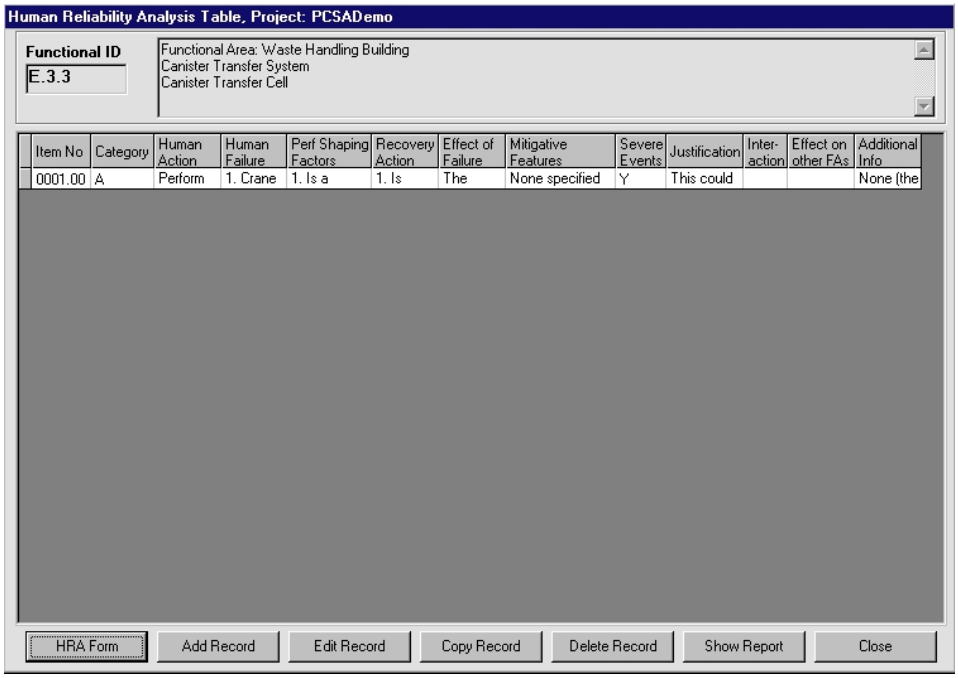


Figure 3.6.4-2. Example of a Human Reliability Analysis Table Window

Action Commands (Figures 3.6.4-1 and 3.6.4-2)

Add Record: Activates the text boxes and allows the user to add a record (Form). Activates a new record by inputting a row (Table).

Delete Record: Deletes the record currently displayed in the **HRA Form** and the row that is currently selected in the **HRA Table**. The user will be prompted "Are you sure you want to delete record?" after **Delete Record** is selected (Form/Table).

Edit Record: Allows the user to modify any data entry fields (Form). Allows the user to modify a selected cell (Table).

Show Report: Displays the information in a report format (Form/Table).

HRA Form/ HRA Table: Allows the user to toggle between **HRA Form** and **HRA Table** windows.

Close:	Returns to the main project screen after saving changes made. However, **Close** does not save changes to the project database. To save changes in the database, the user must save the information from ***File*** menu → *Save* submenu (Form/Table).
Cancel:	Returns the user to the default form display screen without saving the information (Form/Table). The **Cancel** option is displayed only after **Add Record** or **Edit Record** is selected.
Update Record:	Applies and saves any new information or changes made with the **Add Record** and **Edit Record** commands (Form). The **Update Record** option appears only after **Add Record** or **Edit Record** is selected.
Copy Record:	Copies the information of the entire row into another row (Table).

3.6.4.1 *Severe Events*

When the *Severe Events* option is selected from the *HRA* submenu, a table form window is displayed containing the events filtered by "Yes" in the Severe Events field in the **Human Reliability Analysis Form** or **Human Reliability Analysis Table** window. The window displays Category, Human action, Performance Shaping Factors, Recovery Action, Effect of Failure, DOE Safeguards and Controls, Justification from the **Human Reliability Analysis Form** or Table, and Remarks. There is an **Edit Record** button that allows editing only in the Remark column to record additional information. The PCSA tool also generates a report on the severe events list using the **Show Report** button.

3.7 Freq. Analysis

This menu has four submenus *Initiating Event*, *Event Tree*, *Fault Tree*, and *Event Sequence*.

3.7.1 *Initiating Event*

The *Initiating Event* submenu is located in the ***Freq. Analysis*** menu in the main menu bar. The *Initiating Event* submenu can be used only when a functional area has been selected from the ***Proj. Tree*** menu. The information can be input into the **Initiating Event Form** or **Table** using the Action Commands. The **Initiating Event Table** is accessed within the **Initiating Event Form**. The **Initiating Event Form** and **Initiating Event Table** windows are shown in Figures 3.7.1-1 and 3.7.1-2. The description of individual data entry fields shown in Figures 3.7.1-1 and 3.7.1-2 are presented next.

Functional ID: Displays the identification number of the functional area along with the description of the functional area selected from the Project Tree.

Item No.: An item number automatically assigned to the current record.

Event ID: Enter an identification number for each initiating event. The tool will not allow entry of additional data in this window without an identification number. The identification number provides a link to event scenarios and sequences and all other subsequent analyses conducted in the tool.

Hazard ID: Select the Hazard ID from the **Select Hazard ID** Form that opens when the user selects the **Edit Hazard ID** button. The user has the option to select from External Events or Severe Internal Events.

Manual Data: Check this box to allow the user to manually enter doses for event sequences associated with this initiating event.

Description: Provide a short description and nature of initiating event, whether operational or natural, or human induced.

Frequency: Enter frequency of the initiating event.

Preclosure Period (yr): Assign preclosure period associated with each initiating event. User can use the drop-down list to select the preclosure period or type it in.

Operation Period (yr): Assign operational period associated with each initiating event. User can use the drop-down list to select the operational period or type it in.

Category: The tool will automatically input the frequency category of the initiating event based on the frequency category limits defined in 10 CFR Part 63 once frequency is provided.

Uncertainty: Enter information on uncertainty in estimating the frequency of initiating event if the "Yes" radio button is selected.

Frequency Calculation Details: Record detailed information on the frequency estimation, including all calculations, in this field. When the frequency calculator is used, the numbers used in calculating frequency are automatically transferred into this field.

Event Included for Sequence Analysis: Enter the decision to exclude or include initiating events from the hazards list in preclosure safety analysis for determining event sequences using the "Yes" or "No" radio button.

Justification: Record the reason for inclusion or exclusion of initiating events for further preclosure safety analysis to include identifying Structures, Systems, and Components Design Bases or Design Criteria that preclude its inclusion.

Additional Information: Provide comments, remarks, references to reports, and literature citations.

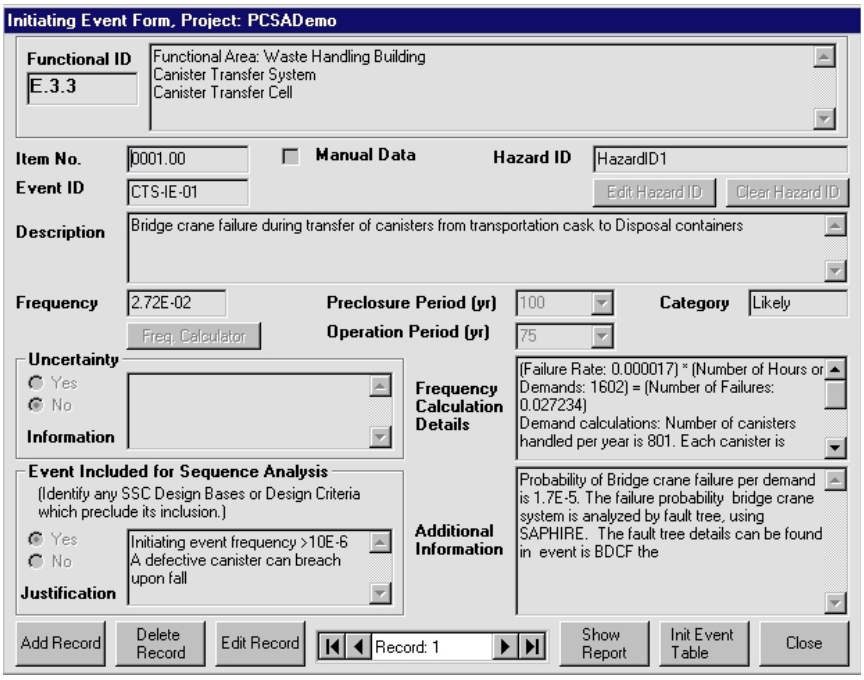


Figure 3.7.1-1. Initiating Event Form

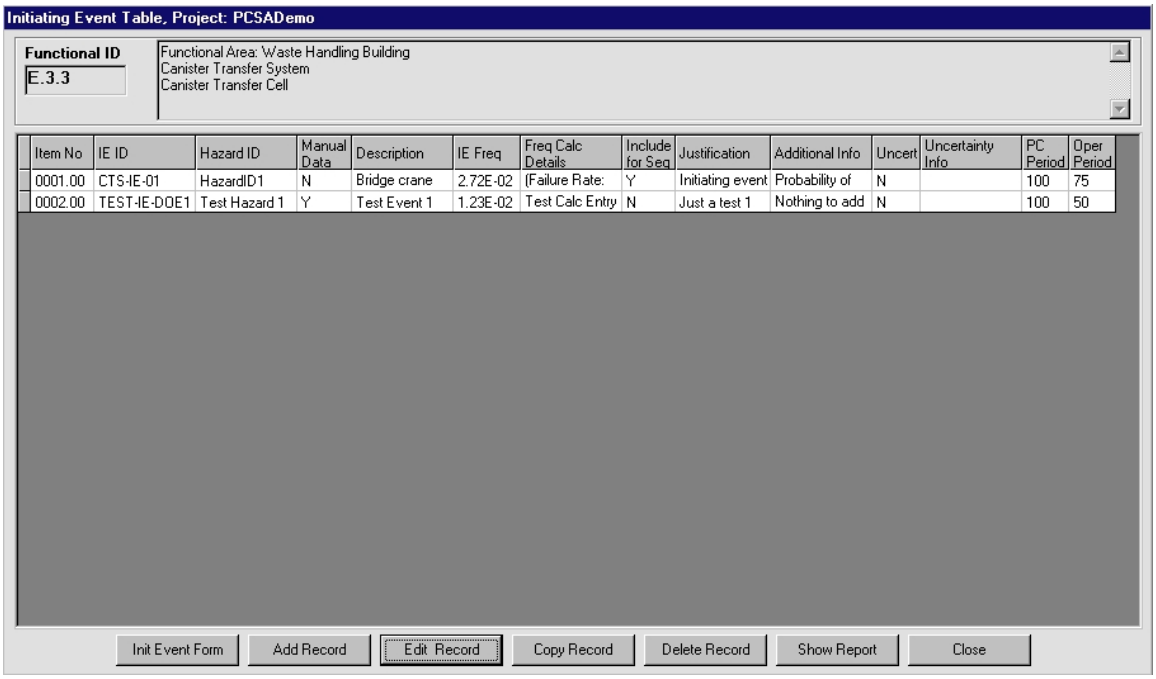


Figure 3.7.1-2. Initiating Event Table

Action Commands (Figures 3.7.1-1 and 3.7.1-2)

Add Record: Activates the text box and allows the user to add a record (Form). Activates a new record by inputting a row (Table).

Delete Record: Deletes the record currently displayed in the **Init. Event Form** and the row that is currently selected in the **Init. Event Table**. The user will be prompted "Are you sure you want to delete record?" after **Delete Record** is selected (Form/Table).

Edit Record: Allows the user to modify any data entry fields (Form). Allows the user to modify a selected cell (Table).

Show Report: Displays the information in a report format (Form/Table).

Init. Event Form/ Init. Event Table: Allows the user to toggle between **Init. Event Form** and **Init. Event Table** windows.

Close: Returns to the main project screen after saving changes made. However, **Close** does not save changes to the project database. To save changes in the database, the user must save the information from ***File*** menu → *Save* submenu (Form/Table).

Cancel: Returns the user to the default form display screen without saving the information (Form/Table). The **Cancel** option is displayed only after **Add Record** or **Edit Record** is selected.

Update Record: Applies and saves any new information or changes made with the **Add Record** and **Edit Record** commands (Form). The Update Record option appears only after **Add Record** or **Edit Record** is selected.

Copy Record: Copies the information of the entire row into another row (Table).

Freq. Calculator: Displays the **Frequency Calculation** window to calculate expected frequency of failure when failure rate and number of operating hours or demands are entered. The information is automatically recorded in this Frequency Calculation Details field (Form).

3.7.2 *Event Tree*

Event scenarios are created in the PCSA Tool to serve as inputs for the event tree diagrams to be modeled and analyzed using the SAPHIRE Version 6.80 code. To develop an event scenario, the user selects the ***Freq. Analysis*** menu in the main menu bar and the *Event Tree* submenu. The event scenarios are developed using the **Event Tree Form**, which contains the Event Scenario tab and Subsequent Events tab. The user develops an event scenario based on the initiating event and postulated sequence of events. The user assigns a unique alphanumeric identification for the scenario in the Scenario ID field and provides the appropriate data entry information. In addition, the **Event Tree Form** includes a "Yes" or "No" radio buttons for the user to select if the postulated event scenario will be used in performance analysis later. By default, all event scenarios are included for performance analysis. Those not required for performance analysis can be deselected. The user, however, can make the choice at any time and is not required to decide while developing the event scenario.

3.7.2.1 *Event Scenario*

This section presents the input parameters for the **Event Scenario** tab shown in Figure 3.7.2-1.

Functional ID: Displays the identification number for the functional area along with a description for the functional area selected from the Project Tree.

Event Scenario Section: To access the text fields in the Event Scenario section, the user must select one of the buttons, **Add Scenario**, **Delete Scenario**, or **Edit Record**, at the bottom of the form.

Item No.: An item number is automatically assigned to the current record.

Scenario ID: Provides alphanumeric identification for the scenario. The tool will not allow entry of additional data without a scenario identification number. The identification number provides a link to initiating events and event sequences and all other subsequent analyses conducted in the tool.

Include for Perform. Analysis: Select or deselect to choose whether or not the event scenario will be included for performance analysis (e.g., safety assessment or risk assessment).

Material at Risk: Enter a description for the waste material that takes part in the scenario.

Event Scenario Description: Provide a short description and nature of the scenario.

Additional Information: Provide comments, remarks, and references to reports. Literature citations may be recorded here.

Saphire Data Path: Provide location of the SAPHIRE data for the Event Tree Analysis.

Initiating Event Section: The user must choose an initiating event ID. The remaining fields in this section are populated based on the user's selection. The data fields: Frequency, Uncertainty, Manual Data, and Description in the Initiating Event section of the **Event Tree Form** are displayed from previous input (see Section 3.7.1) and may not be changed on the current screen. To change any data entry fields in the Initiating Event section, the user must exit the **Event Tree Form** and make the changes on the **Initiating Event Form** discussed in Section 3.7.1.

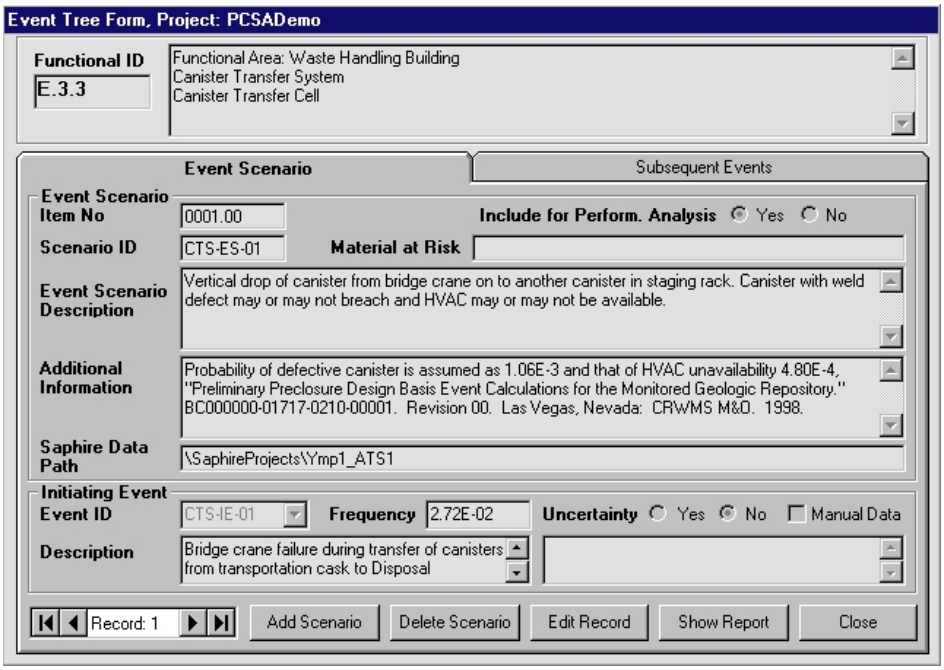


Figure 3.7.2-1. Event Tree Input Tab

Action Commands

Add Scenario:	Activates the text boxes in the Event Scenario section and allows the user to add a scenario.
Delete Scenario:	Deletes the scenario currently displayed in the form. The user will be prompted "Are you sure you want to delete scenario and all subsequent associated events?" after **Delete Scenario** is selected.
Edit Record:	Allows the user to modify previous information input into the Event Scenario section.
Show Report:	Displays information in report format.
Close:	Returns to the main project screen automatically saving any changes.
Update Record:	Applies and saves any changes made in the **Add Scenario** and **Edit Record** commands. The **Update Record** command is displayed only after **Add Scenario** or **Edit Record** is selected.
Cancel:	Returns the user to the **Event Tree Form** without saving any new input information. The **Cancel** command is displayed only after **Add Scenario** or **Edit Record** is selected.

3.7.2.2 *Subsequent Events*

This section presents the input parameters for the **Subsequent Events** tab shown in Figure 3.7.2-2.

Item No: An item or number of a subsequent event is automatically assigned.

Event ID: Assign an alphanumeric subsequent event identification. The same Event IDs that are used in the SAPHIRE event tree models should be used here.

Description: Provide a short description for the Subsequent Event.

Safety System or Structures, Systems, and Components: Select one of the previously entered structures, systems, and components.

Probability: Assign the probability of system/operations failure. The rationale for probability can be entered in the Additional Information field of the **Event Scenario** tab.

Uncertainty: Select "Yes" or "No." If "Yes" is selected, the user can input information concerning the uncertainty of the event.

Uncertainty Data: Enter the uncertainty information for the subsequent event.

Linking: Indicate if the probability of failure is linked to a fault tree in SAPHIRE.

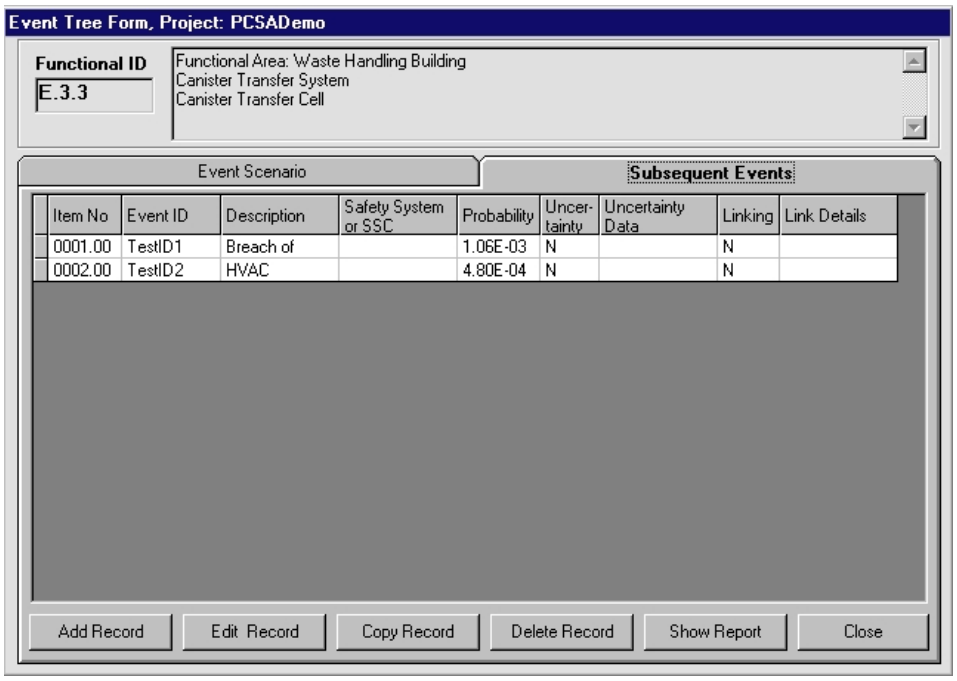


Figure 3.7.2-2. Subsequent Events Input Tab

Link Details: Enter details for linking the probability of failure to the fault tree.

Action Commands

Add Record:	Prompts the user to enter an ID and inserts a new row into the subsequent events folder.
Edit Record:	Allows the user to modify data within a selected cell.
Copy Record:	Prompts the user to enter an ID and copies the selected row and inserts the row into the **Subsequent Events** folder.
Delete Record:	Deletes the record currently selected in the form. The user will be prompted "Are you sure you want to delete (Item No.)?" after **Delete Record** is selected.
Show Report:	Displays the information in report format.
Close:	Returns to the main project screen, automatically saving any changes.

3.7.3 *Fault Tree*

The *Fault Tree* submenu can be accessed through the ***Freq. Analysis*** menu located in the main menu bar. The *Fault Tree* submenu opens the **Fault Tree Form** which allows users to generate data for fault tree analysis. The **Fault Tree Form**, as shown in Figure 3.7.3-1, allows data entry using the Action Commands. Within the **Fault Tree Form**, the user can view the fault tree data in tabular format, as shown in Figure 3.7.3-2, by clicking on the **Event Table** button. Descriptions for the individual data entry fields shown in Figure 3.7.3-1 are presented next.

Functional ID: Displays the identification number and a description of the functional area selected from the Project Tree.

Item No.: An item number is automatically assigned to the current record.

Probabilities: Enter the "Probabilities" or "Frequencies" of the top event derived by SAPHIRE analysis. The mean, median, and 5th- and 95th-percentile values of the top event from the uncertainty analysis can be entered. In addition, the point estimate value is stored in the Point Estimate field.

Top Event Name: Provide the Top Event name.

Top Event Description: Provide a brief description of the event.

Additional Information: Provide comments, remarks, references to reports. Literature citations should be recorded here.

Saphire Data Location: Enter the location of the SAPHIRE data for the fault tree analysis for the current form.

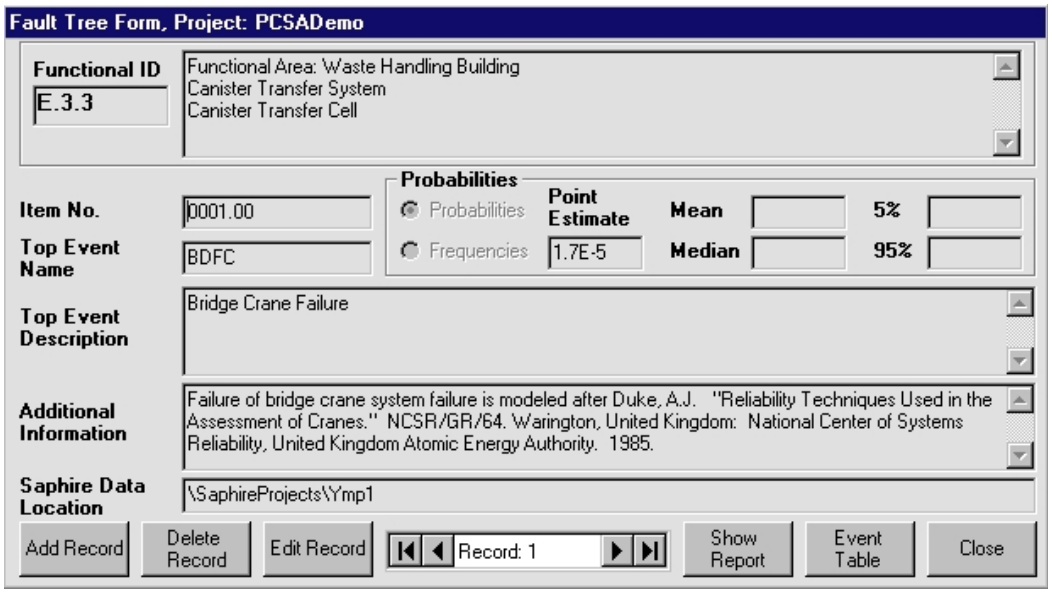
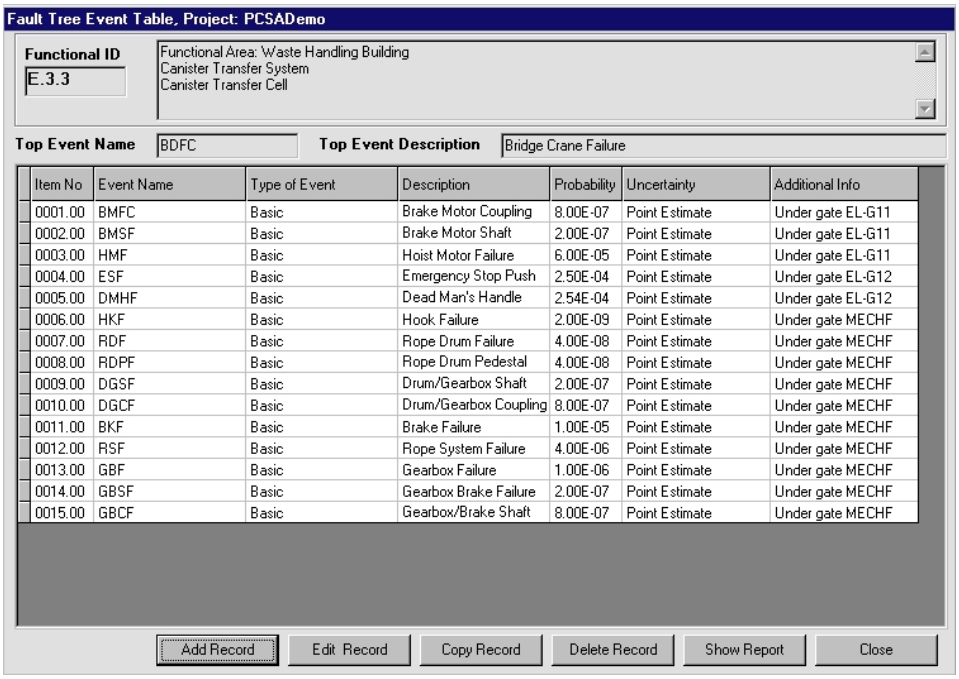


Figure 3.7.3-1. Fault Tree Form



Item No	Event Name	Type of Event	Description	Probability	Uncertainty	Additional Info
0001.00	BMFC	Basic	Brake Motor Coupling	8.00E-07	Point Estimate	Under gate EL-G11
0002.00	BMSF	Basic	Brake Motor Shaft	2.00E-07	Point Estimate	Under gate EL-G11
0003.00	HMF	Basic	Hoist Motor Failure	6.00E-05	Point Estimate	Under gate EL-G11
0004.00	ESF	Basic	Emergency Stop Push	2.50E-04	Point Estimate	Under gate EL-G12
0005.00	DMHF	Basic	Dead Man's Handle	2.54E-04	Point Estimate	Under gate EL-G12
0006.00	HKF	Basic	Hook Failure	2.00E-09	Point Estimate	Under gate MECHF
0007.00	RDF	Basic	Rope Drum Failure	4.00E-08	Point Estimate	Under gate MECHF
0008.00	RDPF	Basic	Rope Drum Pedestal	4.00E-08	Point Estimate	Under gate MECHF
0009.00	DGSF	Basic	Drum/Gearbox Shaft	2.00E-07	Point Estimate	Under gate MECHF
0010.00	DGCF	Basic	Drum/Gearbox Coupling	8.00E-07	Point Estimate	Under gate MECHF
0011.00	BKF	Basic	Brake Failure	1.00E-05	Point Estimate	Under gate MECHF
0012.00	RSF	Basic	Rope System Failure	4.00E-06	Point Estimate	Under gate MECHF
0013.00	GBF	Basic	Gearbox Failure	1.00E-06	Point Estimate	Under gate MECHF
0014.00	GBSF	Basic	Gearbox Brake Failure	2.00E-07	Point Estimate	Under gate MECHF
0015.00	GBCF	Basic	Gearbox/Brake Shaft	8.00E-07	Point Estimate	Under gate MECHF

Figure 3.7.3-2. Fault Tree Event Table

Action Commands (Figures 3.7.3-1 and 3.7.3-2)

Add Record: Activates the text box and allows the user to add a record (Form). Activates a new record by inputting a row (Table).

Delete Record: Deletes the record currently displayed in the **Fault Tree Form** and the row that is currently selected in the **Fault Tree Event Table**. The user will be prompted "Are you sure you want to delete record?" after **Delete Record** is selected (Form/Table).

Edit Record: Allows the user to modify any data entry fields (Form). Allows the user to modify a selected cell (Table).

Show Report: Displays the information in a report format (Form/Table).

Event Table: Allows the user to access the **Fault Tree Event Table** (Form).

Close: Returns to the main project screen after saving the changes. However, **Close** does not save changes to the project database. To save changes in the database, the user must save the information from ***File*** menu → *Save* submenu (Form). Returns the user to the **Fault Tree Form** (Table).

Cancel: Returns the user to the default form display screen without saving the information (Form/Table). The **Cancel** option is displayed only after **Add Record** or **Edit Record** is selected.

Update Record: Applies and saves any new information or changes made with the **Add Record** and **Edit Record** commands (Form). The **Update Record** option appears only after **Add Record** or **Edit Record** is selected.

Copy Record: Copies the information of the entire row into another row (Table).

3.7.4 *Event Sequence*

The *Event Sequence* submenu can be accessed from the ***Freq. Analysis*** menu located in the main toolbar. The **Event Sequence Form** guides the user when entering information into the database for event sequences. The user first selects the Scenario ID from the drop-down list, which shows a list of all the scenario ID, in the functional area. Upon selecting an event scenario, the details about an associated initiating event are displayed. The user can enter data in the data entry fields with the Action Commands. A unique event sequence identification should be provided using any combination of alphanumeric characters. Descriptions of the individual data entry fields shown in Figure 3.7.4-1 are presented next.

Functional ID: Displays the identification number and description of the functional area selected from the Project Tree.

Scenario ID: Select a Scenario ID from drop-down list.

Preclosure Period: Displays the preclosure period associated with the initiating event selected.

Event Scenario and Initiating Event Information section: Once the user selects a Scenario ID, this section displays the event scenario and initiating event information associated with the Scenario ID. Everything listed in the Event Scenario and Initiating Event Information section of the **Event Sequence Form** is displayed from previous input and may not be changed in the current screen.

Item No.: An item number is automatically assigned to the current record.

Event Sequence ID: Enter the identification number of the current event sequence. Tool will not allow the user to save information in this window without an Event Sequence ID.

Applicability of Event: Select “Worker Dose,” “Public Dose,” or “Both.”

Event Seq. Frequency: Enter event sequence frequency from the event tree analysis either based on a point estimate or uncertainty analysis (conducted using the SAPHIRE Version 6.70 code). If the SAPHIRE analysis is based on uncertainty analysis, the mean frequency should be entered.

Description: Provide a brief description of the current event sequence.

Category: Displays the Category (1, 2, or BCFL) of the event sequence.

Expected No. of Events: Displays the calculated expected number of events.

End State: Define the possible radioactive release scenarios qualitatively, for example, low, high, and moderate.

Additional Information: Provide comments, remarks, references to reports; literature citations should be recorded here.

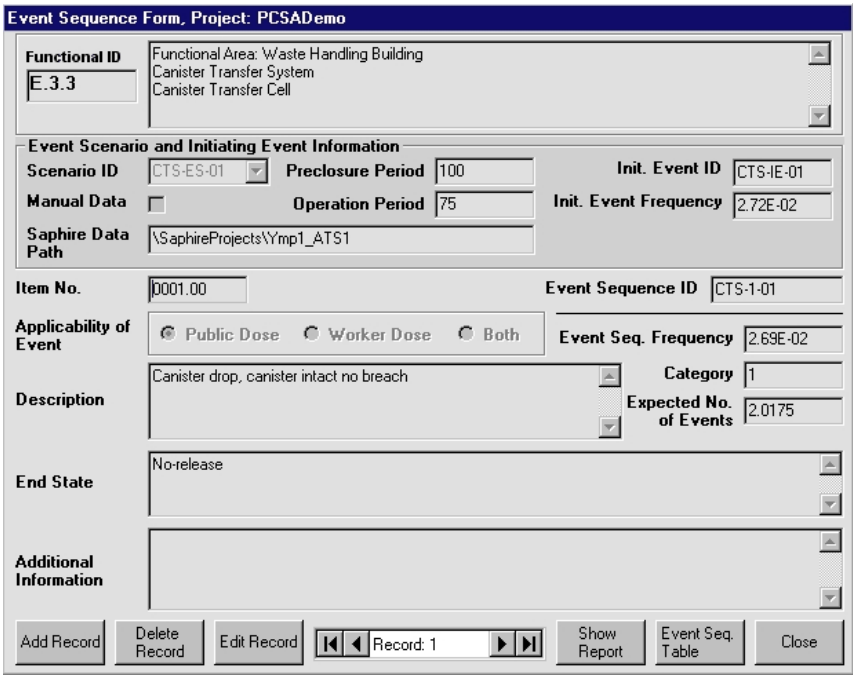
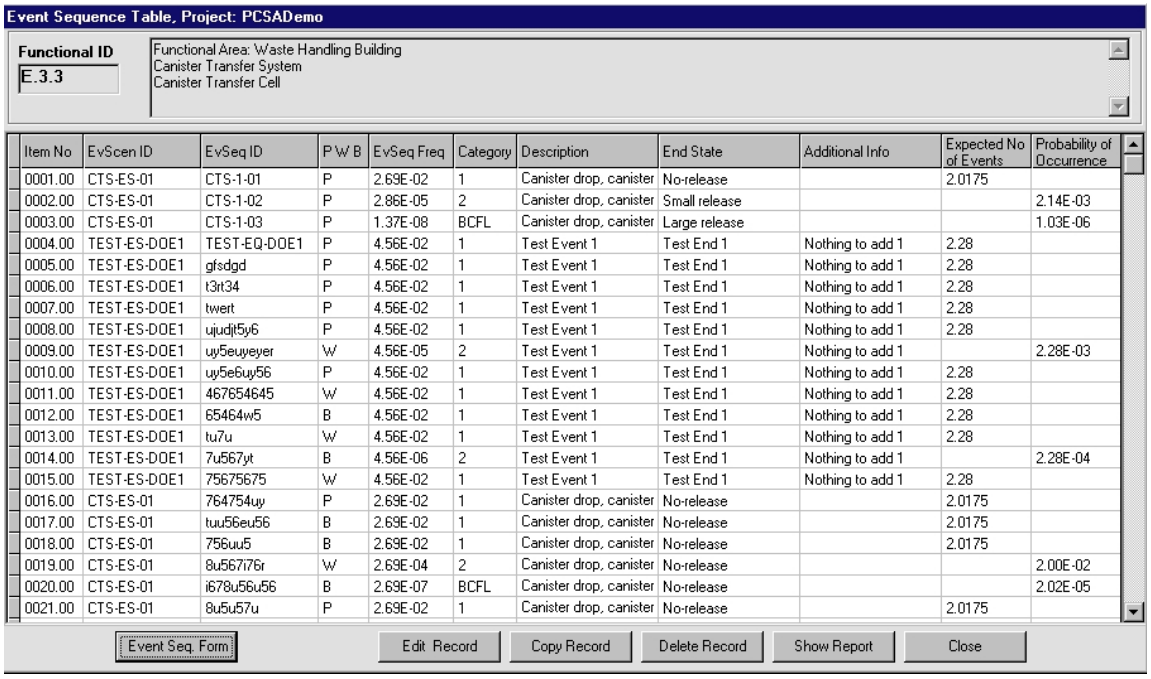


Figure 3.7.4-1. Event Sequence Form



Item No	EvScen ID	EvSeq ID	P W B	EvSeq Freq	Category	Description	End State	Additional Info	Expected No of Events	Probability of Occurrence
0001.00	CTS-ES-01	CTS-1-01	P	2.69E-02	1	Canister drop, canister	No-release		2.0175	
0002.00	CTS-ES-01	CTS-1-02	P	2.86E-05	2	Canister drop, canister	Small release			2.14E-03
0003.00	CTS-ES-01	CTS-1-03	P	1.37E-08	BCFL	Canister drop, canister	Large release			1.03E-06
0004.00	TEST-ES-DOE1	TEST-EQ-DOE1	P	4.56E-02	1	Test Event 1	Test End 1	Nothing to add 1	2.28	
0005.00	TEST-ES-DOE1	gfsdgd	P	4.56E-02	1	Test Event 1	Test End 1	Nothing to add 1	2.28	
0006.00	TEST-ES-DOE1	t3rt34	P	4.56E-02	1	Test Event 1	Test End 1	Nothing to add 1	2.28	
0007.00	TEST-ES-DOE1	twert	P	4.56E-02	1	Test Event 1	Test End 1	Nothing to add 1	2.28	
0008.00	TEST-ES-DOE1	ujudjt5y6	P	4.56E-02	1	Test Event 1	Test End 1	Nothing to add 1	2.28	
0009.00	TEST-ES-DOE1	uy5euyeyer	W	4.56E-05	2	Test Event 1	Test End 1	Nothing to add 1		2.28E-03
0010.00	TEST-ES-DOE1	uy5e6uy56	P	4.56E-02	1	Test Event 1	Test End 1	Nothing to add 1	2.28	
0011.00	TEST-ES-DOE1	467654645	W	4.56E-02	1	Test Event 1	Test End 1	Nothing to add 1	2.28	
0012.00	TEST-ES-DOE1	65464w5	B	4.56E-02	1	Test Event 1	Test End 1	Nothing to add 1	2.28	
0013.00	TEST-ES-DOE1	tu7u	W	4.56E-02	1	Test Event 1	Test End 1	Nothing to add 1	2.28	
0014.00	TEST-ES-DOE1	7u567yt	B	4.56E-06	2	Test Event 1	Test End 1	Nothing to add 1		2.28E-04
0015.00	TEST-ES-DOE1	75675675	W	4.56E-02	1	Test Event 1	Test End 1	Nothing to add 1	2.28	
0016.00	CTS-ES-01	764754uy	P	2.69E-02	1	Canister drop, canister	No-release		2.0175	
0017.00	CTS-ES-01	tuu56eu56	B	2.69E-02	1	Canister drop, canister	No-release		2.0175	
0018.00	CTS-ES-01	756uu5	B	2.69E-02	1	Canister drop, canister	No-release		2.0175	
0019.00	CTS-ES-01	8u567i76r	W	2.69E-04	2	Canister drop, canister	No-release			2.00E-02
0020.00	CTS-ES-01	i678u56u56	B	2.69E-07	BCFL	Canister drop, canister	No-release			2.02E-05
0021.00	CTS-ES-01	8u5u57u	P	2.69E-02	1	Canister drop, canister	No-release		2.0175	

Figure 3.7.4-2. Event Sequence Table

Action Commands (Figures 3.7.4-1 and 3.7.4-2)

Add Record: Activates the text box and allows the user to add a record (Form).

Delete Record: Deletes the record currently displayed in the **Event Sequence Form** and the row that is currently selected in the **Event Sequence Table**. The user will be prompted "Are you sure you want to delete record?" after **Delete Record** is selected (Form/Table).

Edit Record: Allows the user to modify any data entry fields (Form). Allows the user to modify a selected cell (Table).

Show Report: Displays the information in a report format (Form/Table).

Event Seq. Form/ Event Seq. Table: Allows the user to toggle between **Event Sequence Form** and **Event Sequence Table** windows.

Close: Returns to the main project screen after saving the changes. However, **Close** does not save changes to the project database. To save changes in the database, the user must save the information from ***File*** menu → *Save* submenu (Form/Table).

Cancel: Returns the user to the default form display screen without saving the information (Form/Table). The **Cancel** option is displayed only after **Add Record** or **Edit Record** is selected.

Update Record: Applies and saves any new information or changes made with the **Add Record** and **Edit Record** commands (Form). The **Update Record** option appears only after **Add Record** or **Edit Record** is selected.

Copy Record: Copies the information of the entire row into another row (Table).

3.8 *SAPHIRE*

The ***SAPHIRE*** menu in the PCSA Tool is used to run the SAPHIRE Version 6.80 code (Idaho National Engineering and Environmental Laboratory, 1998). Clicking on the **Run Saphire** submenu launches the application for the user. Currently, there is no exchange of data between the tool and the SAPHIRE Version 6.80 code. Consequently, data required to run SAPHIRE Version 6.80 code must be separately entered, and the user must be familiar with the software package. SAPHIRE Version 6.80 code is used for event tree and fault tree analyses.

3.8.1 *Run SAPHIRE*

Selecting the ***Run Saphire*** submenu opens the SAPHIRE for Windows screen illustrated in Figure 3.8.1-1.

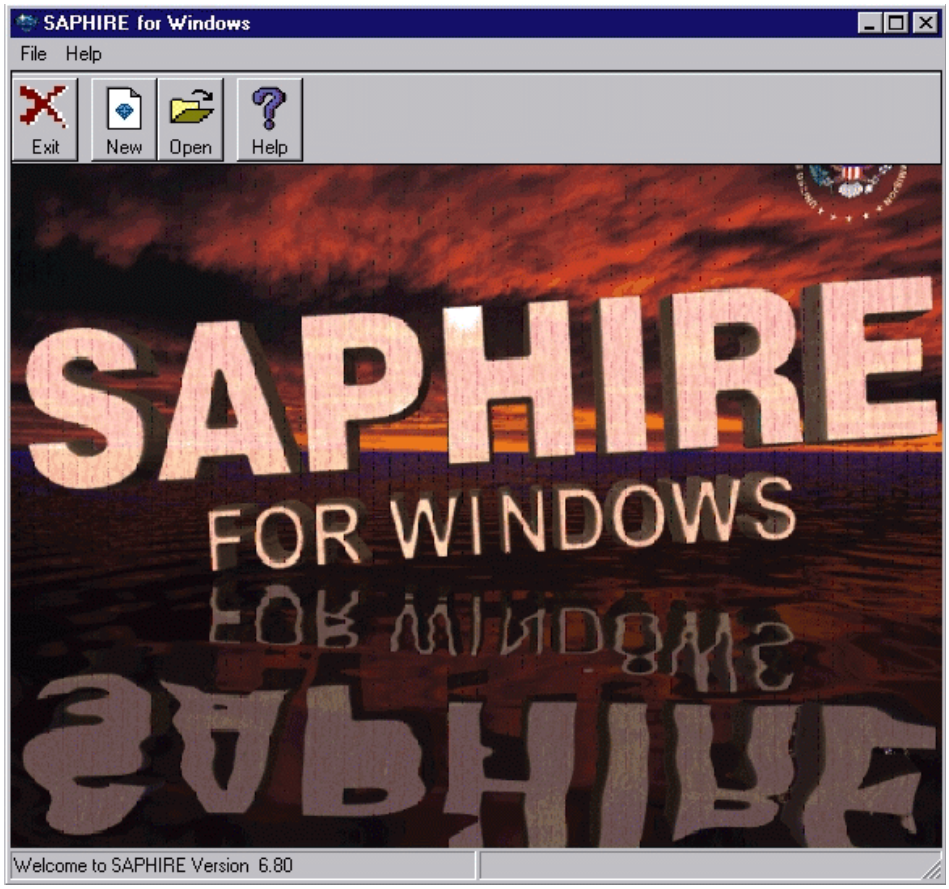


Figure 3.8.1-1. SAPHIRE for Windows Screen

3.9 *Conseq.*

The ***Conseq.*** menu contains three consequence calculation submenus: *Public Dose*, *Worker Dose,* and *Advanced RSAC Input*.

3.9.1 *Public Dose*

The *Public Dose* option performs a calculation of the radiological consequences to an offsite member of the public from an atmospheric release of radioactive material. It uses both deterministic and probabilistic approaches. The receptor is assumed to be an adult located directly downwind from the point where the radioactive material is released. Mitigative credit is taken neither for evacuation of the public nor for remediation of radioactive contamination.

As depicted by the *Public Dose* submenus in Figure 3.9.1-1, the RSAC Version 6.2 code (hereafter referred to as RSAC) and MELCOR Version 1.8.5 code (hereafter referred to as MELCOR) can be used for the *Public Dose* calculation. *RSAC* calculates internal and external doses to the receptor. Internal doses are calculated for the inhalation and ingestion pathways, and the external doses are computed for the pathways of ground surface exposure and submersion in the passing airborne plume. The consequence module calculates public doses for the ingestion pathway based on the consumption of food produced locally at the receptor location. Thus, caution should be used when calculating doses from the ingestion pathway for a residential receptor whose location differs significantly from the location where the receptor's food is produced (see additional discussion in Section 3.9.1.1). *MELCOR* is used to estimate the building discharge fractions, which serve as input parameters for the public dose calculation. Presented in Section 3.9.1.2, execution of *MELCOR* is not required for calculation of the public dose but can be used to determine a realistic source term.

3.9.1.1 *RSAC*

RSAC is used to calculate radiological consequences to an offsite member of the public from an atmospheric release of radioactive material using deterministic and probabilistic approaches. Shown in Figure 3.9.1-1, selecting *RSAC* from the drop-down list invokes the **RSAC Public: New or Modified Analysis** window.

The *RSAC* submenu allows access to the input data for the dose calculation, organized in nine RSAC input tabs. Default values are provided for each parameter. Where possible, site-specific data for the Yucca Mountain site or best-estimate values are assigned as the defaults. Dasgupta, et al. (2002) provide rationale for the selection of the default values.

All parameters used for creating an RSAC input file and performing a dose calculation are displayed in the nine input folders. Several parameters, however, are fixed for the *RSAC* submenu and are displayed for reference only. The following discussion provides the rationale for fixing the value of one example parameter. The first parameter listed for the **Ingestion Dose** input is the Type of dose calculation. This parameter has been fixed at a value of 3 to command RSAC to perform an ingestion dose calculation that allows user-supplied data for ingestion parameters (such as the receptor's annual consumption of contaminated vegetables, meat, and milk). RSAC allows one other option for an ingestion dose calculation in which generic ingestion parameters are used for a chronic (i.e., long-term) release of radioactive

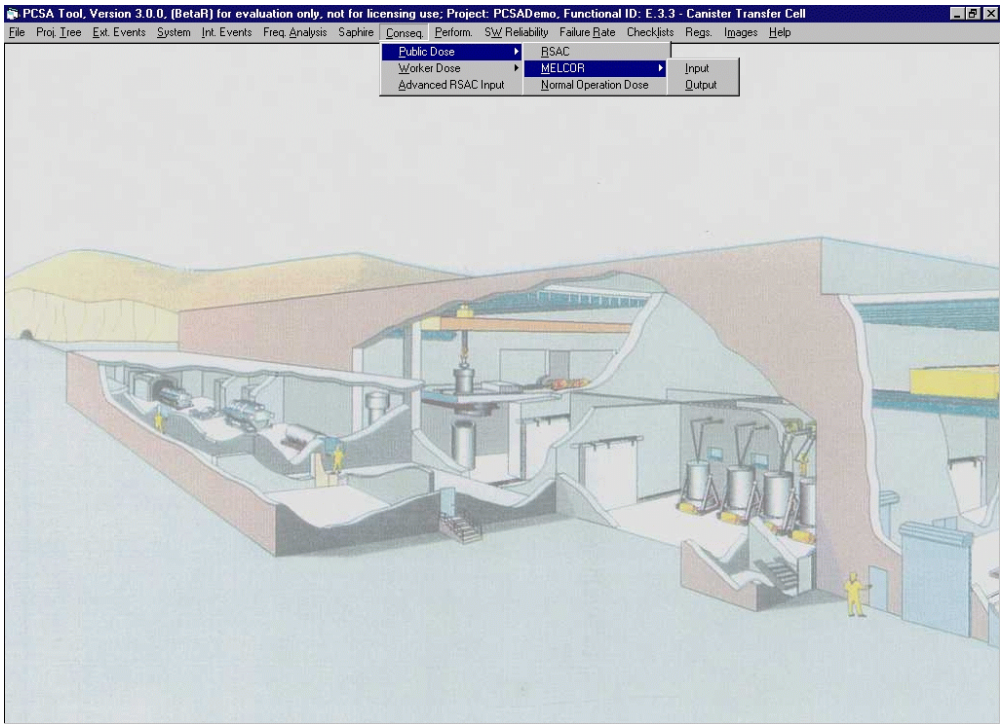


Figure 3.9.1-1. Conseq. Menu

material and the diet of the generic receptor consisting entirely of contaminated food. This other ingestion option is so restrictive it only allows the user to enter input data for two parameters—Decay time for exponential decay function(s) and TB–Plant midpoint of operating life (y). Other options exist for the Type of dose calculation; however, they correspond to dose calculations for pathways other than ingestion. The dose calculation inputs for pathways other than ingestion are addressed separately by the other input folders (**Inhalation Dose**, **Ground Surface Dose**, and **Submersion Dose**).

At the bottom of each folder, the **Restore Point Estimates to Defaults** command is displayed. This command allows the user to reset those input parameters that have not been assigned distributions for Latin Hypercube Sampling (LHS) to their default values. The **Restore Point Estimates to Defaults** option only affects the input in the current folder. To reset all inputs (point estimates and distributions), the **Restore All Defaults** should be used (refer to the discussion in the **Action Commands** section).

For a probabilistic dose calculation, certain parameters throughout the **RSAC Input** window display ****LHS**** in the Input Value column. Double-clicking the ****LHS**** will display the **LHS Input** window shown in Figure 3.9.1-2. The user may select the desired type of distribution from the drop-down list provided or select the **Set Default** button to reset to the default distribution and values. Near the bottom of the window, the user can input the numerical values for that distribution. As shown in Figure 3.9.1-2, the constant A corresponds to a 0.33 numerical value for the parameter, Fraction of annual fresh vegetables that are contaminated by acute release. For a more in-depth description of the **LHS Input** window, refer to Dasgupta, et al. (2002, Section 7.1.3).

The **Type of Run** (“Deterministic” or “Probabilistic”) can be selected at the bottom of any of the nine input folders. The following sections present the nine input folders followed by a section about the execution of the RSAC dose calculation.

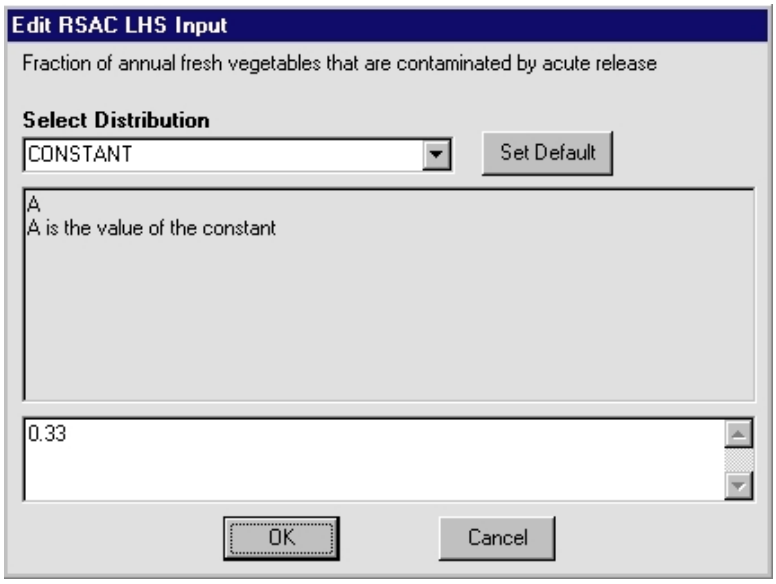


Figure 3.9.1-2. RSAC LHS Input Window for Specifying Input Distributions and Values for a Probabilistic Dose Calculation

3.9.1.1.1 Fuel Selection/Assemblies Breached

This section presents the input parameters for the **Fuel Selection/Assemblies Breached** tab shown in Figure 3.9.1-3.

Fuel Type: Choose between **BWR**, **PWR**, and **User Specified**. **BWR** (Boiling Water Reactor) and **PWR** (Pressurized Water Reactor) options have default values, while the User Specified option enables the user to alter the Inventory (Ci/Assembly) column in the **View Source Term** Folder.

Fuel Characteristics: The fuel characteristics for Fuel Types **BWR** and **PWR** are displayed for reference purposes only and may not be changed by the user.

Co-60 Crud Activity (Ci/Assembly): Enter a value greater than or equal to zero.

Number of Assemblies Breached: Input any desired integer or use the drop-down list for selecting the number of assemblies breached. All of the fuel rods are assumed to be breached in each breached assembly. If the user wants to specify that some fraction of the rods breach for each assembly, the release fractions should be multiplied by that fraction in the **Release Fraction by Group** input folder.

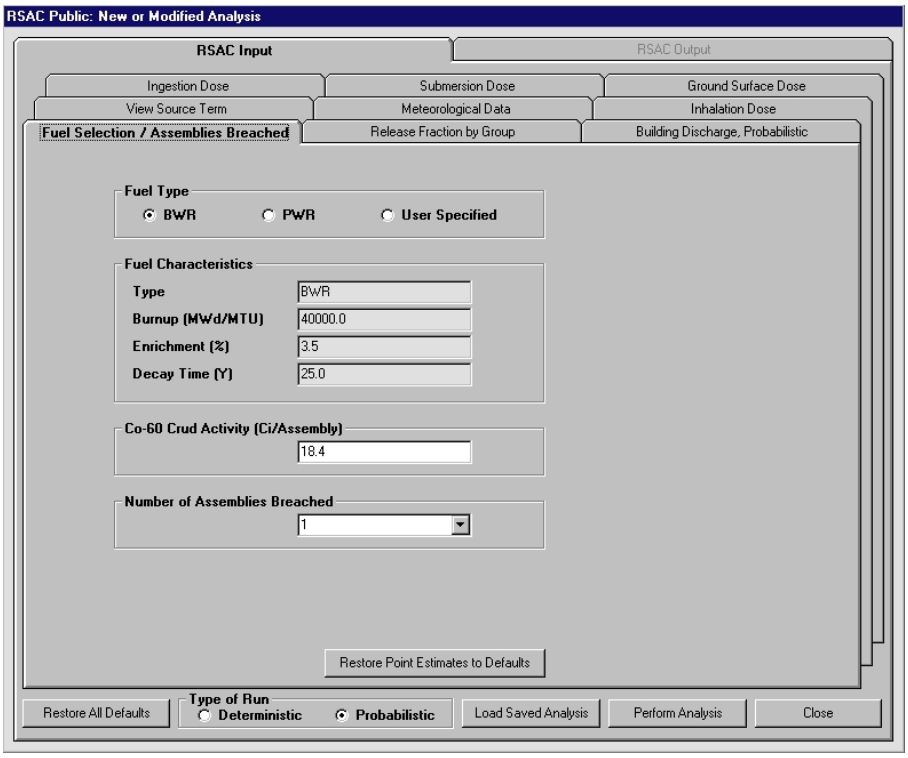


Figure 3.9.1-3. Fuel Selection/Assemblies Breach RSAC Input Tab

The following **Action Commands** correspond to Figures 3.9.1-3 through 3.9.1-11.

Action Commands

Restore All Defaults:	Erases any changes made by the user and returns all values to their default settings.
Type of Run:	Allows the user to choose either a “Deterministic” or “Probabilistic” type of run.
Load Saved Analysis:	Allows the user to input a previously saved analysis to the **RSAC Public: New or Modified Analysis** window.
Perform Analysis:	Executes RSAC run.
Close:	Closes the **RSAC Public** window retaining any user input or changes.

3.9.1.1.2 Bldg. Discharge, HEPA, Probabilistic

This section presents the input parameters for the **Bldg. Discharge, HEPA, Probabilistic** tab shown in Figure 3.9.1-4.

Fraction Discharged from Building Ventilation: Input any value between zero and one (inclusive) for Vapors and Noble Gases, Crud (Co-60), and Particulates. These values can be estimated by executing the MELCOR code (see Section 3.9.1.2).

Probabilistic: The feature may only be changed when “Probabilistic” is selected for **Type of Run**. As a rule of thumb, the computation speed is approximated at 10 realizations per minute (6 seconds per realization) for a personal computer with a 500-MHz processor.

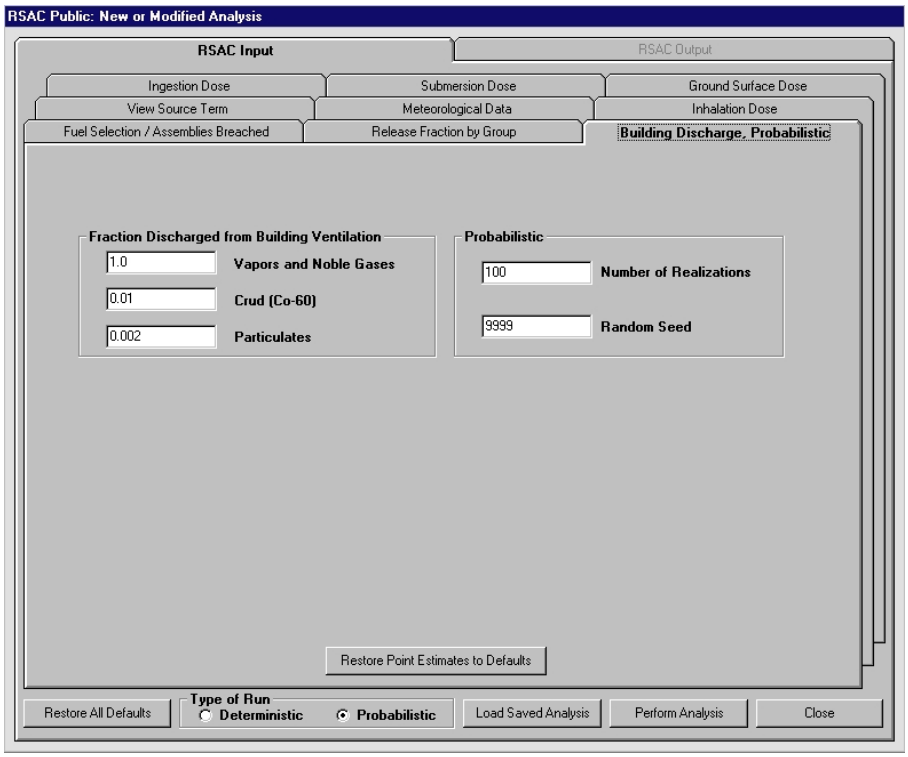


Figure 3.9.1-4. Bldg. Discharge, HEPA, Probabilistic RSAC Input Tab

3.9.1.1.3 Release Fraction by Group

This section presents the input parameters for the **Release Fraction by Group** tab shown in Figure 3.9.1-5. For each Group ID, the corresponding Group Name, Release Fraction, HEPA Mitigation Operative/Inoperative, and Radionuclides in Group columns are displayed in Figure 3.9.1-5. The user may view additional columns by using the horizontal slider. These columns are: Release Fraction Default, HEPA Factor Default, MinValue, MaxValue, MinMitiValue, and MaxMitiValue.

The user should select “Air” or “Pool” under the Release In option located near the bottom of the folder, and then edit the release fractions. The user may also toggle between “Operative” or “Inoperative” for the HEPA Filtration option.

The Release Fraction column and the HEPA Mitigation Operative columns may both be edited by the user. The user may select from “Operative” or “Inoperative” HEPA filtration. Any value between zero and one (inclusive) may be input for the HEPA Mitigation Operative value. A zero value represents 100-percent mitigation (i.e., filtration). A value of one represents 0-percent mitigation (i.e., no filtration). If HEPA Mitigation Inoperative is selected, then the HEPA Mitigation Inoperative value is fixed at 1.0. The Release Fraction Default value displays the default setting for the Release Fraction value. The HEPA Factor Default value displays the

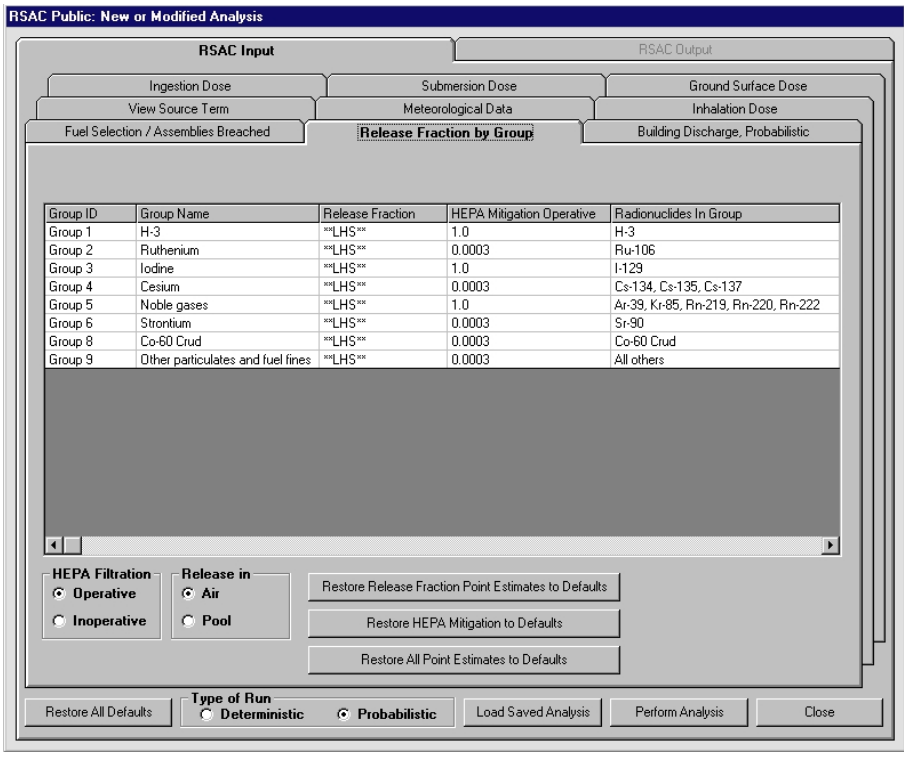


Figure 3.9.1-5. Release Fraction by Group RSAC Input Tab

default setting for the HEPA Mitigation Operative/Inoperative value. The MinValue and MaxValue columns display the minimum and maximum values for the Release Fractions. The MinMitiValue and MaxMitiValue columns display the minimum and maximum values for the HEPA Mitigation Operative/Inoperative values. The minimum and maximum values are used for checking the data entered by the user.

3.9.1.1.4 Meteorological Data

This section presents the input parameters for the **Meteorological Data** folder shown in Figure 3.9.1-6. For each Input Parameter, the corresponding Input Value, Remarks, and Default Value are displayed in Figure 3.9.1-6. The user may view additional columns by using the horizontal slider. These columns are: LHS Abbreviations ("Probabilistic" only), MinValue, MaxValue, and Last Point. The Input Value column is the only column that may be edited by the user. The Default Value column displays the default values for the inputs. The MinValue and MaxValue columns display the physical minimum and maximum values and are used to check the input data. The Last Point column displays the last point estimate value the user entered prior to choosing a run type of "Probabilistic." The individual Input Parameter entries are presented next.

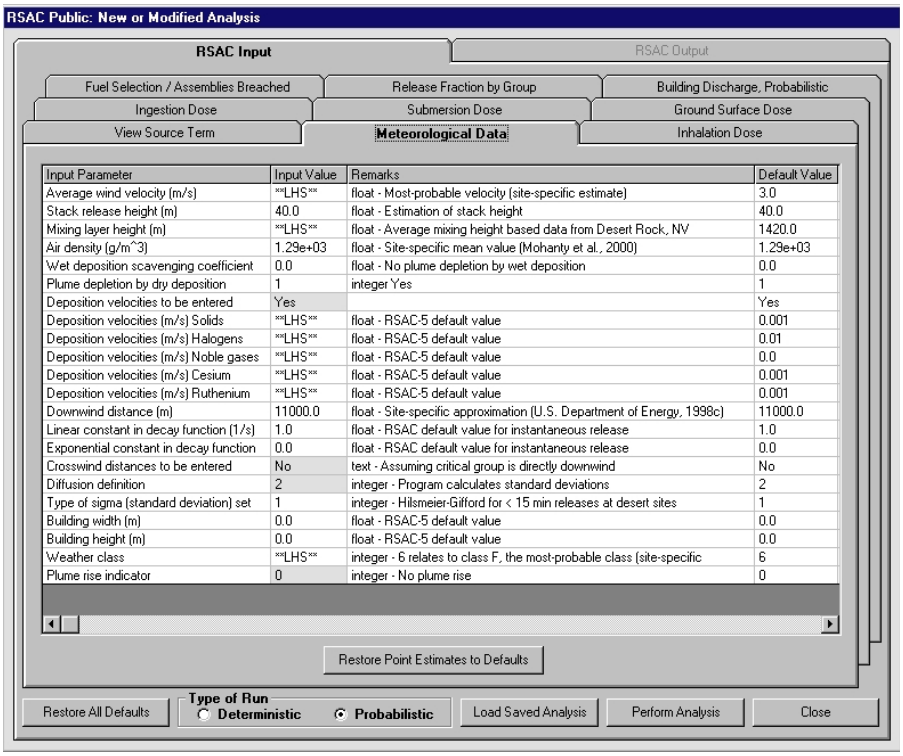


Figure 3.9.1-6. Meteorological Data RSAC Input Tab

Average wind velocity (m/s): Value must be greater than zero. LHS allowed.

Stack release height (m): Value must be greater than or equal to zero.

Mixing layer height (m): Value must be greater than zero. LHS allowed.

Air density (g/m^3): Value must be greater than zero.

Wet deposition scavenging coefficient (1/s): Value must be greater than or equal to zero.

Plume depletion by dry deposition: Input 0 for No or 1 for Yes.

Deposition velocities to be entered: This parameter has a set value of Yes. The parameter may not be changed and is displayed for information purposes only.

Deposition velocities (m/s) Solids: Value must be greater than or equal to zero. LHS allowed.

Deposition velocities (m/s) Halogens: Value must be greater than or equal to zero. Halogens are nonmetallic elements (F, Cl, Br, I, and At). LHS allowed.

Deposition velocities (m/s) Noble gases: Value must be greater than or equal to zero. Noble gases are inert elements (He, Ne, Ar, Kr, Xe, and Rn). LHS allowed.

Deposition velocities (m/s) Cesium: Value must be greater than or equal to zero. LHS allowed.

Deposition velocities (m/s) Ruthenium: Value must be greater than or equal to zero. LHS allowed.

Downwind distance (m): Value must be greater than or equal to zero.

Linear constant in decay function (1/s): Value must be greater than or equal to zero. A value of 1 corresponds to an instantaneous release.

Exponential constant in decay function (1/s): Value must be greater than or equal to zero. A value of zero corresponds to an instantaneous release.

Crosswind distances to be entered: This parameter has a set value of No. The parameter may not be changed and is listed for information purposes only.

Diffusion definition: This input parameter is fixed to a value of 2 so the RSAC code calculates atmospheric diffusion. The parameter may not be changed and is listed for information purposes only.

Type of sigma (standard deviation) set: This input parameter takes a value of 1, 2, or 3.

Value	Diffusion Model	Comments
1	Hilsmeier-Gifford	Should be used for desert terrains for releases of a few minutes to 15 minutes in duration (Wenzel, 1994, pp. 4–18)
2	Markee	Should be used for desert terrains for releases of 15 to 60 minutes in duration (Wenzel, 1994, pp. 4–18)
3	Pasquill-Gifford	Should be used for prairie grass terrains for releases of 10 to 60 minutes in duration (Wenzel, 1994, pp. 4–18)

Building width (m): Value must be greater than or equal to zero. Stack release height must equal zero for building wake effects to be calculated.

Building height (m): Value must be greater than or equal to zero. Stack release height must equal zero for building wake effects to be calculated.

Weather class: This input parameter must be an integer between 1 and 8 with the following definitions. LHS allowed.

Value	Weather Class	Comments
1	A	Most unstable; implies greatest dispersion
2	B	—
3	C	—
4	D	—
5	E	—
6	F	Most stable; implies least dispersion
7	Fumigation	Special case; requires a stack release height greater than zero but less than or equal to the mixing layer height
8	G	Only for Pasquill-Gifford model; most stable; implies least dispersion

Plume rise indicator: This input parameter is assigned a fixed value of zero, which indicates no plume rise. In general, plume rise corresponds to higher effective stack heights, more diffusion, lower radionuclide concentrations in the air at the ground surface, less deposition of radionuclides on the ground, and lower doses.

3.9.1.1.5 Inhalation Dose

This section presents the input parameters for the **Inhalation Dose** tab shown in Figure 3.9.1-7. For each Input Parameter, the corresponding Input Value, Remarks, and Default Value are displayed in Figure 3.9.1-7. The user may view additional columns by using the horizontal slider. These columns are: LHS Abbreviations ("Probabilistic" only), MinValue, MaxValue, and Last Point. The individual entries are presented next.

Type of dose calculation: Fixed for an inhalation dose calculation and may not be edited.

Output control for dose: Fixed for dose summary output and may not be edited.

Dose unit: Fixed for units of rem and may not be edited.

Elements for calculation: Fixed for a dose calculation for all elements and may not be edited.

Organ choice: Fixed for a dose calculation for all organs and may not be edited.

For inhalation, breathing rate (m^3/s): Value must be greater than zero. LHS allowed.

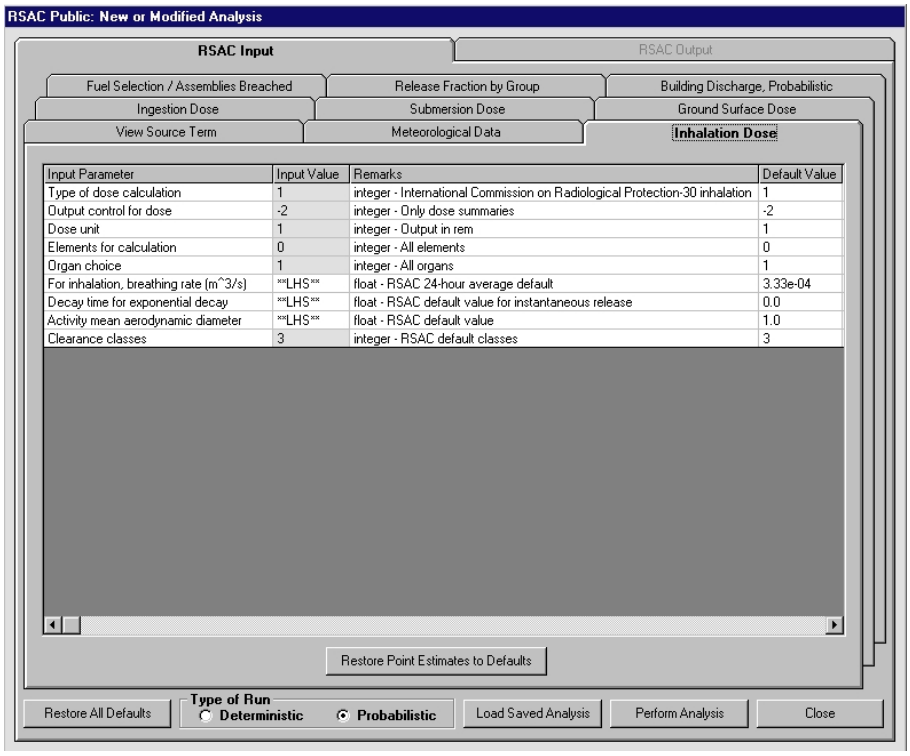


Figure 3.9.1-7. Inhalation Dose RSAC Input Tab

Decay time for exponential decay fraction (s): Value must be greater than or equal to zero. Value of zero corresponds to an instantaneous release. LHS allowed.

Activity mean aerodynamic diameter (micrometer): Value must be greater than zero. LHS allowed.

Clearance classes: This value is a fixed parameter and may not be edited.

3.9.1.1.6 Ingestion Dose

This section presents the input parameters for the **Ingestion Dose** tab shown in Figure 3.9.1-8. For each Input Parameter, the corresponding Input Value, Remarks and Default Value are shown in Figure 3.9.1-8. The user may view additional columns by using the horizontal slider. These columns are: LHS Abbreviations (Probabilistic only), MinValue, MaxValue, and Last Point. The individual entries are presented below.

Currently, the consequence module calculates public doses for the ingestion pathway based on the consumption of food produced locally at the receptor location. Thus, caution should be used when calculating doses from the ingestion pathway for a residential receptor whose location differs significantly from the location where the receptor's food is produced. To account for residential receptors who eat significant amounts of the contaminated, locally produced food, ingestion doses for the residential receptor should be calculated based on the distance from the source to the farm where the food is produced.

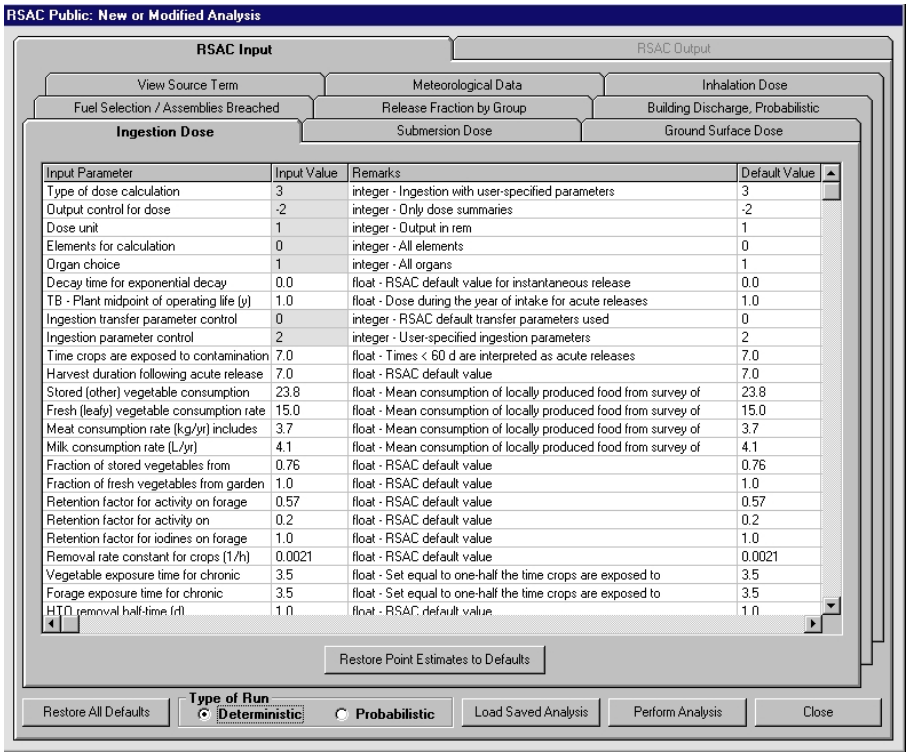


Figure 3.9.1-8. Ingestion Dose RSAC Input Tab

Type of dose calculation: Fixed for an ingestion dose calculation and may not be edited.

Output control for dose: Fixed for dose summary output and may not be edited.

Dose unit: Fixed for units of rem and may not be edited.

Elements for calculation: Fixed for a dose calculation for all elements and may not be edited.

Organ choice: Fixed for a dose calculation for all organs and may not be edited.

Decay time for exponential decay function (s): Value must be greater than or equal to zero. Value of zero corresponds to an instantaneous release. LHS allowed.

TB–Plant mid point of operating life (y): Value must be greater than or equal to zero. If a value of zero is specified, the RSAC code defaults to a value of 1 year. LHS allowed.

Ingestion transfer parameter control: Fixed for default transfer parameters and may not be edited.

Ingestion parameter control: Fixed to allow user-specified ingestion parameters and may not be edited.

Time crops are exposed to contamination during the growing season (d): Value must be between 0.04167 and 60 days. If values of 0 days or greater than 60 days are specified, the RSAC code defaults to a value of 60 days. LHS allowed. The RSAC code will not calculate an ingestion dose for values less than 0.04167 day.

Harvest duration following acute release (d): Value must be greater than or equal to zero. LHS allowed.

Stored (other) vegetable consumption rate (wet kg/yr) includes fruits and grains: Value must be greater than or equal to zero. LHS allowed.

Fresh (leafy) vegetable consumption rate (wet kg/yr): Value must be greater than or equal to zero. LHS allowed.

Meat consumption rate (kg/yr) includes beef and poultry: Value must be greater than or equal to zero. LHS allowed.

Milk consumption rate (L/yr): Value must be greater than or equal to zero. LHS allowed.

Fraction of stored vegetables from garden: Unitless value must be between zero and one (inclusive). LHS allowed.

Fraction of fresh vegetables from garden: Unitless value must be between zero and one (inclusive). LHS allowed.

Retention factor for activity on forage: Unitless value must be between zero and one (inclusive). LHS allowed.

Retention factor for activity on vegetables: Unitless value must be between zero and one (inclusive). LHS allowed.

Retention factor for iodines on forage: Unitless value must be between zero and one (inclusive). LHS allowed.

Removal rate constant for crops (1/h): Value must be greater than or equal to zero. LHS allowed.

Vegetable exposure time for chronic releases (d): Value must be greater than or equal to zero. LHS allowed.

Forage exposure time for chronic releases (d): Value must be greater than or equal to zero. LHS allowed.

HTO removal half-time (d): HTO refers to tritiated water (where at least one of the hydrogen atoms in H_2O is tritium, ^3H). Value must be greater than or equal to zero. LHS allowed.

Effective surface density for soil (kg/m^3): Value must be greater than zero. LHS allowed.

Stored vegetable holdup time after harvest (d): Value must be greater than or equal to zero. LHS allowed.

Fresh vegetable holdup time after harvest (d): Value must be greater than or equal to zero. LHS allowed.

Animals daily forage feed (dry kg/d): Value must be greater than or equal to zero. LHS allowed.

Feed-milk receptor transfer time (d): Value must be greater than or equal to zero. LHS allowed.

Slaughter to consumption time (d): Value must be greater than or equal to zero. LHS allowed.

Fraction of year that animals graze: Unitless value must be between zero and one (inclusive). LHS allowed.

Fraction of feed that is pasture when grazing: Unitless value must be between zero and one (inclusive). LHS allowed.

Stored feed holdup time (d): Value must be greater than or equal to zero. LHS allowed.

Vegetable vegetation yield (wet kg/m^2): Value must be greater than or equal to zero. LHS allowed.

Forage vegetation yield (dry kg/m^2): Value must be greater than zero. LHS allowed.

Absolute humidity (kg/m^3): Value must be greater than zero. LHS allowed.

Fraction of annual stored vegetables that are contaminated by acute release: Unitless value must be between zero and one (inclusive). LHS allowed.

Fraction of annual fresh vegetables that are contaminated by acute release: Unitless value must be between zero and one (inclusive). LHS allowed.

Fraction of annual stored forage that is contaminated by acute release: Unitless value must be between zero and one (inclusive). LHS allowed.

Fraction of annual fresh forage that is contaminated by acute release: Unitless value must be between zero and one (inclusive). LHS allowed.

3.9.1.1.7 Ground Surface Dose

This section presents the input parameters for the **Ground Surface Dose** tab shown in Figure 3.9.1-9. For each Input Parameter, the corresponding Input Value, Remarks, and Default Value are displayed in Figure 3.9.1-9. The user may view additional columns by using the horizontal slider. These columns are: LHS Abbreviations (Probabilistic Only), MinValue, and MaxValue. The individual entries are presented below.

Type of dose calculation: Fixed for a ground surface dose calculation and may not be edited.

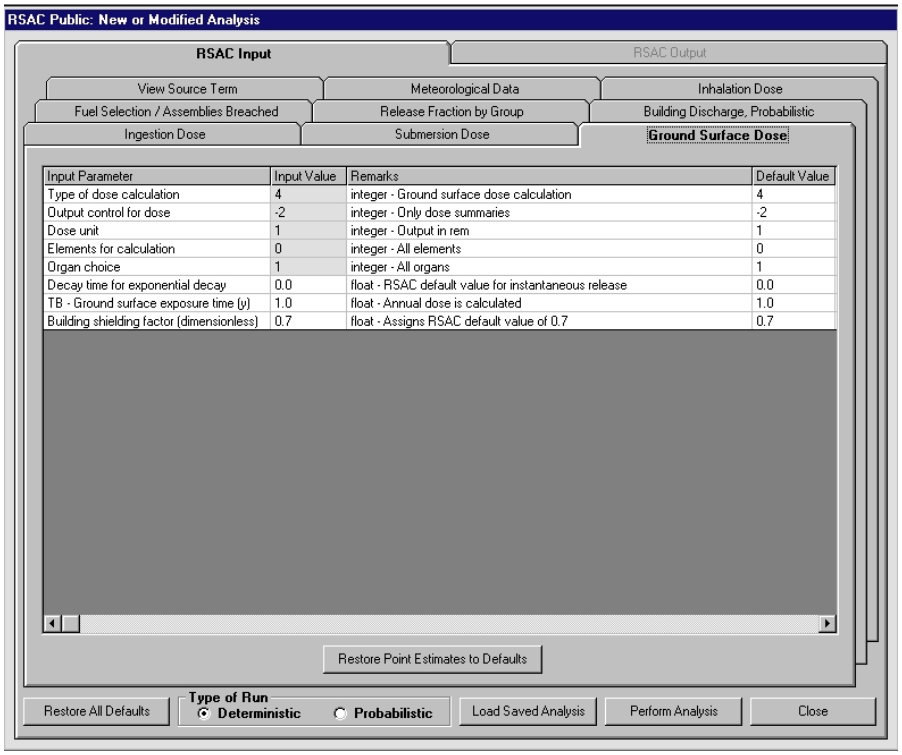


Figure 3.9.1-9. Ground Surface Dose Input Tab

Output control for dose: Fixed for dose summary output and may not be edited.

Dose unit: Fixed for units of rem and may not be edited.

Elements for calculation: Fixed for a dose calculation for all elements and may not be edited.

Organ choice: Fixed for a dose calculation for all organs and may not be edited.

Decay time for exponential decay function(s): Value must be greater than or equal to zero. Value of zero corresponds to an instantaneous release. LHS allowed.

TB–Ground surface exposure time (y): Value must be greater than or equal to zero. If a value of zero is specified, the RSAC code defaults to a value of 1 year. LHS allowed.

Building shielding factor (dimensionless): Value must be between zero and one (inclusive). If a value of zero is specified, the RSAC code defaults to a value of 0.7.

3.9.1.1.8 Submersion Dose

This section presents the input parameters for the **Submersion Dose** tab shown in Figure 3.9.1-10. For each Input Parameter, the corresponding Input Value, Remarks, and

Default Value are displayed in Figure 3.9.1-10. The user may view additional columns by using the horizontal slider. These columns are: MinValue, and MaxValue. The individual entries are presented below.

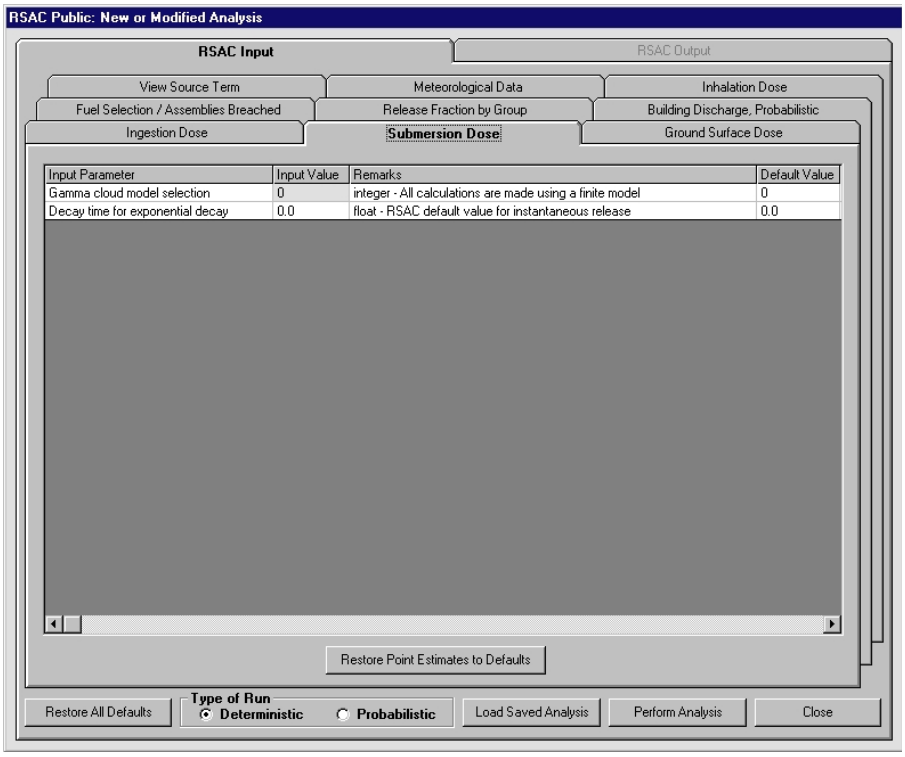


Figure 3.9.1-10. Submersion Dose RSAC Input Tab

Gamma cloud model selection: Fixed for a finite plume calculation and may not be edited.

Decay time for exponential decay function (s): Value must be greater than or equal to zero. Value of zero corresponds to an instantaneous release. LHS allowed.

3.9.1.1.9 View Source Term

This section presents the **View Source Term** tab shown in Figure 3.9.1-11. This tab displays the parameter values for the source term calculation. The column Released Activity (Ci), located on the far right, presents the radionuclide activities released from the stack into the atmosphere. These activities are calculated by the PCSA Tool (as the product of the other numerical columns) and are transferred directly to the RSAC input file as the source term for the atmospheric transport and dose calculations. The user can only edit the Inventory (Ci/Assembly) column if User Specified was selected for Fuel Type in the **Fuel Selection/ Assemblies Breached** folder.

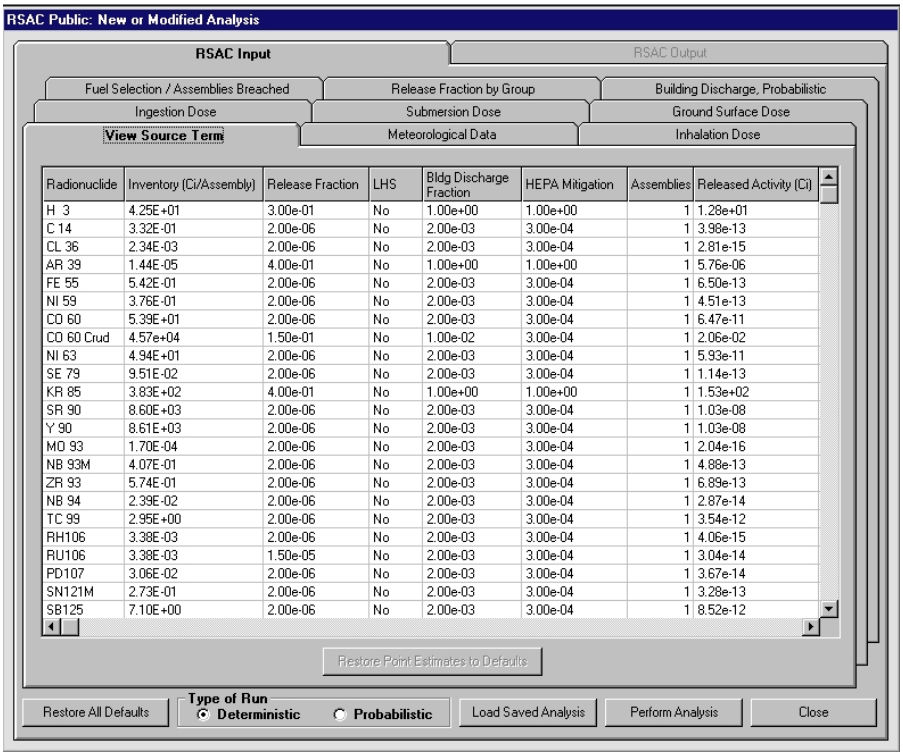


Figure 3.9.1-11. View Source Term RSAC Input Tab

3.9.1.2 *MELCOR*

The *MELCOR* code is used to estimate building discharge fractions, which serve as input parameters for the public dose calculation (see Fraction Discharged from Building Ventilation for Vapors and Noble Gases, Crud (Co-60), and Particulates in Figure 3.9.1-4), for a cladding breach (in air) during transfer and handling bare assemblies of spent nuclear fuel.

3.9.1.2.1 *Input*

The **MELCOR Input** window consists of three folders providing the input data and their default value as shown in Figures 3.9.1-12 through 3.9.1-14. The parameter names and units for ventilation and volumetric flow rate are consistent with their presentation in the MELCOR code manual (NRC, 2000). The user may make any changes to the input data located in the value column—data in the default column cannot be changed. Note, selecting the **Defaults** button in the folder only resets those data in that folder.

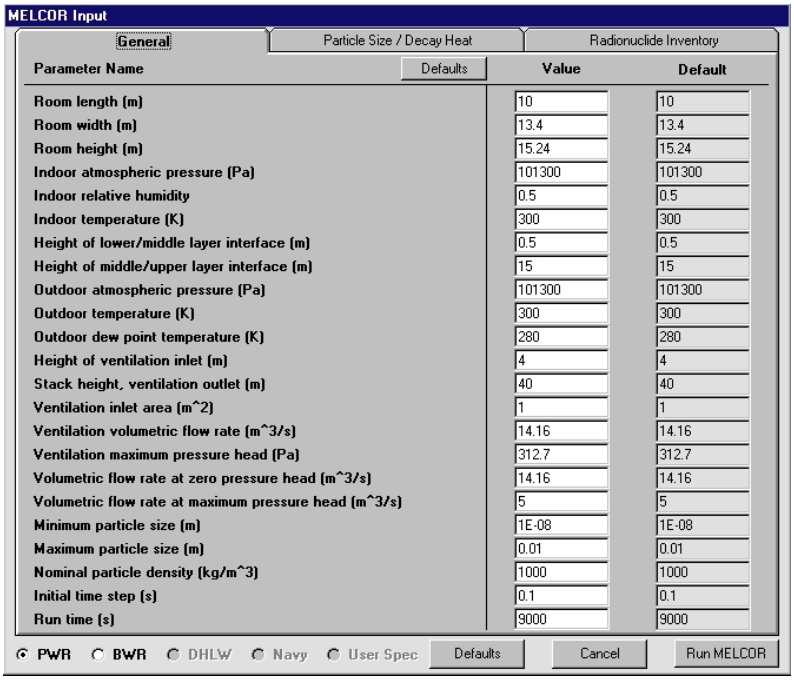


Figure 3.9.1-12. MELCOR Input Window, General

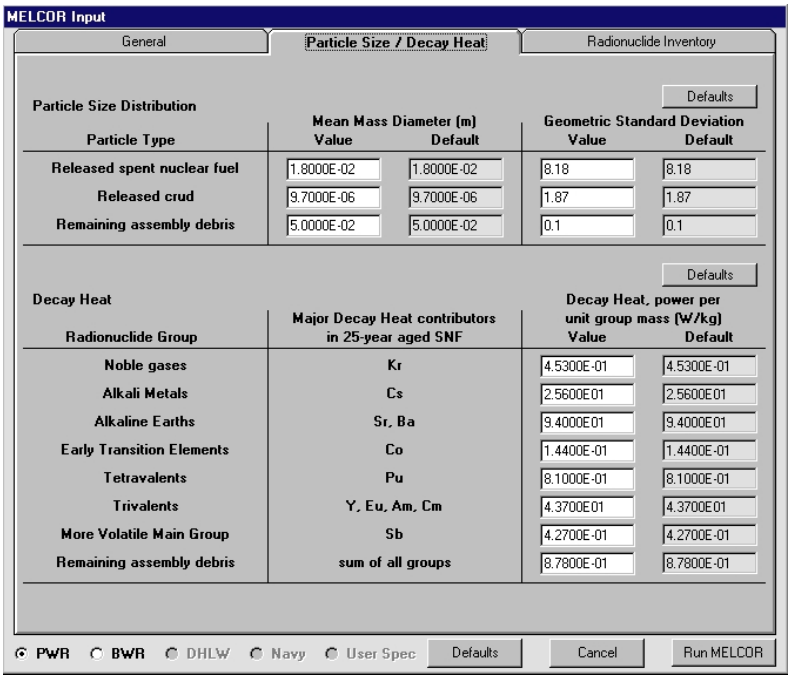


Figure 3.9.1-13. MELCOR Input Window, Particle Size/Decay Heat

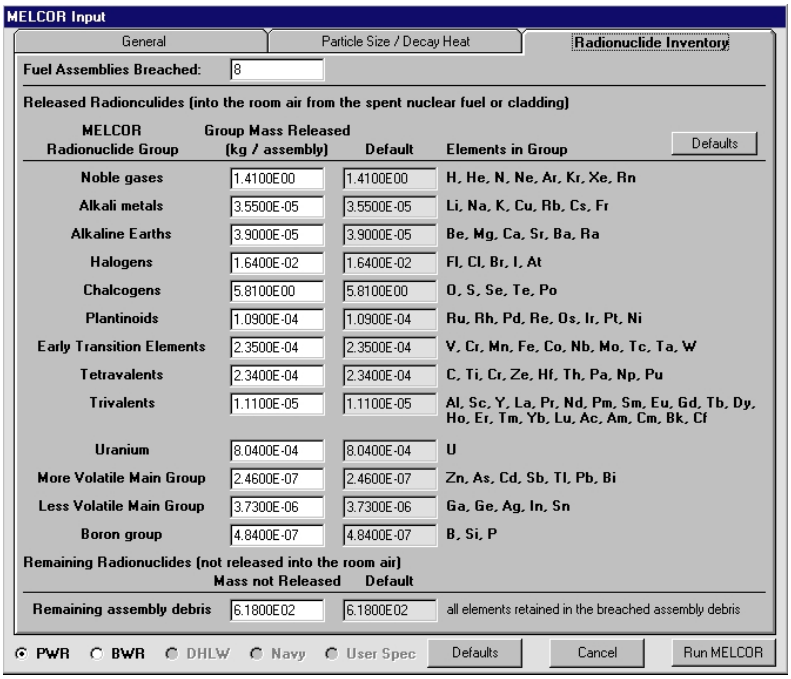


Figure 3.9.1-14. MELCOR Input Window, Radionuclide Inventory

Action Commands

"PWR/BWR": The user may select "PWR" or "BWR" for fuel type.

Defaults: Resets all **MELCOR Input** window data to the default values.

Cancel: Closes the **MELCOR Input** window erasing any changes.

Run MELCOR: Executes a MELCOR run with the data in the **MELCOR Input** window.

Figure 3.9.1-15 displays the room geometry for the *MELCOR* calculation. The air volume of the room is divided into three vertical regions (upper, middle, and lower). The heights of the region interfaces are specified as input parameters in Figure 3.9.1-12. Airborne radionuclide concentrations are uniformly distributed within a region. The Radionuclide Group Masses Released are released into the middle region, while the remaining mass (not released) occupies the lower region as assembly debris and serves as a heat source. The ventilation inlet height is listed as an input parameter in Figure 3.9.1-12. The ventilation inlet should be located in the middle or upper region of the room. Figure 3.9.1-15 shows the ventilation inlet located in the middle region of the room. Air flows into the ventilation inlet and passes through HEPA filters before being exhausted out a stack into the environment.

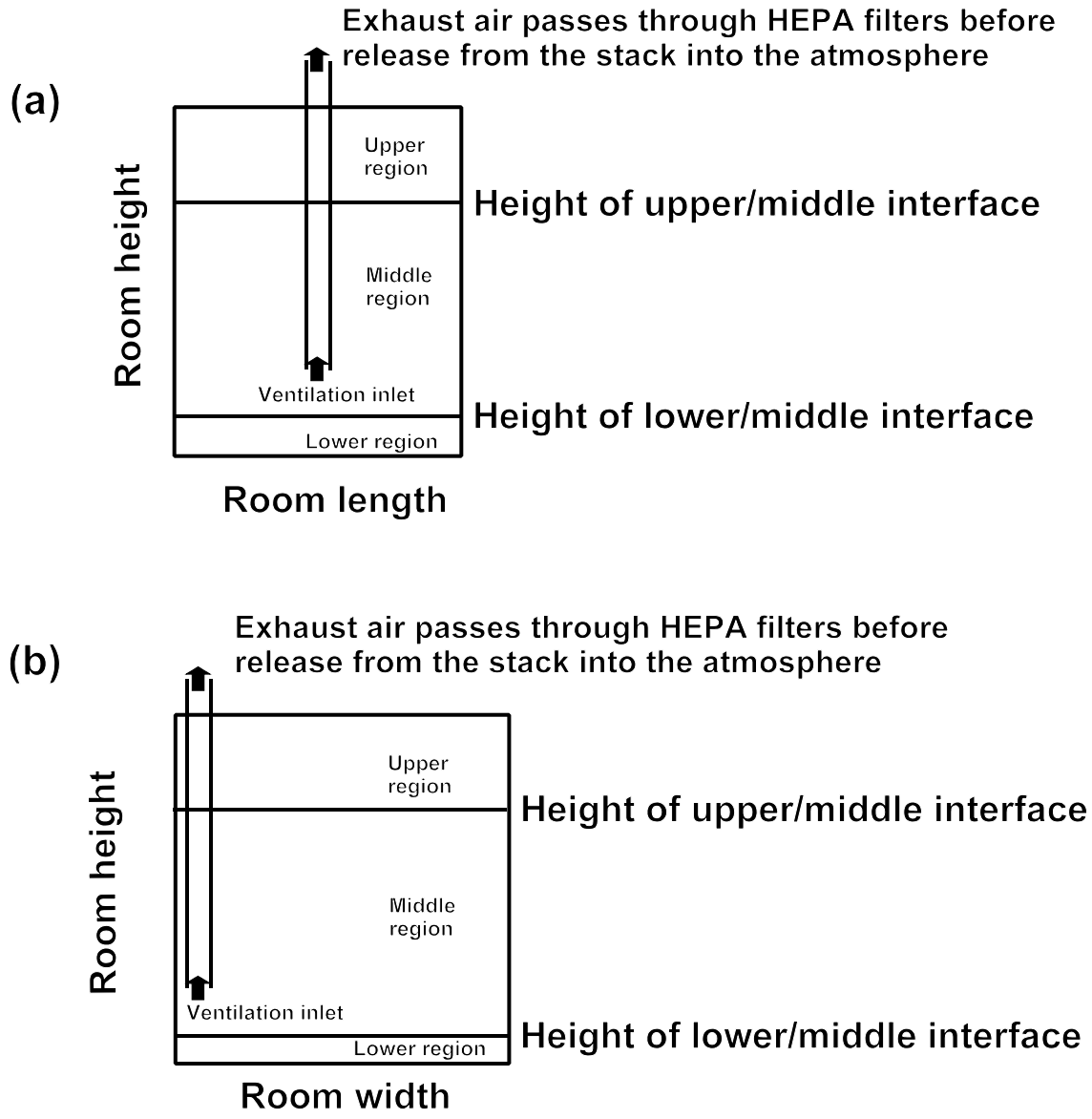


Figure 3.9.1-15. Room Geometries for the MELCOR Calculation (a) Side View Looking Along Room Width and (b) Side View Looking Along Room Length

3.9.1.2.2 *Output*

The *Output* option will be displayed only when a *MELCOR* run has been executed from the **MELCOR Input** window. As shown in Figure 3.9.1-16, execution of the MELCOR code is computationally demanding and time consuming (typically requires more than 1 hour). The time required to complete a *MELCOR* simulation is quite sensitive to the values of the last two input parameters in the **General** tab in the **MELCOR Input** window, Initial timestep(s) and Run time(s). In general, shorter computation times can be achieved for larger initial timesteps or shorter run times. Figure 3.9.1-17 displays the MELCOR output for the fractions discharged from building ventilation of Vapors and Noble Gases, Crud (Co-60), and Particulates. These three MELCOR outputs can serve as input for the public dose calculation (see Section 3.9.1.1.2).

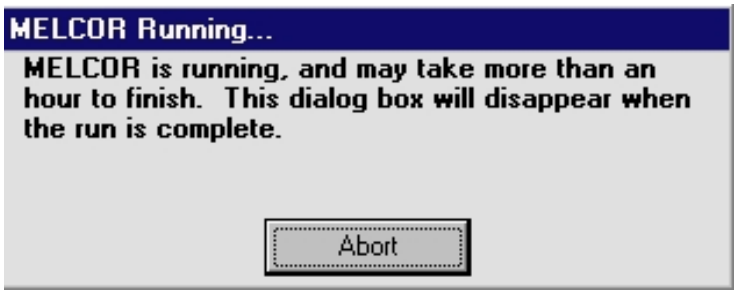


Figure 3.9.1-16. MELCOR Running Window

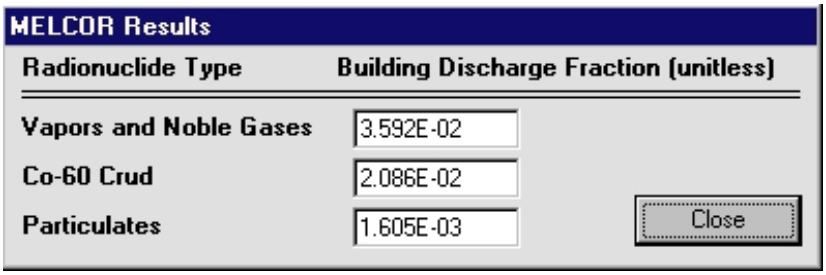


Figure 3.9.1-17. MELCOR Output Window

3.9.1.3 *Normal Operation Dose*

Selecting the *Normal Operation Dose* option displays the **Public Normal Operation Dose** window shown in Figure 3.9.1-18. The **Public Normal Operation Dose** window allows the user to enter a normal operational dose to the public and a description or justification for the data.

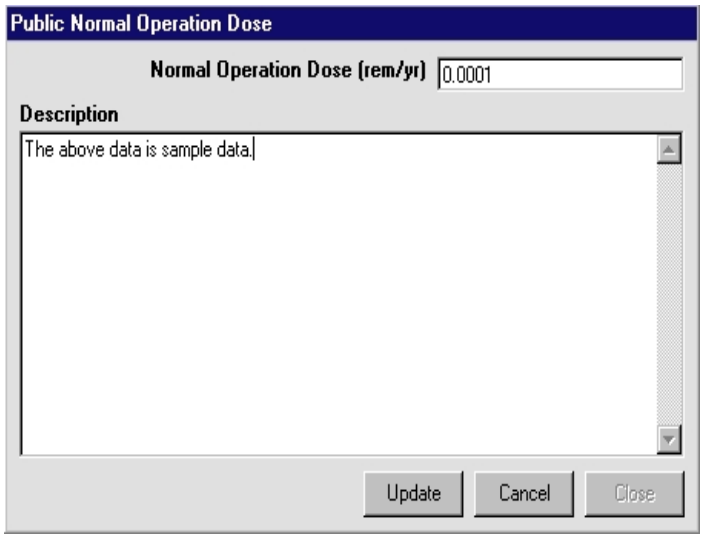


Figure 3.9.1-18. Public Normal Operation Dose Window

Action Commands

Edit: Allows the user to change the Normal Operation Dose and Description.

Cancel: Cancels changes made by the user.

Update: Saves changes made by the user.

Close: Closes the **Public Normal Operation Dose** window.

3.9.2 Worker Dose

The *Worker Dose* submenu contains the following three options: *Workers Outside*, *Worker Internal,* and *Normal Operation Dose*.

3.9.2.1 *Worker Outside*

Selecting the *Workers Outside* submenu displays the **RSAC Worker Dose Options** window shown in Figure 3.9.2-1A. The **RSAC Worker Dose Options** window will guide the user through a series of dialogs and will prompt the user for input. Figure 3.9.2-1A illustrates sample input involving five steps that lead into the **RSAC Controlled Area Worker: New or Modified Analysis** window, shown in Figure 3.9.2-1B, which is similar to the **Public RSAC: New or Modified Analysis** window discussed in Section 3.9.1.1.

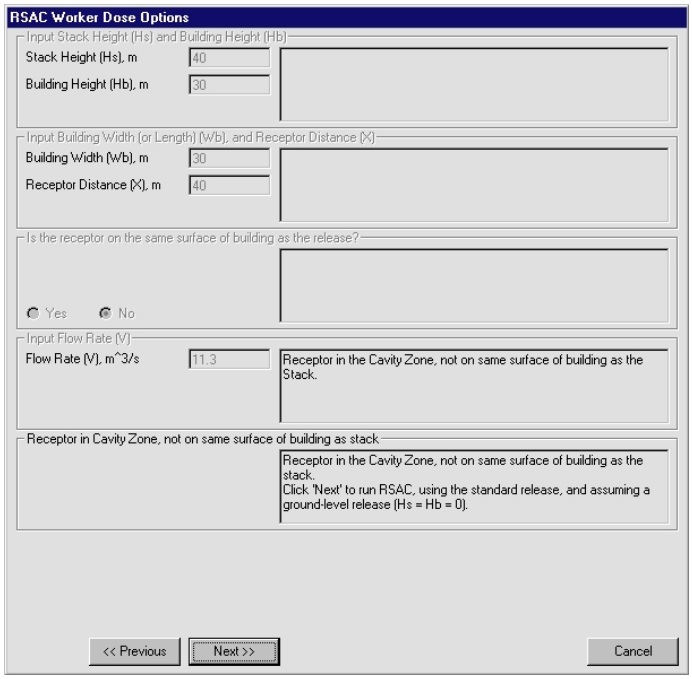


Figure 3.9.2-1A. RSAC Worker Dose Options Window

Action Commands

Next: Accepts user input and proceeds to the next prompt.

Previous: Disregards user input and returns to the previous prompt. Enables the user to return to the **RSAC Worker Dose Options** window from the **RSAC Controlled Area Worker: New or Modified Analysis** window.

Cancel: Closes **RSAC Worker Dose Options** window without saving user input.

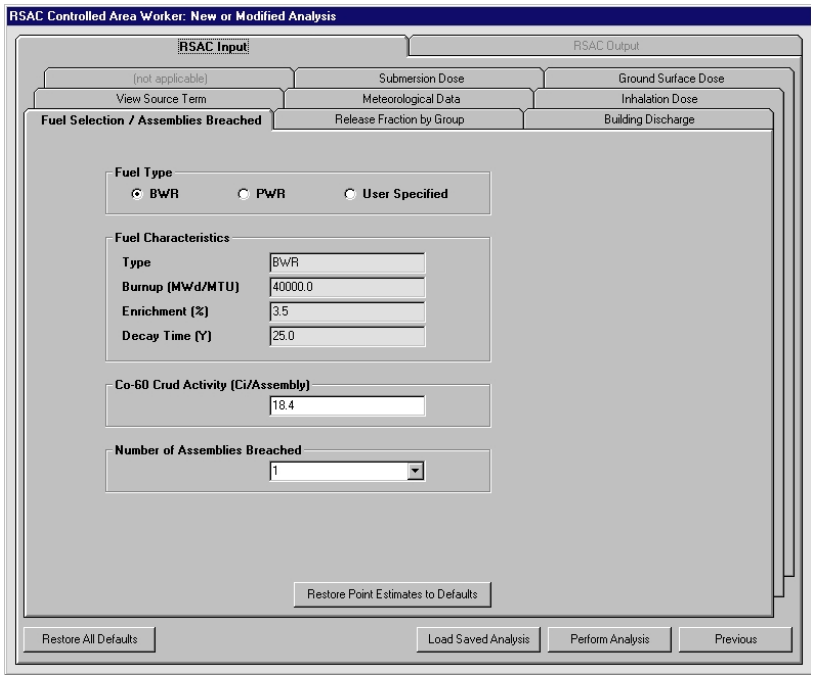


Figure 3.9.2-1B. RSAC Controlled Area Worker

Action Commands

Restore All Defaults: Erases any changes made by the user and returns all values to their default settings.

Load Saved Analysis: Allows the user to input a previously saved analysis to the **RSAC Controlled Area Worker** window.

Perform Analysis: Executes RSAC.

Previous: Closes the **RSAC Controlled Area Worker** window and returns to the **RSAC Worker Dose Options** window.

3.9.2.2 *Worker Internal*

The *Worker Internal* option contains the following two submenus: *Pool* and *Dry.*

3.9.2.2.1 *Pool*

The form used to calculate the worker dose from the pool is shown in Figure 3.9.2-2. This stylized worker dose calculation estimates the doses from gaseous radionuclides released into the air following an underwater breach of fuel cladding. The worker, who is not wearing respiratory protection, is assumed to be located within the transfer room above an open pool.

The input parameters and output for the Worker Dose calculation are consolidated on a single screen. The user may make changes to the white boxes located under Input Data at the top left of the menu, which includes the option for Fuel Type, and Intermediate Results at the bottom left of the menu. The gray boxes are for reference and may not be edited. When the desired input is complete, select **Calculate Dose**, and the results are displayed in the yellow boxes at the bottom right of the menu.

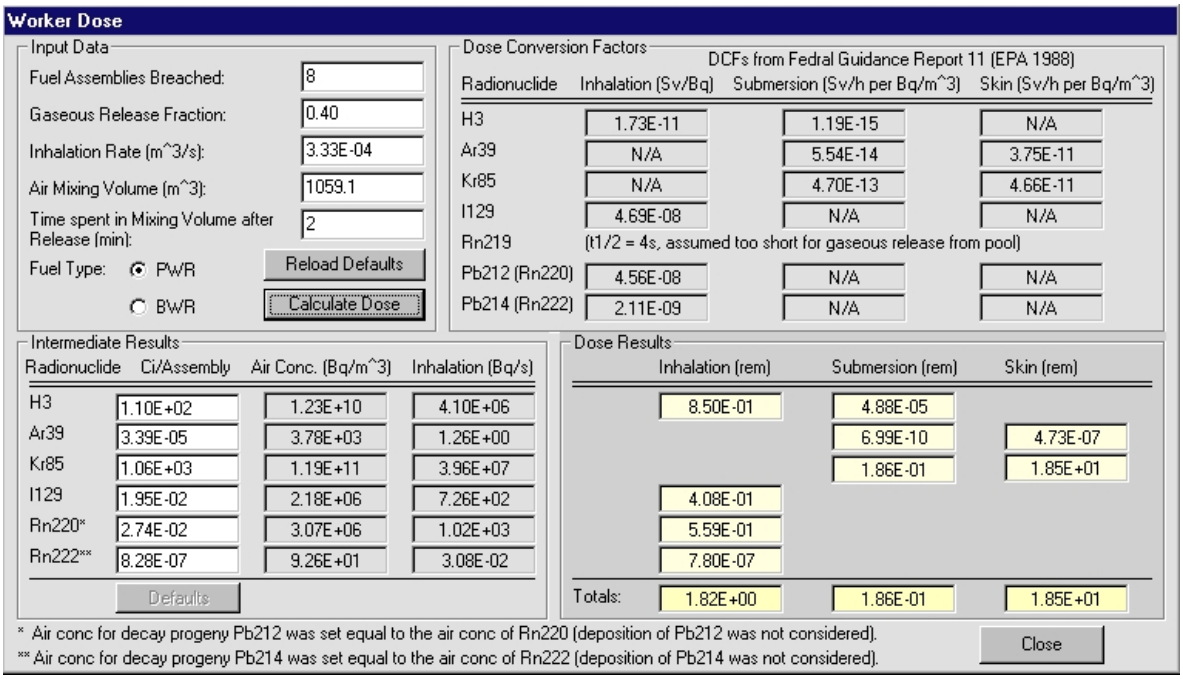


Figure 3.9.2-2. Worker Dose Input Window for Release from the Pool

Action Commands

Fuel Type: Allows selection of “PWR” or “BWR” and loads the default radionuclide inventories (shown with the intermediate results under Ci/Assembly) for that fuel type.

Reload Defaults: Resets input data for the worker dose calculation to the default values.

Calculate Dose: Performs a worker dose calculation with the current input data and updates the intermediate results and dose results.

Defaults: Becomes active when changes are made to the default radionuclide inventories. Resets the radionuclide inventories to the default values.

Close: Closes the worker dose calculation interface.

3.9.2.2.2 *Dry*

Selecting the *Dry* submenu displays the **Worker Dry** window as shown in Figure 3.9.2-3. The **Worker Dry** window contains the following three tabs: Internal Worker Dose, Source Term, and Release Fraction by Group.

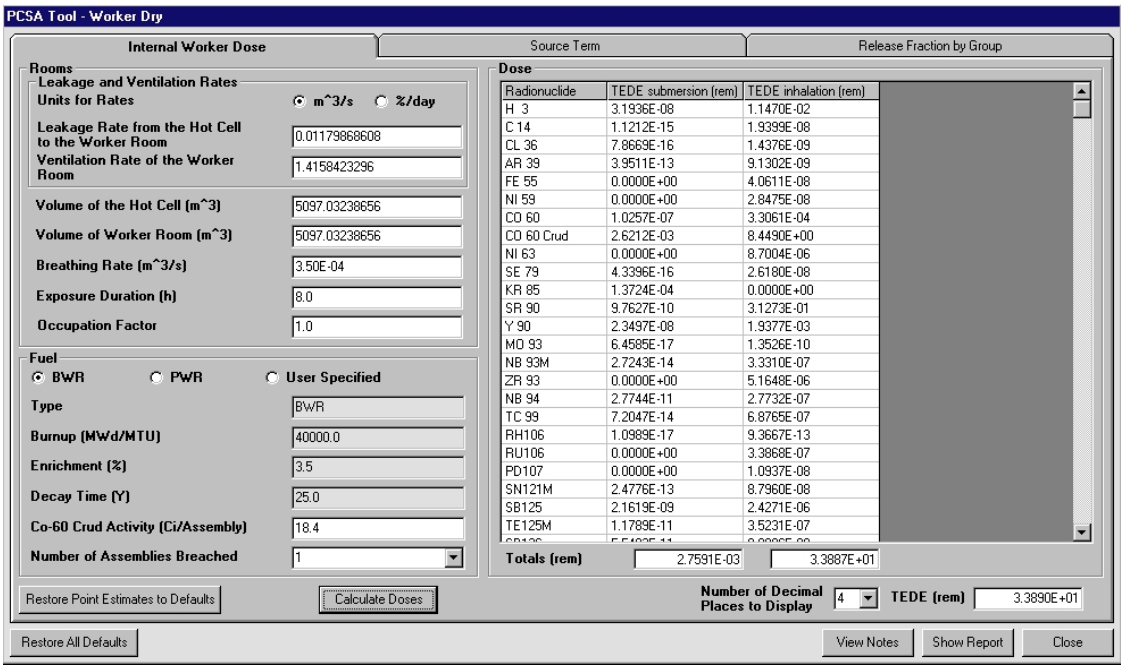


Figure 3.9.2-3. Worker Dose Window for Dry Release—Internal Worker Dose Tab

The following Action Commands correspond to Figures 3.9.2-3 through 3.9.2-5.

Action Commands

Restore All Defaults:	Restores all data within all three folders to their default values.
View Notes:	Displays the Notes for Worker Dose Calculations window.
Show Report:	Displays the information within the folder in report format.
Close:	Closes the **Worker Dry** window retaining any changes made by the user.
Calculate Doses:	Performs a dose calculation from the Rooms and Fuel values. (Available only in the Internal Worker Dose folder.)
Restore Point Estimates to Defaults:	Restores all data within the currently selected folder to their default values.

3.9.2.2.2.1 Internal Worker Dose

The **Internal Worker Dose** folder is divided into the following three sections: Rooms, Fuel, and Dose as shown in Figure 3.9.2-3.

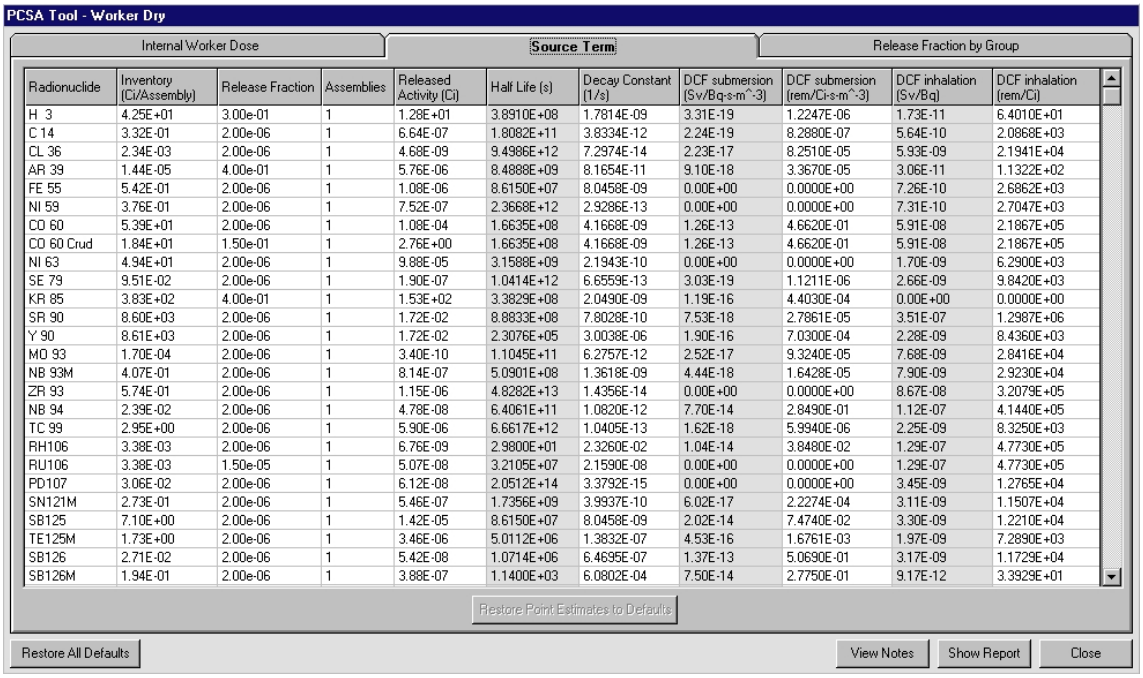
Rooms: The user may utilize the default values or input new values. For all parameters, any numerical input will be accepted except for "Occupation Factor" which must be equal to or less than one. The user is provided the option to select the units for leakage and ventilation rates.

Fuel: The user may select one of three fuel types: "BWR," "PWR," or "User Specified." BWR and PWR have set values for Burnup, Enrichment, and Decay Time. The user may utilize the default values or input new values for Co-60 Activity and Number of Assemblies Breached. By selecting User Specified, the user must input numerical data for all four data entry fields.

Dose: This section is not visible until the **Calculate Doses** command is performed. This section provides the TEDE submersion and inhalation results for each radionuclide. It also shows the totals for submersion and inhalation. At the bottom of the screen, the user selects the number of decimal places to displays in the results.

3.9.2.2.2.2 *Source Term*

This section presents the **Source Term** tab shown in Figure 3.9.2-4. This tab displays the parameter values for the source term calculation. The user can only edit the Inventory (Ci/Assembly) column if User Specified was selected for Fuel Type in the **Internal Worker Dose** tab.



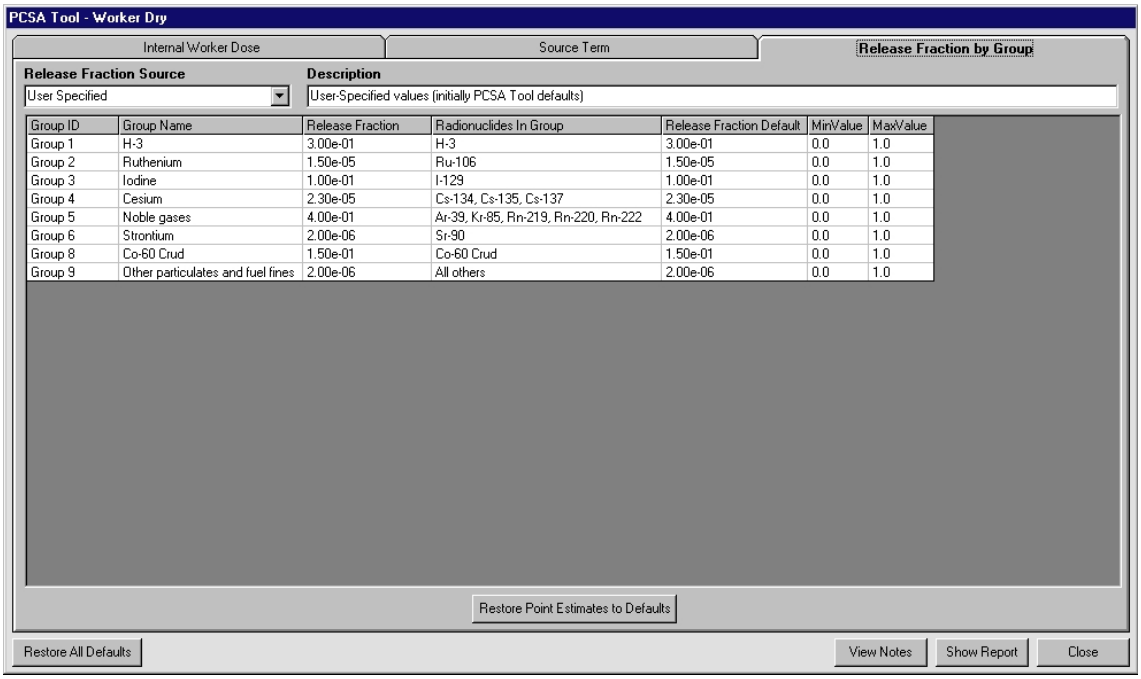
Radionuclide	Inventory (Ci/Assembly)	Release Fraction	Assemblies	Released Activity (Ci)	Half Life (s)	Decay Constant (1/s)	DCF submersion (Sv/Bq-s-m^-3)	DCF submersion (rem/Ci-s-m^-3)	DCF inhalation (Sv/Bq)	DCF inhalation (rem/Ci)
H 3	4.25E+01	3.00e-01	1	1.28E+01	3.8910E+08	1.7814E-09	3.31E-19	1.2247E-06	1.73E-11	6.4010E+01
C 14	3.32E-01	2.00e-06	1	6.64E-07	1.8082E+11	3.8334E-12	2.24E-19	8.2880E-07	5.64E-10	2.0868E+03
CL 36	2.34E-03	2.00e-06	1	4.68E-09	9.4986E+12	7.2974E-14	2.23E-17	8.2510E-05	5.93E-09	2.1941E+04
AR 39	1.44E-05	4.00e-01	1	5.76E-06	8.4888E+09	8.1654E-11	9.10E-18	3.3670E-05	3.06E-11	1.1322E+02
FE 55	5.42E-01	2.00e-06	1	1.08E-06	8.6150E+07	8.0458E-09	0.00E+00	0.0000E+00	7.26E-10	2.6862E+03
NI 59	3.76E-01	2.00e-06	1	7.52E-07	2.3688E+12	2.9286E-13	0.00E+00	0.0000E+00	7.31E-10	2.7047E+03
CO 60	5.39E+01	2.00e-06	1	1.08E-04	1.6635E+08	4.1668E-09	1.26E-13	4.6620E-01	5.91E-08	2.1867E+05
CO 60 Crud	1.84E+01	1.50e-01	1	2.76E+00	1.6635E+08	4.1668E-09	1.26E-13	4.6620E-01	5.91E-08	2.1867E+05
NI 63	4.94E+01	2.00e-06	1	9.88E-05	3.1588E+09	2.1943E-10	0.00E+00	0.0000E+00	1.70E-09	6.2900E+03
SE 79	9.51E-02	2.00e-06	1	1.90E-07	1.0414E+12	6.6559E-13	3.03E-19	1.1211E-06	2.66E-09	9.8420E+03
KR 85	3.83E+02	4.00e-01	1	1.53E+02	3.3829E+08	2.0490E-09	1.19E-16	4.4030E-04	0.00E+00	0.0000E+00
SR 90	8.60E+03	2.00e-06	1	1.72E-02	8.8833E+08	7.8028E-10	7.53E-18	2.7861E-05	3.51E-07	1.2987E+06
Y 90	8.61E+03	2.00e-06	1	1.72E-02	2.3076E+05	3.0038E-06	1.90E-16	7.0300E-04	2.28E-09	8.4360E+03
MO 93	1.70E-04	2.00e-06	1	3.40E-10	1.1045E+11	6.2757E-12	2.52E-17	9.3240E-05	7.68E-09	2.8416E+04
NB 93M	4.07E-01	2.00e-06	1	8.14E-07	5.0901E+08	1.3618E-09	4.44E-18	1.6428E-05	7.90E-09	2.9230E+04
ZR 93	5.74E-01	2.00e-06	1	1.15E-06	4.8282E+13	1.4356E-14	0.00E+00	0.0000E+00	8.67E-08	3.2079E+05
NB 94	2.39E-02	2.00e-06	1	4.78E-08	6.4061E+11	1.0820E-12	7.70E-14	2.8490E-01	1.12E-07	4.1440E+05
TC 99	2.95E+00	2.00e-06	1	5.90E-06	6.6617E+12	1.0405E-13	1.62E-18	5.9940E-06	2.25E-09	8.3250E+03
RH106	3.38E-03	2.00e-06	1	6.76E-09	2.9800E+01	2.3260E-02	1.04E-14	3.8480E-02	1.29E-07	4.7730E+05
RU106	3.38E-03	1.50e-05	1	5.07E-08	3.2105E+07	2.1590E-08	0.00E+00	0.0000E+00	1.29E-07	4.7730E+05
PD107	3.06E-02	2.00e-06	1	6.12E-08	2.0512E+14	3.3792E-15	0.00E+00	0.0000E+00	3.45E-09	1.2765E+04
SN121M	2.73E-01	2.00e-06	1	5.46E-07	1.7356E+09	3.9937E-10	6.02E-17	2.2274E-04	3.11E-09	1.1507E+04
SB125	7.10E+00	2.00e-06	1	1.42E-05	8.6150E+07	8.0458E-09	2.02E-14	7.4740E-02	3.30E-09	1.2210E+04
TE125M	1.73E+00	2.00e-06	1	3.46E-06	5.0112E+06	1.3832E-07	4.53E-16	1.6761E-03	1.97E-09	7.2890E+03
SB126	2.71E-02	2.00e-06	1	5.42E-08	1.0714E+06	6.4695E-07	1.37E-13	5.0690E-01	3.17E-09	1.1729E+04
SB126M	1.94E-01	2.00e-06	1	3.88E-07	1.1400E+03	6.0802E-04	7.50E-14	2.7750E-01	9.17E-12	3.3929E+01

Figure 3.9.2-4. Worker Dose Window for Dry Release—Source Term Tab

3.9.2.2.2.3 *Release Fraction by Group*

This section presents the input parameters for the **Release Fraction by Group** tab shown in Figure 3.9.2-5. For each Group ID, the corresponding Group Name, Release Fraction, Radionuclides in Group, Default Value, MinValue, and MaxValue are displayed.

The Release Fraction column is the only column that can be edited by the user, and it can only be edited if the Release Fraction Source is set to "User Specified." The Release Fraction Default column displays the default setting for the Release Fraction value. The MinValve and MaxValve columns display the minimum and maximum values for each respective group and is used for checking the user input.



Group ID	Group Name	Release Fraction	Radionuclides In Group	Release Fraction Default	MinValue	MaxValue
Group 1	H-3	3.00e-01	H-3	3.00e-01	0.0	1.0
Group 2	Ruthenium	1.50e-05	Ru-106	1.50e-05	0.0	1.0
Group 3	Iodine	1.00e-01	I-129	1.00e-01	0.0	1.0
Group 4	Cesium	2.30e-05	Cs-134, Cs-135, Cs-137	2.30e-05	0.0	1.0
Group 5	Noble gases	4.00e-01	Ar-39, Kr-85, Rn-219, Rn-220, Rn-222	4.00e-01	0.0	1.0
Group 6	Strontium	2.00e-06	Sr-90	2.00e-06	0.0	1.0
Group 8	Co-60 Crud	1.50e-01	Co-60 Crud	1.50e-01	0.0	1.0
Group 9	Other particulates and fuel fines	2.00e-06	All others	2.00e-06	0.0	1.0

Figure 3.9.2-5. Worker Dose Window for Dry Release—Release Fraction by Group Tab

3.9.2.3 *Normal Operation Dose*

Selecting the *Normal Operation Dose* submenu displays the **Worker Normal Operation Dose** window shown in Figure 3.9.2-6. The **Worker Normal Operation Dose** window allows the user to enter a normal operational dose to the worker and a description or justification for the data.

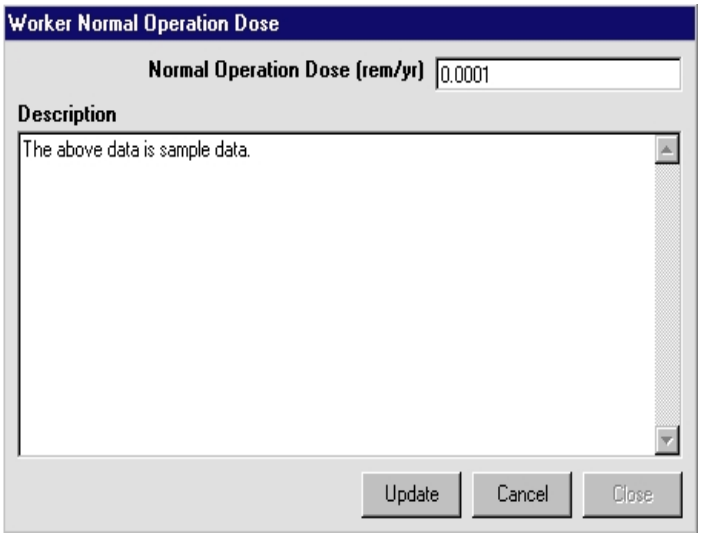


Figure 3.9.2-6. Public Normal Operation Dose Window

Action Commands

Edit: Allows the user to change the Normal Operation Dose and Description.

Cancel: Cancels changes made by the user.

Update: Saves changes made by the user.

Close: Closes the **Worker Normal Operation Dose** window.

3.9.3 *Advanced RSAC Input*

3.9.3.1 Input

The additional menu, *Advanced RSAC Input*, enables a deterministic dose calculation and is intended for advanced users familiar with the RSAC code and input file. This menu was added to provide maximum flexibility to the user. As a result, the advanced RSAC calculations are isolated from the rest of the PCSA Tool and are not tracked by the PCSA Tool. The results of the advanced RSAC calculations cannot be retrieved. The most recent advanced RSAC input file can be restored and rerun.

For those instances when the *Standard RSAC Input* does not contain the radionuclides desired for the dose calculation, it is recommended the user select the *Advanced RSAC Input* menu and add appropriate radionuclides into the input file from the full list of radionuclides allowed by the standard RSAC code.

To perform advanced RSAC calculations, users edit the RSAC input file directly. As shown in Figure 3.9.3-1, the user has two options for selecting the advanced RSAC input file: (i) the RSAC input file can be generated from the current consequence input of the PCSA Tool or (ii) the existing advanced RSAC input file can be retrieved.

For option (a), select **Get RSAC input file from PCSA Tool** (see Figure 3.9.3-1) and click **OK** on the following window stating, **RSAC Input File copied to RSAC directory**. The Advanced RSAC input file will open in the Microsoft Windows notepad editor notepad.exe, as shown in Figure 3.9.3-2.

For option (b), select **Edit existing Advanced RSAC Input File** (see Figure 3.9.3-1). The Advanced RSAC input file will open in notepad.exe as shown in Figure 3.9.3-2.

Edit, **Save**, and **Close** the *Advanced RSAC Input* file and then press the **Run Advanced** button (see Figure 3.9.3-1).

When the calculation is complete, the RSAC output file will automatically open in notepad.exe. In the RSAC output files, the results of the dose calculation are listed after the RSAC inputs. Close the output file when the inspection of the results is completed. Check the **Exit Run Advanced** button (see Figure 3.9.3-1) when no further advanced RSAC calculations are needed.

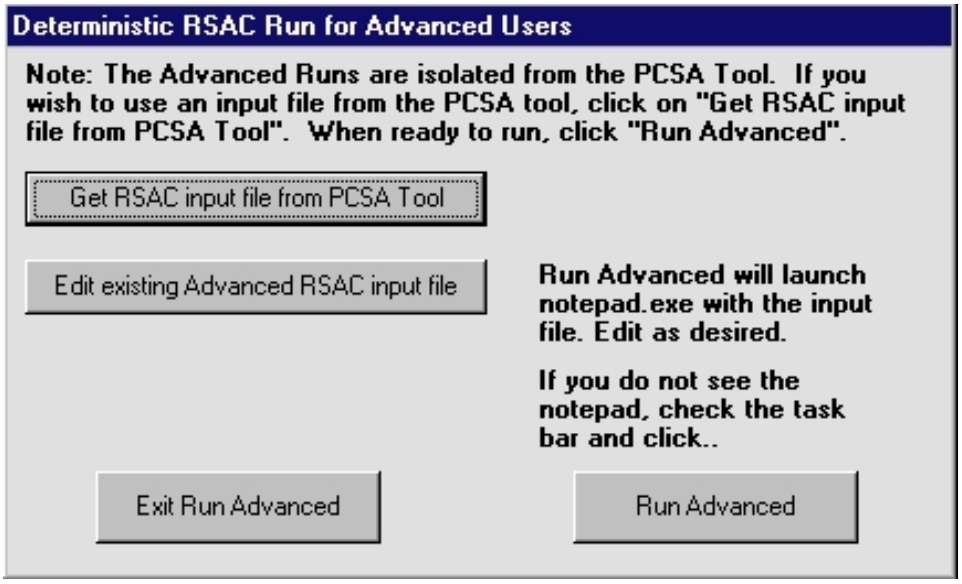


Figure 3.9.3-1. Advanced Input for RSAC

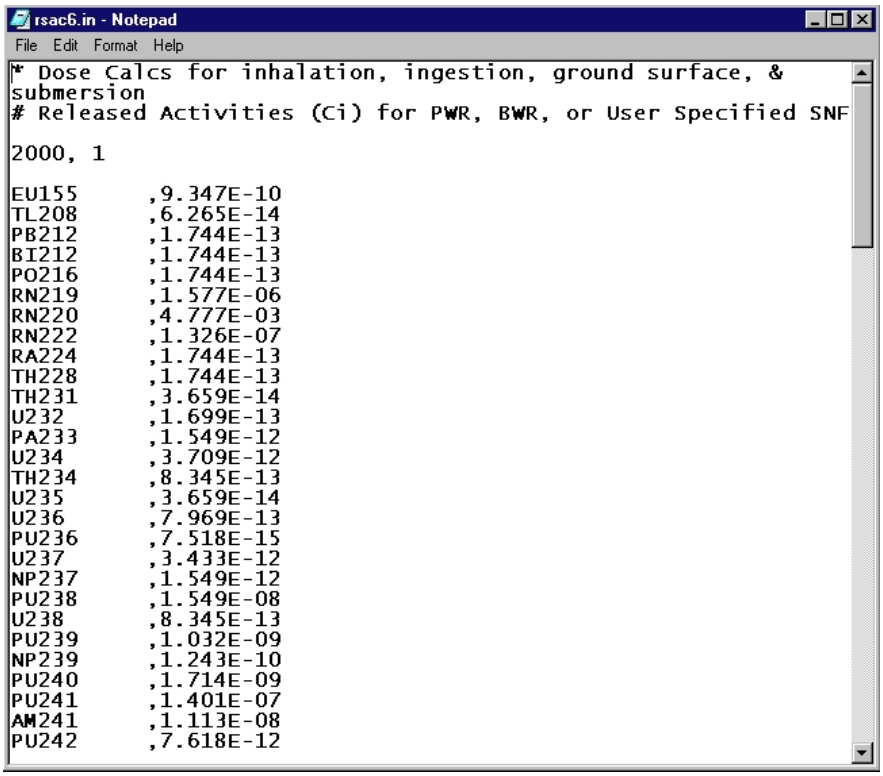


Figure 3.9.3-2. Advanced RSAC Input File

3.9.3.2 Output

Outputs are automatically displayed after a public dose calculation is performed. Selecting *Show Output* Folder will display the results from the most recent RSAC run in tabular and graphical format, as shown in Figure 3.9.3-3 (a, b).

The RSAC Output window contains five result tabs:

(1) **Summary Results**—This folder lists the effective dose equivalents (i.e., whole body doses) from the four pathways. The doses from the four pathways are summed, and the results are displayed in the bottom row labeled TEDE.

(2) **Inhalation**—This tab lists the organ committed dose equivalents from the inhalation pathway. The committed effective dose equivalent (CEDE) for inhalation corresponds to the effective whole-body dose from inhalation shown in the **Summary Results** folder.

(3) **Ingestion**—This tab lists the organ committed dose equivalents from the ingestion pathway. CEDE for ingestion corresponds to the effective whole-body dose from ingestion shown in the **Summary Results** folder.

(4) **Ground Surface**—This tab lists the organ committed dose equivalents from the ground surface pathway. The external effective dose equivalent (EXTEDE) from the ground

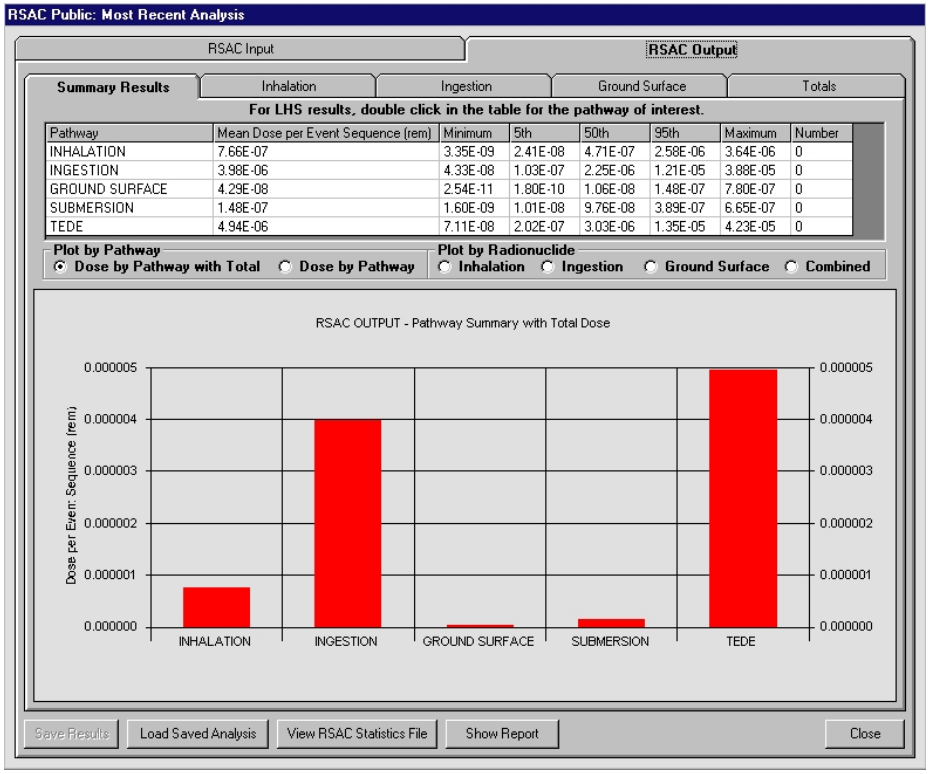
surface pathway corresponds to the effective whole-body dose from deposition on the ground surface shown in the **Summary Results** folder.

(5) **Totals**—This tab lists the total doses summed for the four pathways for each organ. The row labeled TEDE lists the effective whole-body doses (i.e., TEDEs) for reference.

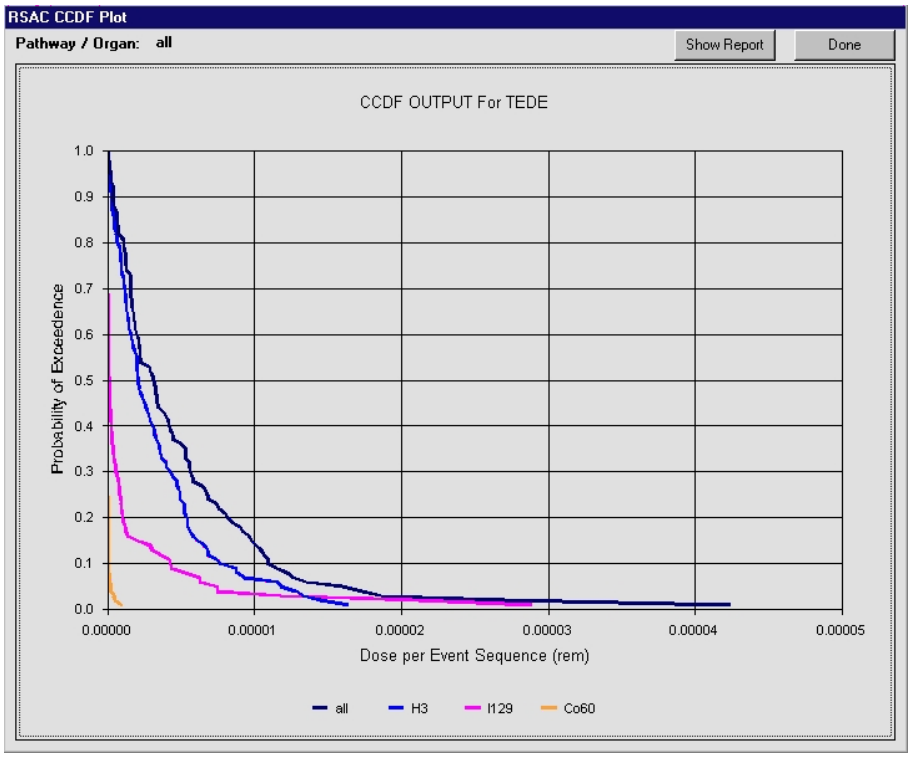
The RSAC code does not calculate organ doses for the submersion pathway. The effective dose equivalent from the submersion pathway is calculated and included in the **Summary Results** folder for the whole body and in the **Totals** folder for individual organs.

For deterministic calculations, a bar chart displays the pathway and radionuclide contributions corresponding to the tabulated values in the **Summary Results** folder [see Figure 3.9.3-3(a)].

For probabilistic calculations, the bar chart displays the pathway and radionuclide contributions to the mean dose to the whole body. In the **Summary Results** folder, the user can double-click on any pathway dose to display a plot of the complementary cumulative distribution function of the whole body dose for that pathway [see Figure 3.9.3-3(b)]. In the other results folders, the user can double-click on any organ or radionuclide dose to display a plot of the complementary cumulative distribution function for that organ or radionuclide and pathway.



(a)



(b)

Figure 3.9.3-3. RSAC Output for (a) Deterministic Calculation and (b) Probabilistic Calculation

Action Commands

Load Saved Analysis:	Allows the user to view the results from a previously saved analysis. The saved analysis can be selected as follows: • Select and open the /Det directory for a deterministic run or the /Prb directory for a probabilistic run • Select and open the results folder (folder name was specified by the user when the results were saved) • Select and open the file RSAC_Run.mdb
Save Results:	Prompts the user for a subdirectory name to save the current results. The name can be used for viewing previously stored data and should be sufficiently descriptive of the dose calculation. A dose calculation typically corresponds to some event sequence that can be described by the file name.
Show Report:	Displays the output data in graphical and tabular format.
View RSAC Output File:	(for deterministic runs) Opens the pcsastat.txt results file in notepad.exe. Shows all the results of the five results folders.
View RSAC Statistics File:	(for probabilistic runs) Opens the pcsastat.txt results file in notepad.exe. Shows all the results of the five results folders.
Close:	Closes the RSAC Output window.

3.10 Perform.

The ***Perform.*** menu has two submenus: *Current Level Results* and *Project Results*.

3.10.1 *Current Level Results*

The *Current Level Results* submenu contains the *Public* and *Worker* options.

3.10.1.1 *Public*

Selecting the *Public* submenu opens the **Results Table** window (see Figure 3.10.1-1) that shows the integrated results from event frequency analysis and dose consequence analysis in tabular form. The frequency data for event sequences for the functional area entered in the **Event Sequence Form** are automatically brought into this window. The dose consequence results for point estimate (deterministic) and probabilistic cases for each event sequence are populated in this window. The individual data entry fields are presented next.

Item No: Displays an item number of event sequences

EvScen ID: Displays event Scenario ID

EvSeq ID: Displays event Sequence ID

EvSeq Freq: Displays Event Sequence Frequency entered in the **Event Sequence Form** (Figure 3.8.4-1)

Category: The PSCA Tool assigns a frequency Category 1, 2, or Below Category 2 frequency to the event sequence based on definitions in 10 CFR Part 63 and the preclosure period.

Description: Corresponds to the Description input in the **Event Sequence Form**

Manual Data: From the event scenario initiating event form, the user specifies if manual data may be entered. If so, the user is allowed to enter point estimate (deterministic) dose information directly.

Det Conseq Path: Displays file name and path for point estimate or deterministic dose evaluated using the ***Conseq***. menu. Double clicking in any of the Det Conseq Path cells will display a directory menu (see Figure 3.10.1-2) that allows the user to select a file from any deterministic runs that have been saved. The user has the option to **Accept** a selected file, choose **No Release**, or **Cancel**. For DOE-analyzed Events, the Det Conseq Path cell will be inactive.

Dose PtEst: Displays point estimate (deterministic) dose from the selected consequence analysis file. If data are allowed to be entered manually, an edit box appears by double clicking on the cell as shown in Figure 3.10.1-3. The user manually enters the dose.

Prob Conseq Path: Displays file name and path for probabilistic dose evaluated using ***Conseq***. menu.

Dose, Mean: Displays value automatically when Prob Conseq Path is selected. Additional Info_: Displays additional information for the event sequence and is entered manually on this form.

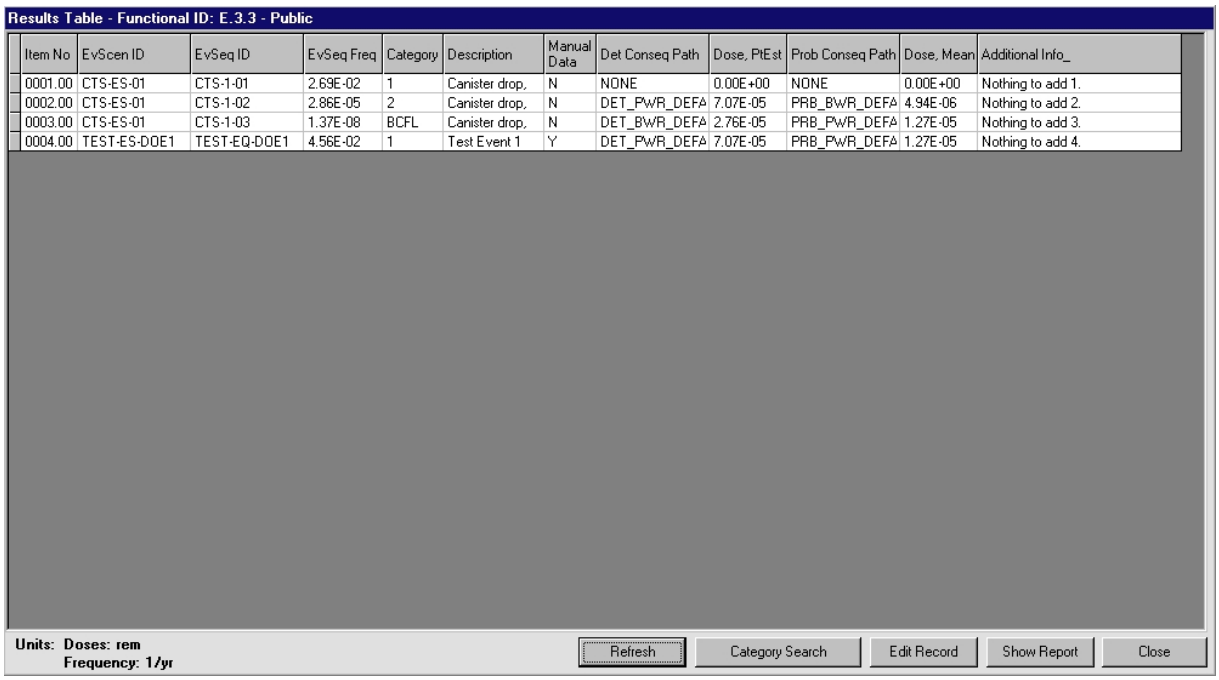


Figure 3.10.1-1. Results Table Window

Action Commands

Refresh: Displays all categories in the **Results Table** window.

Category Search: Prompts the user to enter a Category of 1, 2, or Below Category 2 frequency and displays list of event sequences sorted by frequency category.

Edit Record: Allows the user to edit the Det Conseq Path, Dose, PtEst (if Manual Data is "Y"), Prob Conseq Path, and Additional Info_ fields.

Show Report: Displays information in report format.

Close: Return to main project screen retaining any changes made in the window.

⇛ *Note: The **Results Table** window displays only data from the **Event Sequence Form** that corresponds to the selected Functional ID from the Project Tree.*

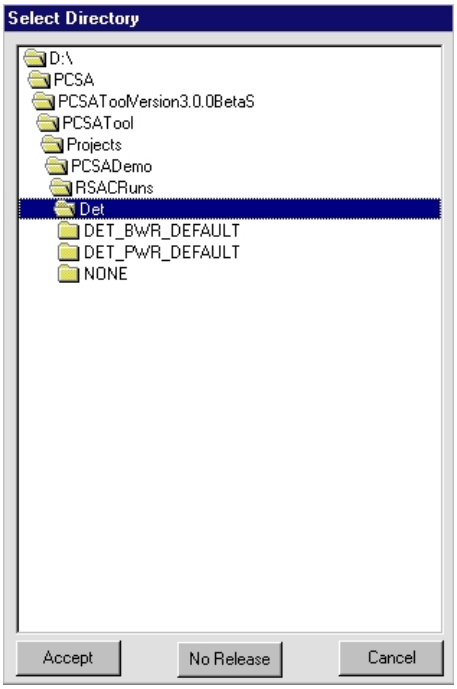


Figure 3.10.1-2. Directory Window

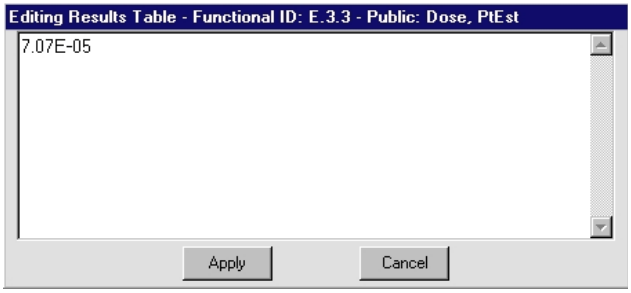


Figure 3.10.1-3. Dose Input Window

3.10.1.2 *Worker*

The *Worker* submenu contains two options: *Involved* and *Noninvolved*.

3.10.1.2.1 *Involved*

Selecting the *Involved* option will display the involved worker **Results Table** (see Figure 3.10.1-4) that shows the integrated results from event frequency analysis and dose consequence analysis in tabular form for the involved worker. The frequency data for event sequences for the functional area entered in the **Event Sequence Form** designated Worker Dose or Both are automatically brought into this window. The dose consequence results for Internal and External dose to the involved worker are entered in this window and then added together to obtain the TEDE for the involved worker. The individual data fields are presented next.

Item No: Displays item number of event sequences

EvScen ID: Displays event Scenario ID

EvSeq ID: Displays event Sequence ID

EvSeq Freq: Displays Event Sequence Frequency entered in the **Event Sequence Form** (Figure 3.8.4-1).

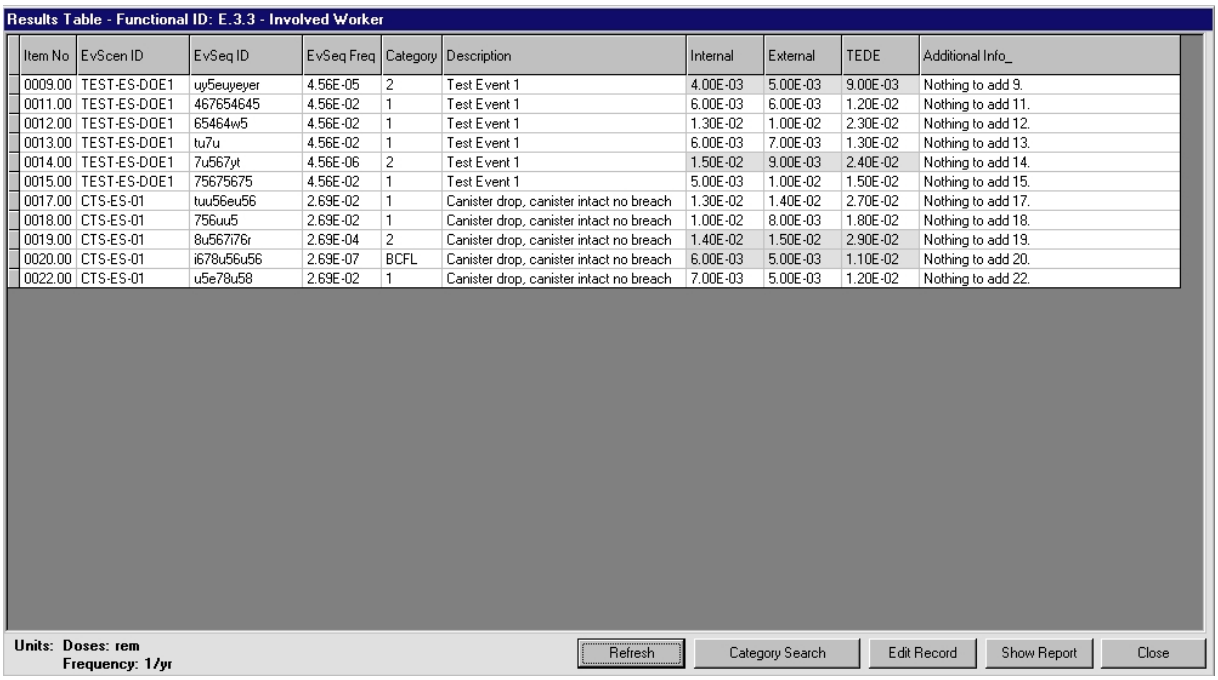
Category: The PCSA Tool assigns a frequency Category 1, 2, or BCFL to the event sequence based on definitions in 10 CFR Part 63 and the preclosure period.

Description: Corresponds to the Description input in the **Event Sequence Form**

Internal: Displays the internal dose to the involved worker entered manually on this form.

External: Displays the external dose to the involved worker entered manually on this form.

TEDE: Displays the sum of the internal dose and external dose to the involved worker.



Item No	EvScen ID	EvSeq ID	EvSeq Freq	Category	Description	Internal	External	TEDE	Additional Info_
0009.00	TEST-ES-DOE1	uy5euyeyer	4.56E-05	2	Test Event 1	4.00E-03	5.00E-03	9.00E-03	Nothing to add 9.
0011.00	TEST-ES-DOE1	467654645	4.56E-02	1	Test Event 1	6.00E-03	6.00E-03	1.20E-02	Nothing to add 11.
0012.00	TEST-ES-DOE1	65464w5	4.56E-02	1	Test Event 1	1.30E-02	1.00E-02	2.30E-02	Nothing to add 12.
0013.00	TEST-ES-DOE1	tu7u	4.56E-02	1	Test Event 1	6.00E-03	7.00E-03	1.30E-02	Nothing to add 13.
0014.00	TEST-ES-DOE1	7u567yt	4.56E-06	2	Test Event 1	1.50E-02	9.00E-03	2.40E-02	Nothing to add 14.
0015.00	TEST-ES-DOE1	75675675	4.56E-02	1	Test Event 1	5.00E-03	1.00E-02	1.50E-02	Nothing to add 15.
0017.00	CTS-ES-01	tuu56eu56	2.69E-02	1	Canister drop, canister intact no breach	1.30E-02	1.40E-02	2.70E-02	Nothing to add 17.
0018.00	CTS-ES-01	756uu5	2.69E-02	1	Canister drop, canister intact no breach	1.00E-02	8.00E-03	1.80E-02	Nothing to add 18.
0019.00	CTS-ES-01	8u567i76r	2.69E-04	2	Canister drop, canister intact no breach	1.40E-02	1.50E-02	2.90E-02	Nothing to add 19.
0020.00	CTS-ES-01	i678u56u56	2.69E-07	BCFL	Canister drop, canister intact no breach	6.00E-03	5.00E-03	1.10E-02	Nothing to add 20.
0022.00	CTS-ES-01	u5e78u58	2.69E-02	1	Canister drop, canister intact no breach	7.00E-03	5.00E-03	1.20E-02	Nothing to add 22.

Figure 3.10.1-4. Involved Worker Window

Additional Info_: Displays additional information for the event sequence and is entered manually on this form.

Action Commands

Refresh: Displays all categories in the **Results Table** window.

Category Search: Prompts the user to enter a Category of 1, 2, or BCFL and displays a list of event sequences sorted by frequency category.

Edit Record:	Allows the user to edit the Internal, External, and Additional Info_ fields.
Show Report:	Displays the information in report format.
Close:	Returns to the main project screen retaining any changes made in the window.

⇒ *Note: The **Results Table** window displays only data from the **Event Sequence Form** that correspond to the selected Functional ID from the Project Tree.*

3.10.1.2.2 *Noninvolved*

Selecting the *Noninvolved* option will display the noninvolved worker **Results Table** (see Figure 3.10.1-5) that shows the integrated results from event frequency analysis and dose consequence analysis in tabular form for the noninvolved worker. The frequency data for event sequences for the functional area entered in the **Event Sequence Form** that are designated Public or Both are automatically brought into this window. The dose consequence results for Internal (Facility) and External (Facility) dose to the noninvolved worker are entered in this window and then added together to obtain the TEDE (Facility) for the noninvolved worker. In addition, the Dose Rate for the noninvolved worker is entered in this window. The individual data fields are presented next.

Item No: Displays the item number of event sequences.

EvScen ID: Displays the event Scenario ID.

EvSeq ID: Displays the event Sequence ID.

EvSeq Freq: Displays the Event Sequence Frequency entered in the Event Sequence Form (Figure 3.8.4-1).

Category: The PCSA Tool assigns a frequency Category 1, 2, or Below Category 2 frequency (BCFL) to the event sequence based on definitions in 10 CFR Part 63 and the preclosure period.

Description: Corresponds to the Description input in the **Event Sequence Form**.

Dose Rate (rem/hr): Displays the dose rate to the noninvolved worker entered manually on this form.

Internal (Facility): Displays the internal dose to the noninvolved worker entered manually on this form.

External (Facility): Displays the external dose to the noninvolved worker entered manually on this form.

TEDE (Facility): Displays the sum of the internal and external dose to the noninvolved worker.

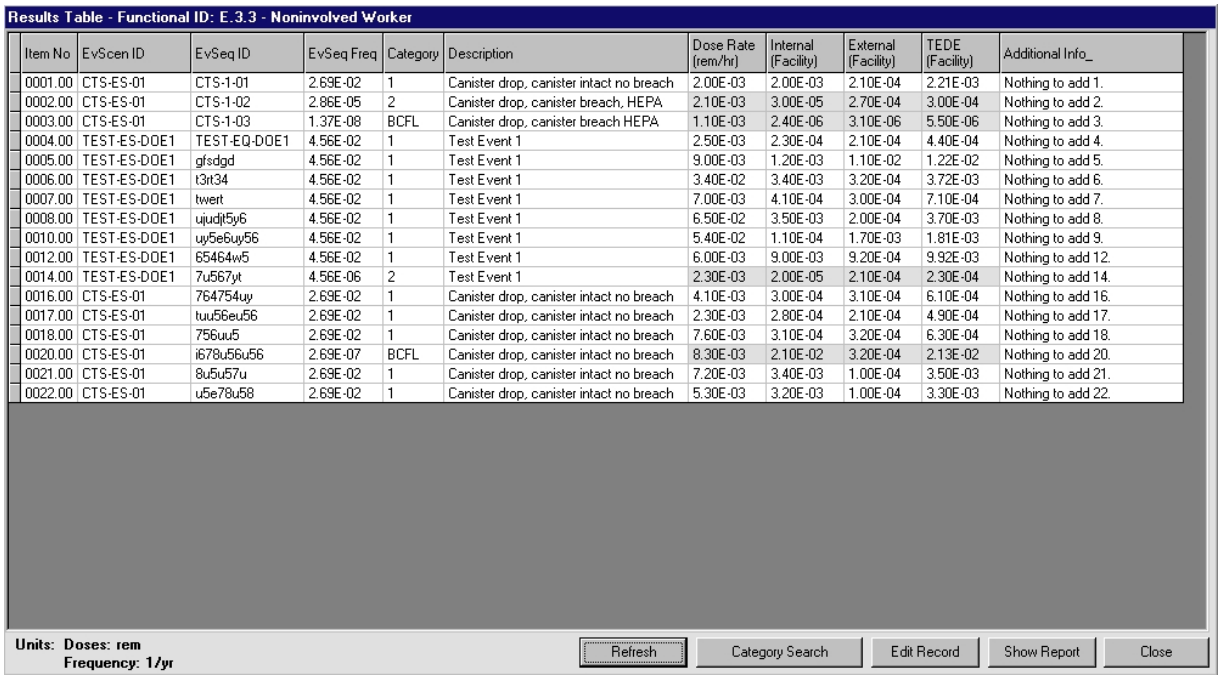


Figure 3.10.1-5. Noninvolved Worker Window

Additional Info_: Displays additional information for the event sequence and is entered manually on this form.

Action Commands

Refresh: Displays all categories in the **Results Table** window.

Category Search: Prompts the user to enter a Category of 1, 2, or Below Category 2 frequency and displays a list of event sequences sorted by frequency category.

Edit Record: Allows the user to edit the Dose Rate, Internal (Facility), External (Facility), and Additional Info_ fields.

Show Report: Displays information in report format.

Close: Returns to main project screen retaining any changes made in the window.

⇛ *Note: The **Results Table** window displays only data from the **Event Sequence Form** that corresponds to the selected Functional ID from the Project Tree.*

3.10.2 *Project Results*

The *Project Results* submenu has more submenus, *Safety Assessment*, *Risk Assessment, Public*, and *Display Structures, Systems, and Components*.

3.10.2.1 *Safety Assessment*

The *Safety Assessment* submenu contains two options: *Public* and *Worker*.

3.10.2.1.1 *Public*

Selecting the *Public* submenu will display the **Result Table–Project View Base Case Public** form (see Figure 3.10.2-1) showing the results (i.e., frequencies and consequences) from all Functional ID areas. Data cannot be entered or edited in this form. The user selects the type of information to display—either Deterministic (Point Estimate) or Probabilistic (Mean). Clicking the **Compliance Assessment** button prompts the user to enter a Category of 1, 2, or below Category 2 frequency.

Selecting Category 1 will sort all Category 1 event sequences in the Result Table and display the Safety Assessment–Category 1 **Event Sequences** window as shown in Figure 3.10.2-2. The dose in the Normal Operation Dose field does not correspond to any event sequence and is estimated outside the tool. The Total Dose is compared in the regulatory dose limit given next. If the Total Dose value is greater than the Regulatory Limit, the Total Dose box will be highlighted in red. Clicking the **Calculate** button in the Combination of Events group (on the right side of the window) will display Figure 3.10.2-3. The PCSA tool provides the capability to evaluate combination Category 1 event sequences that could occur in the same year and in which the expected number of occurrences equals or exceeds the cutoff. The combination dose should not exceed the regulatory dose limit for Category 1 event sequences. More details about combining event sequences can be found in Benke, et al. (2003).

Choosing Category 2, in response to Compliance Assessment button, will sort all Category 2 event sequences, and the user must look for Compliance in each event sequence.

Results Table - Project View Base Case - Public

FunctionalID	EvScen ID	EvSeq ID	EvSeq Freq	Category	Description	Manual Data	Dose, PtEst	Dose, Mean	Additional Info_
B.2.2	ES-TROVHE-1	ESQ-TROVHE-1-1	1.40E+00	1	Human error (Operator initiates	N	0.00E+00		
B.2.2	ES-TROVHE-1	ESQ-TROVHE-1-2	0.00E+00	BCFL	Human error (Operator initiates	N	0.00E+00		
B.2.2	ES-TROVHE-1	ESQ-TROVHE-1-3	0.00E+00	BCFL	Human error (Operator initiates	N	0.00E+00		
B.2.2	ES-TROVHE-1	ESQ-TROVHE-1-4	0.00E+00	BCFL	Human error (Operator initiates	N	0.00E+00		
B.2.2	ES-TROVHE-1	ESQ-TROVHE-1-5	2.10E-07	BCFL	Human error (Operator initiates	N	1.87E-03		
B.2.2	ES-TROVHE-1	ESQ-TROVHE-1-6	2.50E-12	BCFL	Human error (Operator initiates	N	4.73E-03		
B.2.2	ES-TROVHE-1	ESQ-TROVHE-1-7	1.70E-10	BCFL	Human error (Operator initiates	N			
B.2.3	ES-ADHP1-1	ESQ-ADHP1-1-1	0.00E+00	BCFL	Fuel cladding intact	N	0.00E+00		
B.2.3	ES-ADHP1-1	ESQ-ADHP1-1-2	1.00E-02	2	Fuel cladding breach, HVAC	N	7.07E-05		Height of Stack=34 m
B.2.3	ES-ADHP1-1	ESQ-ADHP1-1-3	1.20E-07	BCFL	Fuel cladding breach, HVAC	N	1.00E-04		
B.2.3	ES-ATMFL1-1	ESQ-ATMFL-1-1-3	1.40E-05	2	Fuel cladding breach, HVAC	N	2.00E-04		
B.2.3	ES-ATMFL1-1	ESQ-ATMFL1-1-1	0.00E+00	BCFL	Fuel cladding intact . All	N	0.00E+00		
B.2.3	ES-ATMFL1-1	ESQ-ATMFL1-1-2	1.15E+00	1	Fuel cladding breach, HVAC	N	1.42E-04		Height of Stack=34 m
B.2.3	ES-ATMFL2-1	ESQ-ATMFL2-1-1	0.00E+00	BCFL	Fuel caldding intact.	N	0.00E+00		
B.2.3	ES-ATMFL2-1	ESQ-ATMFL2-1-2	1.43E-01	1	Fuel cladding breach, HVAC	N	7.07E-05		Height of Stack=34 m
B.2.3	ES-ATMFL2-1	ESQ-ATMFL2-1-3	1.72E-06	BCFL	Cladding breach, HVAC	N	1.00E-04		
B.2.3	ES-ATMFL3-1	EQS-ATMFL3-1-2	5.73E-01	1	Cladding breach, HVAC and	N	1.42E-04		Height of Stack=34 m
B.2.3	ES-ATMFL3-1	ESQ-ATMFL3-1-1	0.00E+00	BCFL	Cladding intact upon drop	N	0.00E+00		
B.2.3	ES-ATMFL3-1	ESQ-ATMFL3-1-3	6.88E-06	2	Cladding breach; HVAC	N	2.00E-04		
B.2.3	ES-ATMFL4-1	ESQ-ATMFL4-1-1	0.00E+00	BCFL	Fuel cladding intact	N	0.00E+00		
B.2.3	ES-ATMFL4-1	ESQ-ATMFL4-1-2	7.17E-01	1	Fuel cladding breach, HVAC	N	1.42E-04		Height of Stack=34 m
B.2.3	ES-ATMFL4-1	ESQ-ATMFL4-1-3	8.60E-06	2	Cladding breach, HVAC	N	2.00E-04		
B.2.3	ES-ATMFL5-1	ESQ-ATMFL5-1-1	0.00E+00	BCFL	Fuel cladding intact	N	0.00E+00		
B.2.3	ES-ATMFL5-1	ESQ-ATMFL5-1-2	5.60E-02	1	Fuel cladding breach, HVAC	N	7.07E-05		Height of Stack=34 m
B.2.3	ES-ATMFL5-1	ESQ-ATMFL5-1-3	6.72E-07	BCFL	Fuel cladding breach, HVAC	N	1.00E-04		
B.2.3	ES-ATMFL6-1	ESQ-ATMFL6-1-1	0.00E+00	BCFL	Fuel cladding intact	N	0.00E+00		
B.2.3	ES-ATMFL6-1	ESQ-ATMFL6-1-2	2.24E-01	1	Fuel cladding breach, HVAC	N	1.42E-04		Height of Stack=34 m
B.2.3	ES-ATMFL6-1	ESQ-ATMFL6-1-3	2.69E-06	BCFL	Fuel cladding breach, HVAC	N	2.00E-04		

Units: Doses: rem
Frequency: 1/yr

Takeaway | Refresh | Compliance Assessment | Edit Record | Show Report | Close

Figure 3.10.2-1. Safety Assessment Results Table - Public

Safety Assessment - Category 1 Event Sequences

Frequency-Weighted Annualized Dose

	Dose Rem / Year
Frequency Weighted Sum:	7.35E-05
Normal Operation Dose:	0.00E+00
Total Dose:	7.35E-05
Regulatory Limit:	0.015

[10CFR Part 63.111(a)(2)]

Combination of Events

Cutoff for Expected Number of Events: 1.00E-02

Calculate

Done

Figure 3.10.2-2. Category 1 Event Sequences

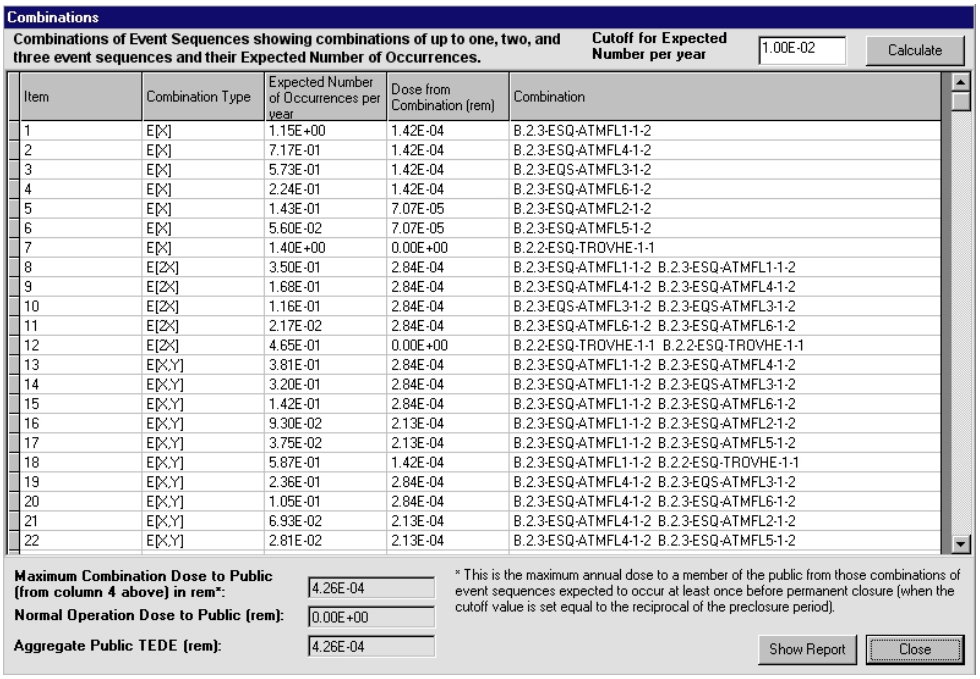


Figure 3.10.2-3. Output for the Calculations of Combination of Events

Action Commands

Takeaway: Allows the user to perform a takeaway analysis involving structures, systems, and components important to safety. Users interested in using this feature are advised to consult Dasgupta, et al. (2002, Chapter 9).

Refresh: Displays all categories in the **Results Table** window if **Safety Assessment** has been activated.

Compliance Assessment: Prompts the user to enter a Category of 1, 2, or below Category 2 frequency and displays only that Category in the **Results Table** window. Selecting Category 1 prompts the user with a Safety Assessment window, as in Figure 3.10.2-2.

Show Report: Displays information in report format.

Close: Returns to the main project screen retaining any changes made in the window.

3.10.2.1.2 *Worker*

The *Worker* option contains two suboptions: *Involved* and *Noninvolved*.

3.10.2.1.2.1 *Involved*

Selecting the *Involved* suboption will display the **Result Table–Project View Base Case Involved Worker** form (see Figure 3.10.2-4) showing results (i.e., frequencies and consequences) from all Functional ID areas for the involved worker. Data cannot be entered or edited in this form. This form and the associated **Compliance Assessment** forms are similar to those for the public except, in this case, only a deterministic assessment is performed.

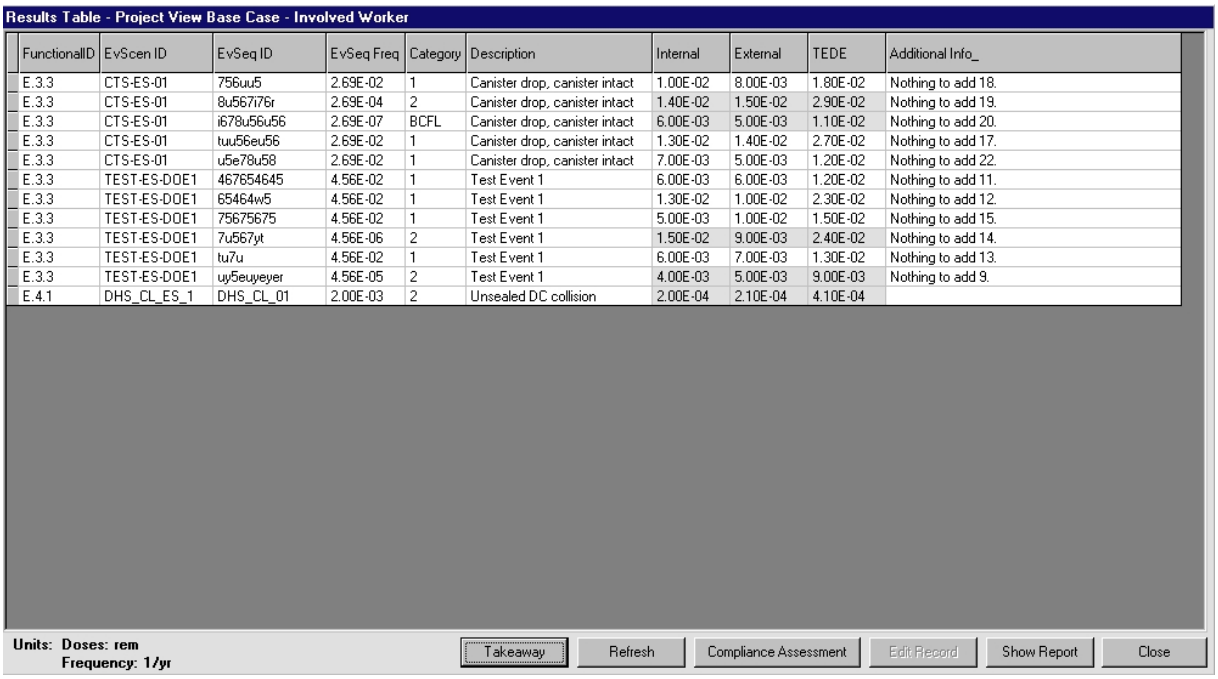
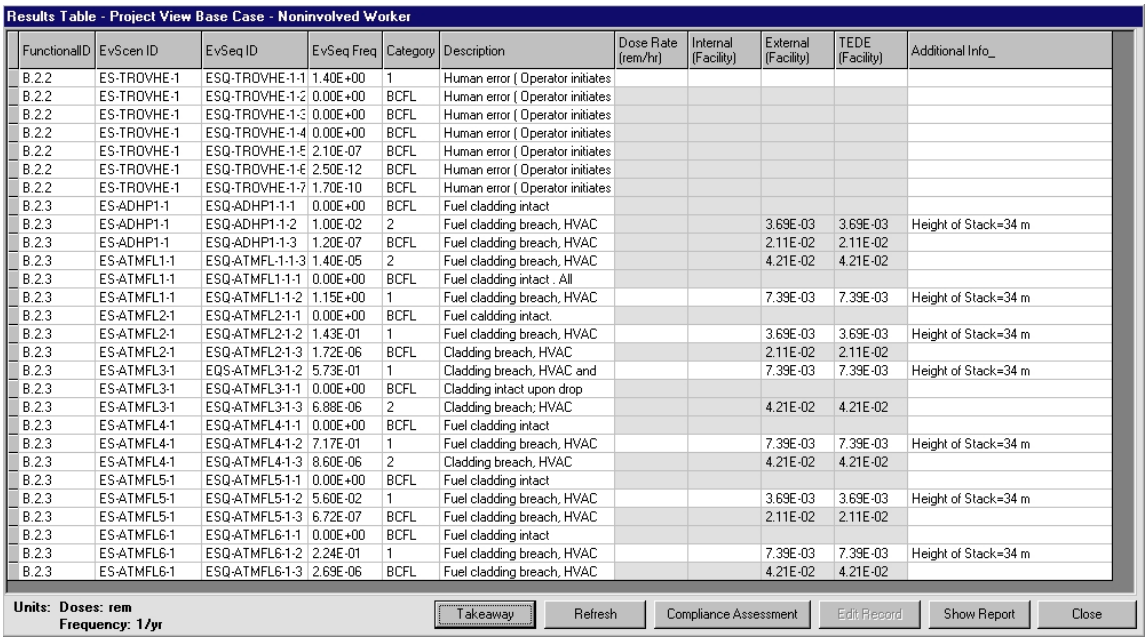


Figure 3.10.2-4. Safety Assessment Results Table - Involved Worker

3.10.2.1.2.2 *Noninvolved*

Selecting the *Noninvolved* suboption will display the **Result Table–Project View Base Case Noninvolved Worker** form (see Figure 3.10.2-5) showing results (i.e., frequencies and consequences) from all Functional ID areas for the noninvolved worker. Data cannot be entered or edited in this form. This form and the associated **Compliance Assessment** forms are similar to those for the public except, in this case, only a deterministic assessment is performed.



Results Table - Project View Base Case - Noninvolved Worker

FunctionalID	EvScen ID	EvSeq ID	EvSeq Freq	Category	Description	Dose Rate (rem/hr)	Internal (Facility)	External (Facility)	TEDE (Facility)	Additional Info_
B.2.2	ES-TROVHE-1	ESQ-TROVHE-1-1	1.40E+00	1	Human error (Operator initiates					
B.2.2	ES-TROVHE-1	ESQ-TROVHE-1-2	0.00E+00	BCFL	Human error (Operator initiates					
B.2.2	ES-TROVHE-1	ESQ-TROVHE-1-3	0.00E+00	BCFL	Human error (Operator initiates					
B.2.2	ES-TROVHE-1	ESQ-TROVHE-1-4	0.00E+00	BCFL	Human error (Operator initiates					
B.2.2	ES-TROVHE-1	ESQ-TROVHE-1-5	2.10E-07	BCFL	Human error (Operator initiates					
B.2.2	ES-TROVHE-1	ESQ-TROVHE-1-6	2.50E-12	BCFL	Human error (Operator initiates					
B.2.2	ES-TROVHE-1	ESQ-TROVHE-1-7	1.70E-10	BCFL	Human error (Operator initiates					
B.2.3	ES-ADHP1-1	ESQ-ADHP1-1-1	0.00E+00	BCFL	Fuel cladding intact					
B.2.3	ES-ADHP1-1	ESQ-ADHP1-1-2	1.00E-02	2	Fuel cladding breach, HVAC			3.69E-03	3.69E-03	Height of Stack=34 m
B.2.3	ES-ADHP1-1	ESQ-ADHP1-1-3	1.20E-07	BCFL	Fuel cladding breach, HVAC			2.11E-02	2.11E-02	
B.2.3	ES-ATMFL1-1	ESQ-ATMFL-1-1-3	1.40E-05	2	Fuel cladding breach, HVAC			4.21E-02	4.21E-02	
B.2.3	ES-ATMFL1-1	ESQ-ATMFL1-1-1	0.00E+00	BCFL	Fuel cladding intact . All					
B.2.3	ES-ATMFL1-1	ESQ-ATMFL1-1-2	1.15E+00	1	Fuel cladding breach, HVAC			7.39E-03	7.39E-03	Height of Stack=34 m
B.2.3	ES-ATMFL2-1	ESQ-ATMFL2-1-1	0.00E+00	BCFL	Fuel caldding intact.					
B.2.3	ES-ATMFL2-1	ESQ-ATMFL2-1-2	1.43E-01	1	Fuel cladding breach, HVAC			3.69E-03	3.69E-03	Height of Stack=34 m
B.2.3	ES-ATMFL2-1	ESQ-ATMFL2-1-3	1.72E-06	BCFL	Cladding breach, HVAC			2.11E-02	2.11E-02	
B.2.3	ES-ATMFL3-1	EQS-ATMFL3-1-2	5.73E-01	1	Cladding breach, HVAC and			7.39E-03	7.39E-03	Height of Stack=34 m
B.2.3	ES-ATMFL3-1	ESQ-ATMFL3-1-1	0.00E+00	BCFL	Cladding intact upon drop					
B.2.3	ES-ATMFL3-1	ESQ-ATMFL3-1-3	6.88E-06	2	Cladding breach; HVAC			4.21E-02	4.21E-02	
B.2.3	ES-ATMFL4-1	ESQ-ATMFL4-1-1	0.00E+00	BCFL	Fuel cladding intact					
B.2.3	ES-ATMFL4-1	ESQ-ATMFL4-1-2	7.17E-01	1	Fuel cladding breach, HVAC			7.39E-03	7.39E-03	Height of Stack=34 m
B.2.3	ES-ATMFL4-1	ESQ-ATMFL4-1-3	8.60E-06	2	Cladding breach, HVAC			4.21E-02	4.21E-02	
B.2.3	ES-ATMFL5-1	ESQ-ATMFL5-1-1	0.00E+00	BCFL	Fuel cladding intact					
B.2.3	ES-ATMFL5-1	ESQ-ATMFL5-1-2	5.60E-02	1	Fuel cladding breach, HVAC			3.69E-03	3.69E-03	Height of Stack=34 m
B.2.3	ES-ATMFL5-1	ESQ-ATMFL5-1-3	6.72E-07	BCFL	Fuel cladding breach, HVAC			2.11E-02	2.11E-02	
B.2.3	ES-ATMFL6-1	ESQ-ATMFL6-1-1	0.00E+00	BCFL	Fuel cladding intact					
B.2.3	ES-ATMFL6-1	ESQ-ATMFL6-1-2	2.24E-01	1	Fuel cladding breach, HVAC			7.39E-03	7.39E-03	Height of Stack=34 m
B.2.3	ES-ATMFL6-1	ESQ-ATMFL6-1-3	2.69E-06	BCFL	Fuel cladding breach, HVAC			4.21E-02	4.21E-02	

Units: Doses: rem
Frequency: 1/yr

Takeaway | Refresh | Compliance Assessment | Edit Record | Show Report | Close

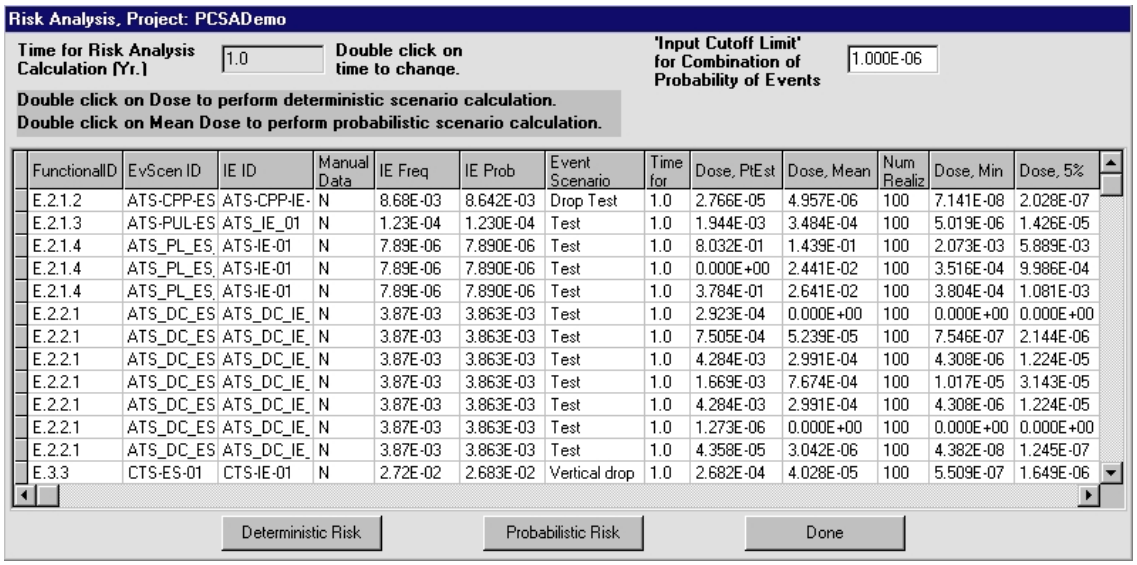
Figure 3.10.2-5. Safety Assessment Results Table - Noninvolved Worker

3.10.2.2 *Risk Assessment*

The *Risk Assessment* suboption allows evaluation of the total aggregate risk based on the frequencies and consequences of event scenarios from all functional areas. Details of the risk assessment methodology were previously described (Benke, et al., 2002). This calculation is not required by the regulation; it is an additional option for generating risk insights. The **Risk Analysis** (see Figure 3.10.2-6) form displays a table of data for every event scenario from all functional areas. All event scenarios are selected for risk assessment by default. Scenarios excluded from this analysis should be deselected from the **Event Tree Form**. For this analysis, an event scenario relates a single initiating event to its corresponding event sequences. The data fields of the **Risk Analysis** form are described next. Only the first two fields (Time for Risk Analysis Calculation (Yr.) and "Input Cutoff Limit" for Combination of Probability of Events) allow the user to input data directly. The other fields display previously entered or calculated data. The individual data entry fields are presented next.

Time for Risk Analysis Calculation (Yr.): Results of the risk assessment, risk (rem within the specified time period), and the probability of occurrence for combinations of event scenarios within the specified time period are based on this time period. The default value for time of duration for risk evaluation is 1 year. The user may enter a different value by double clicking on the time.

"Input Cutoff Limit" for Combination of Probability of Events: The user can assign a probability cutoff limit for combinations of probability in risk calculations. Event scenario combinations with probabilities of occurrence (within the specified time period) less than the cutoff limit are not included in the calculation of total aggregate risk.



FunctionalID	EvScen ID	IE ID	Manual Data	IE Freq	IE Prob	Event Scenario	Time for	Dose, PtEst	Dose, Mean	Num Realiz	Dose, Min	Dose, 5%
E.2.1.2	ATS-CPP-ES	ATS-CPP-IE-	N	8.68E-03	8.642E-03	Drop Test	1.0	2.766E-05	4.957E-06	100	7.141E-08	2.028E-07
E.2.1.3	ATS-PUL-ES	ATS_IE_01	N	1.23E-04	1.230E-04	Test	1.0	1.944E-03	3.484E-04	100	5.019E-06	1.426E-05
E.2.1.4	ATS_PL_ES	ATS-IE-01	N	7.89E-06	7.890E-06	Test	1.0	8.032E-01	1.439E-01	100	2.073E-03	5.889E-03
E.2.1.4	ATS_PL_ES	ATS-IE-01	N	7.89E-06	7.890E-06	Test	1.0	0.000E+00	2.441E-02	100	3.516E-04	9.986E-04
E.2.1.4	ATS_PL_ES	ATS-IE-01	N	7.89E-06	7.890E-06	Test	1.0	3.784E-01	2.641E-02	100	3.804E-04	1.081E-03
E.2.2.1	ATS_DC_ES	ATS_DC_IE_	N	3.87E-03	3.863E-03	Test	1.0	2.923E-04	0.000E+00	100	0.000E+00	0.000E+00
E.2.2.1	ATS_DC_ES	ATS_DC_IE_	N	3.87E-03	3.863E-03	Test	1.0	7.505E-04	5.239E-05	100	7.546E-07	2.144E-06
E.2.2.1	ATS_DC_ES	ATS_DC_IE_	N	3.87E-03	3.863E-03	Test	1.0	4.284E-03	2.991E-04	100	4.308E-06	1.224E-05
E.2.2.1	ATS_DC_ES	ATS_DC_IE_	N	3.87E-03	3.863E-03	Test	1.0	1.669E-03	7.674E-04	100	1.017E-05	3.143E-05
E.2.2.1	ATS_DC_ES	ATS_DC_IE_	N	3.87E-03	3.863E-03	Test	1.0	4.284E-03	2.991E-04	100	4.308E-06	1.224E-05
E.2.2.1	ATS_DC_ES	ATS_DC_IE_	N	3.87E-03	3.863E-03	Test	1.0	1.273E-06	0.000E+00	100	0.000E+00	0.000E+00
E.2.2.1	ATS_DC_ES	ATS_DC_IE_	N	3.87E-03	3.863E-03	Test	1.0	4.358E-05	3.042E-06	100	4.382E-08	1.245E-07
E.3.3	CTS-ES-01	CTS-IE-01	N	2.72E-02	2.683E-02	Vertical drop	1.0	2.682E-04	4.028E-05	100	5.509E-07	1.649E-06

Figure 3.10.2-6. Output Screen Showing Risk Analysis Form

Action Commands

Deterministic Risk: Calculates system risk using point estimates for the scenario doses. The deterministic risk will be evaluated only when the IE Prob and Dose, PtEst columns are populated for all event scenarios. The results from the risk analysis are displayed in Figure 3.10.2-8, which shows Outcome State (in symbolic notation), Probability (within the specified time period), Consequence (rem), Risk (rem in time period), Total Risk (rem in time period), and the Contribution (%) for this combination to the total risk. The Outcome State field shows results of outcome analysis with each column representing an event. A + sign indicates the event scenario occurred at least once within the specified time period, and a – sign indicates the event scenario did not occur. For example, +–+– denotes at least one occurrence of the first and third event scenarios and no occurrences of the second and fourth event scenarios. The probability, consequence, and risk for each combination of event scenarios (outcome) are tabulated in Figure 3.10.2-8, followed by a row presenting the total risk.

Probabilistic Risk: Conducts probabilistic risk calculations after the button is clicked. Probabilistic risk is evaluated only when the IE Prob column and columns associated with probabilistic dose columns are populated for all event scenarios. The **Probabilistic Results** window (Figure 3.10.2-9) displays a complementary cumulative distribution function plot of total risk; it also shows the mean, minimum, 5^{th}-, 50^{th}-, 95^{th}-percent, and maximum risk values at the top of the form.

Done: Closes the **Risk Analysis** window.

Functional ID: Displays identification number of the functional area along with the description of the functional area selected from the Project Tree.

EvScen ID: Displays event scenario identification.

IE ID: Displays initiating event identification.

Manual Data: Displays Y if event scenario allows manual data to be entered, otherwise, N.

IE Freq: Displays initiating event frequency (in units of 1 year). Data are transferred into this field automatically for previously specified initiating events.

IE Prob: Displays initiating event probability. This field is populated separately for each event scenario by calculations performed in the **Event Scenario Risk** form (see Figure 3.10.2-7).

Event Scenario: Displays descriptions of the event scenarios.

Time for Calculation: Displays time for risk calculation (in units of 1 year).

Dose, PtEst: The point estimate or deterministic dose for each event scenario is evaluated through a separate set of calculations, initiated by double-clicking on each cell to display the **Event Scenario Risk** form, shown in Figure 3.10.2-7. Steps to calculate a point estimate (deterministic) dose for the event scenarios are discussed for **Deterministic Dose** at the end of this section with the other **Action Commands**.

Dose, Mean: The mean dose for each event scenario is evaluated through a separate set of probabilistic calculations, initiated by double-clicking on each cell to display the **Event Scenario Risk** form, shown in Figure 3.10.2-7. Steps to calculate a probabilistic scenario dose for the event scenarios are discussed for **Probabilistic Dose** at the end of this section with the other **Action Commands**.

Num Realiz: Shows the number of realizations for probabilistic scenario dose calculation. The tool requires the same number of realizations for all event sequences used in the scenario dose calculation. The number of realizations is displayed once the probabilistic dose path has been selected for an event sequence in the **Event Scenario Risk** form (see Figure 3.10.2-7).

Dose, Min: Displays minimum dose from the probabilistic scenario dose calculation.

Dose, 5%: Displays 5^{th} percentile dose from the probabilistic scenario dose calculation.

Dose, 50%: Displays 50^{th} percentile dose from the probabilistic scenario dose calculation.

Dose, 95%: Displays 95^{th} percentile dose from the probabilistic scenario dose calculation.

Dose, Max: Displays maximum dose from the probabilistic scenario dose calculation.

NoneFilesOnly: Indicates if the event scenario dose has been calculated from previously saved consequence runs as specified by the user in the **Event Scenario Risk** form. Y denotes consequence paths have not been specified. N denotes previous consequence paths were

used to calculate the event dose. The tool uses this column to determine if sufficient information has been specified by the user to perform the risk analysis.

Calculation of Dose, PtEst and Dose, Mean for Each Event Scenario: Double-clicking in any cell of the Dose, PtEst or Dose, Mean columns will open the **Event Scenario Risk** form, shown in Figure 3.10.2-7, corresponding to that event scenario. The **Event Scenario Risk** form displays existing data about the event scenario: Functional ID, Type of Run, Event Scenario ID, (Ti) Time for [risk] Calculation (yr), and (Fi) Initiating Event Freq (/yr). The field for (Ei) Event Probability is calculated, and the field for (Ci) Event Deterministic Dose (rem) (Event Mean Dose for probabilistic calculations) is initially empty. The **Event Dose** button calculates deterministic (or probabilistic) event dose and populates the Event Deterministic Dose (or Event Mean Dose) fields. The window also displays a table of previously specified data associated with the event sequences of the event scenario: EvSeq ID (Event Sequence ID), EvSeq Freq (Event Sequence Frequency), Coefficient, and Det Conseq Path (Deterministic Consequence Path) or Prob Conseq Path (Probabilistic Consequence Path). The Det Conseq Path or Prob Conseq Path columns display the directory paths for previously saved consequence analysis (either point estimate or probabilistic) results. The PCSA Tool also creates a file containing data from deterministic and probabilistic dose calculations and assigns a path for data storage in the (Ci) Event Dose Path field. The user may not specify the Deterministic Consequence Path or Probabilistic Consequence Path in the table provided in the **Event Scenario Risk** form (Figure 3.10.2-7). Using the **Results Table** window (see Figure 3.10.1-1), the user must double-click in the empty cells under the Det Conseq Path (or Prob Conseq Path) columns and select the directory in which the consequence results are saved to assign a consequence path to an event sequence.

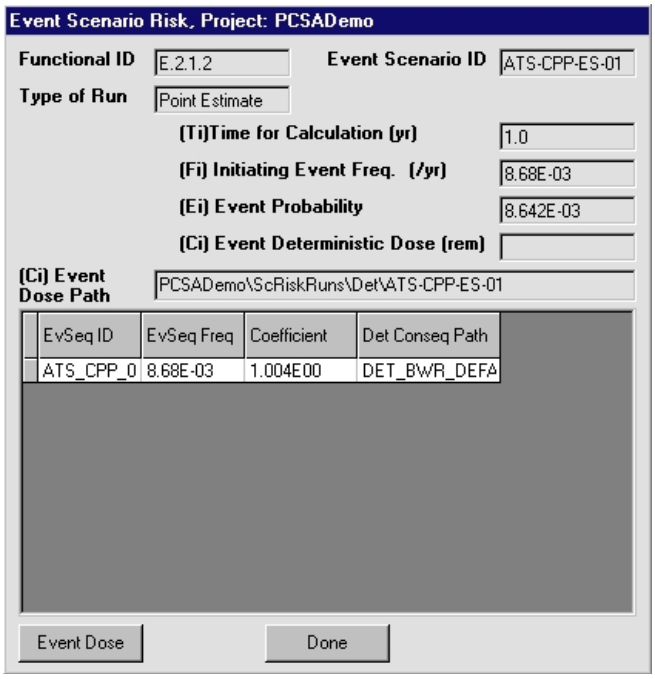
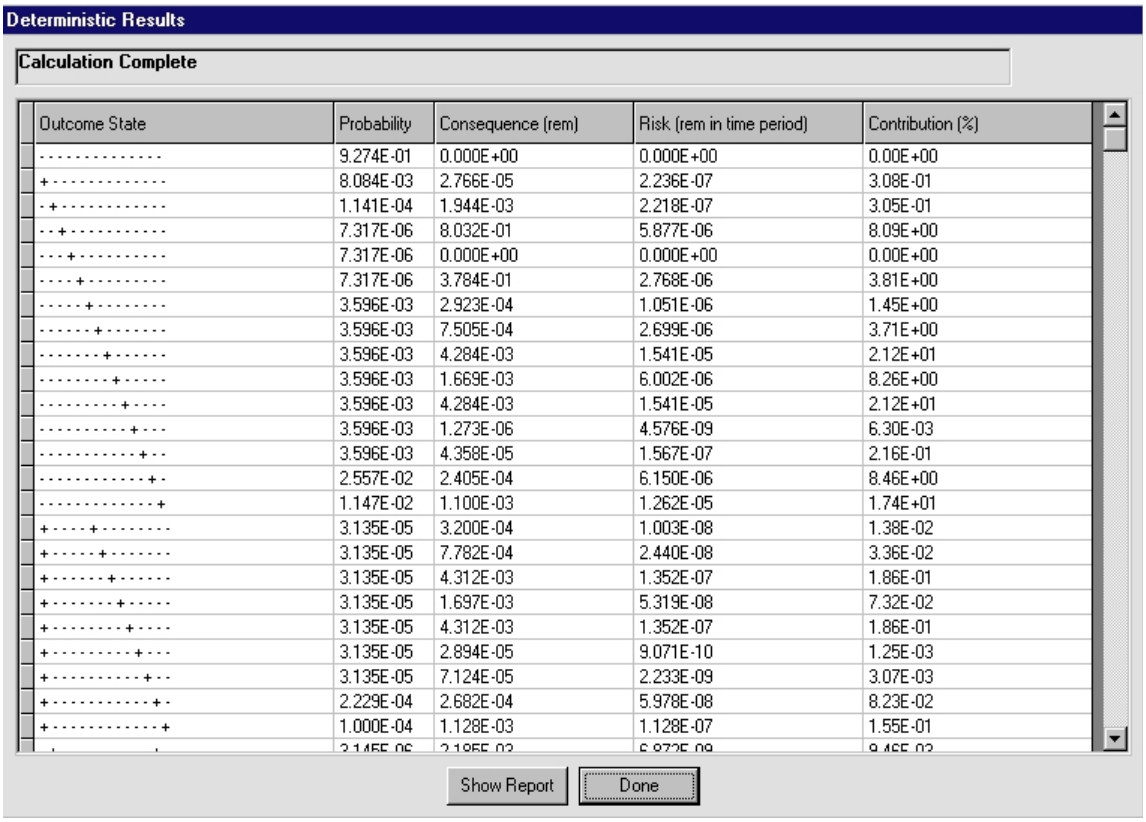


Figure 3.10.2-7. Output Screen Showing Event Scenario Risk Form



Outcome State	Probability	Consequence (rem)	Risk (rem in time period)	Contribution (%)
----------	9.274E-01	0.000E+00	0.000E+00	0.00E+00
+---------	8.084E-03	2.766E-05	2.236E-07	3.08E-01
-+--------	1.141E-04	1.944E-03	2.218E-07	3.05E-01
--+-------	7.317E-06	8.032E-01	5.877E-06	8.09E+00
---+------	7.317E-06	0.000E+00	0.000E+00	0.00E+00
----+-----	7.317E-06	3.784E-01	2.768E-06	3.81E+00
-----+----	3.596E-03	2.923E-04	1.051E-06	1.45E+00
------+---	3.596E-03	7.505E-04	2.699E-06	3.71E+00
-------+--	3.596E-03	4.284E-03	1.541E-05	2.12E+01
--------+-	3.596E-03	1.669E-03	6.002E-06	8.26E+00
---------+	3.596E-03	4.284E-03	1.541E-05	2.12E+01
----------+	3.596E-03	1.273E-06	4.576E-09	6.30E-03
-----------+	3.596E-03	4.358E-05	1.567E-07	2.16E-01
------------+	2.557E-02	2.405E-04	6.150E-06	8.46E+00
-------------+	1.147E-02	1.100E-03	1.262E-05	1.74E+01
+----+-----	3.135E-05	3.200E-04	1.003E-08	1.38E-02
+-----+----	3.135E-05	7.782E-04	2.440E-08	3.36E-02
+------+---	3.135E-05	4.312E-03	1.352E-07	1.86E-01
+-------+--	3.135E-05	1.697E-03	5.319E-08	7.32E-02
+--------+-	3.135E-05	4.312E-03	1.352E-07	1.86E-01
+---------+	3.135E-05	2.894E-05	9.071E-10	1.25E-03
+----------+	3.135E-05	7.124E-05	2.233E-09	3.07E-03
+-----------+	2.229E-04	2.682E-04	5.978E-08	8.23E-02
+------------+	1.000E-04	1.128E-03	1.128E-07	1.55E-01

Figure 3.10.2-8. Output Showing Deterministic Results Form

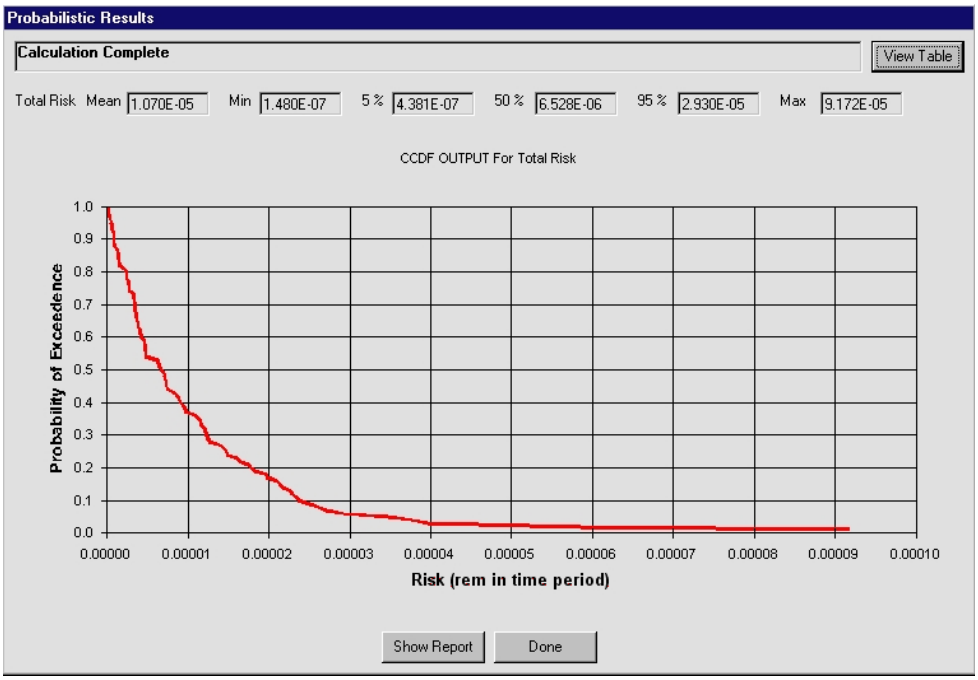


Figure 3.10.2-9. Output Screen Showing Probabilistic Results Form

3.10.2.3 *Display Structures, Systems, and Components*

Selecting the *Display* submenu will display the **View Selected** structures, systems, and components form (see Figure 3.10.3-1). Data cannot be entered or edited on this form—only viewed. The user has the option of displaying structures, systems, and components for all functional areas or only the current functional area. In addition, the user has the option of filtering structures, systems, and components based on mode of operation and based on how the structures, systems, and components is designated Important to Safety (ITS). The user selects an structures, systems, and components in the upper portion of the form to display the associated design bases and design criteria in the lower portion of the form.

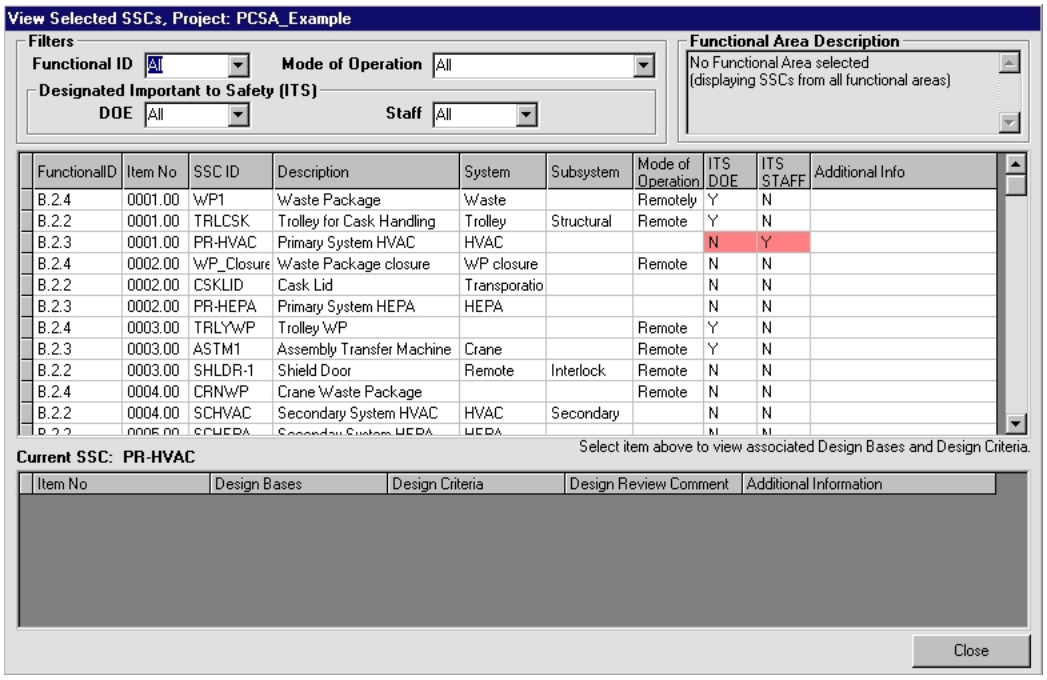


Figure 3.10.3-1. View Selected Structures, Systems, and Components Window

Action Commands

Filters

Functional ID: View structures, systems, and components for all functional areas (by default) or only the current functional area.

Mode of Operation: View structures, systems, and components for all modes of operation (by default) or only those structures, systems, and components with modes of operation designated: none, manual, remote, or software driven.

Designated Imported to Safety (ITS)

DOE: View all structures, systems, and components regardless of the DOE designation as important to safety (by default) or only view those structures, systems, and components identified yes or no with regard to the DOE designation.

Staff: View all structures, systems, and components regardless of the staff's designation as important to safety (by default) or only view those structures, systems, and components identified yes or no with regard to the staff's designation.

Close: Return to the main project screen.

3.11 *SW Reliability*

Information required for the qualitative analysis of software reliability is compiled using this menu. The feature may be selected from the main menu bar of the PCSA Tool. Because a software system may have application to a limited part of preclosure repository operations or may be applied to all operations, the extent of applicability is defined for each software system described. The *SW Reliability* menu opens the **Software Systems** window, shown in Figure 3.11-1, which allows access to various fields by selecting one of five tabs: **Characterization, Items 1–4**; **Characterization, Items 5–7**; **Use in Repository, Items 1–5**; **Use in Repository, Items 6–8**; **Potential Failures**.

Enter initial information using the **Add Software System** button. Data entry fields on the tabs in the **Software Systems** window can be accessed by selecting the **Edit** button. The individual data entry fields shown in Figures 3.11-1 to 3.11-5 are presented below. Some data entry fields are self explanatory and are not described further.

Select Software System: Display a drop-down menu of the software system included in the database by using the **Add Software System** button. Selecting a software system allows the user to view information already stored or to enter data about the software.

Functional Areas Where this system is used: List all the functional areas, taken from the system description, in which this software system is used.

Tabs:

- Characterization, Items 1–4 (see Figure 3.11-1)

1. Any extant failure data on the software system: Provide any extant failure data on the software system recorded during the development phase or operation of the software system; frequently, failures experienced in developing the software are not reported.

2. Characteristics of the software development process: Describe what methods and actions were used to manage the process for developing this software.

3. Characteristics (especially Maturity Level) of the software development organization: This characterization is keyed to the Capability Maturity Model developed by the Software Engineering Institute of Carnegie-Mellon University (Paulk, et al., 1993).

4. Analysis of the requirements specification for the software: How were the operational requirements for the software stated and to what depth?

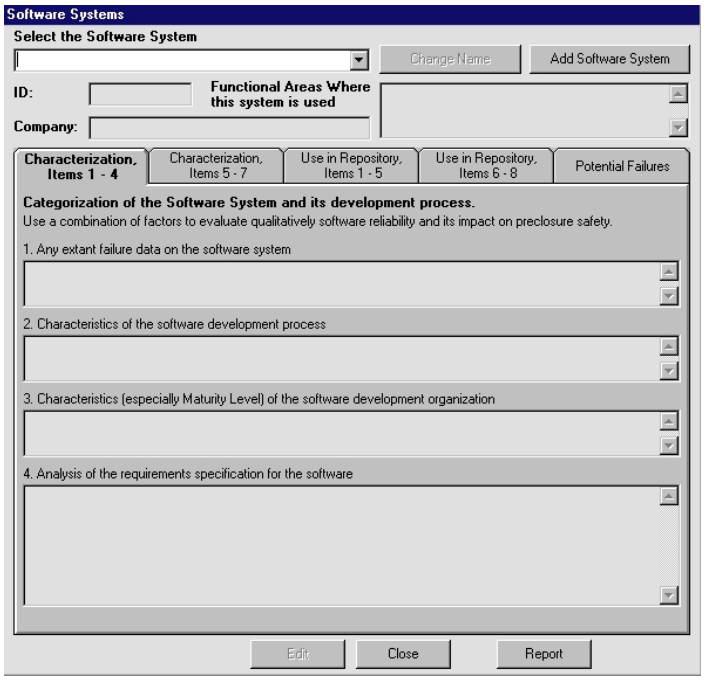


Figure 3.11-1. Software Systems Window and Characterization, Items 1–4

- Characterization, Items 5–7 (see Figure 3.11-2)

5. Identification and evaluation of the software standards used in developing and applying the software, if any: Describe standards used, if any, and how applicable they are to the particular application.

6. Determination of the degree to which the software has been previously used and corrected or the degree to which software components (subsystems and reused software) might be employed.

7. Other: Provide any other information characterizing the software or its development.

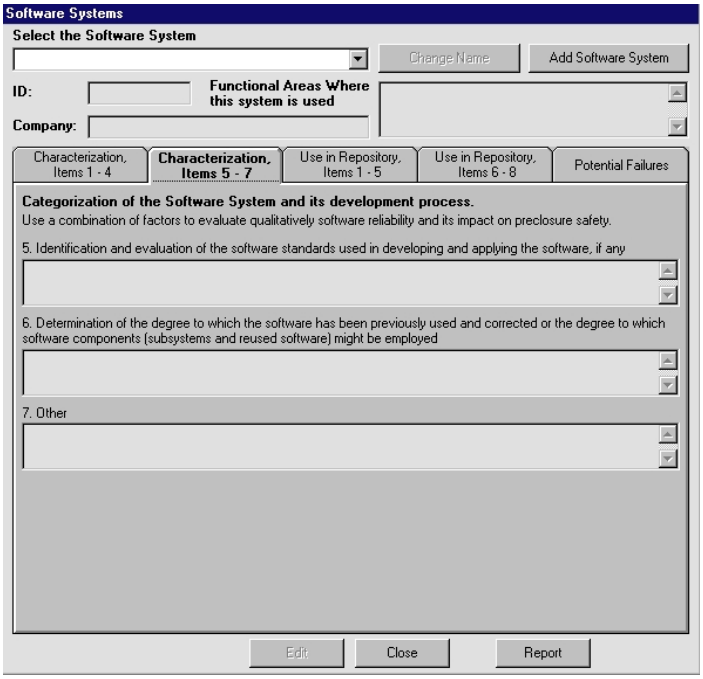


Figure 3.11-2. Software Systems Window and Characterization, Items 5–7

- Use in Repository, Items 1–5 (see Figure 3.11-3)

1. Functions Performed by this System.

2. Hardware Components Controlled.

3. Sensors and other Input Devices (including keyboard etc.).

4. Description of how humans interact with the software system under routine operations and how humans can decide to take action through the software system.

5. Is the Software System involved in actively controlling the process, in providing standby interaction and/or notification during an upset condition, or both?

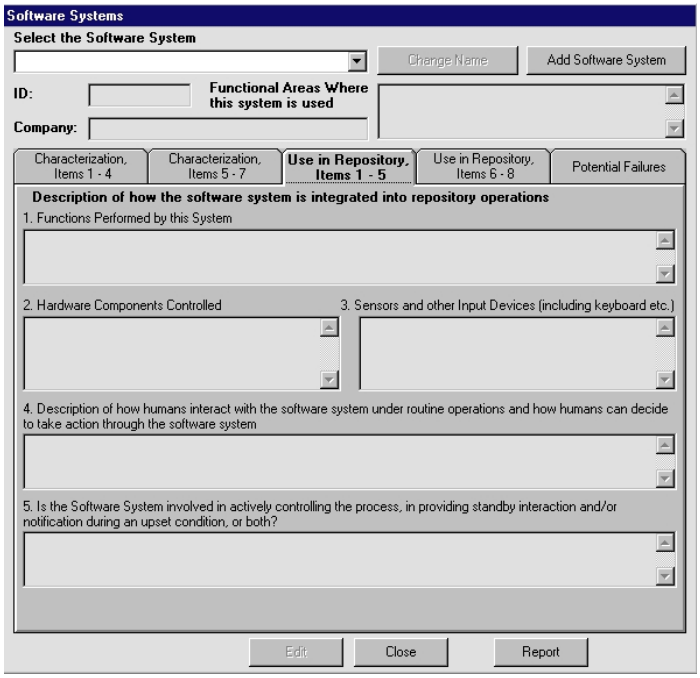


Figure 3.11-3. Software Systems Window and Use in Repository, Items 1–5

- Use in Repository, Items 6–8 (see Figure 3.11-4)

6. Is the Software System applied to specific types of hardware individually or multiple times, or does it control several types of hardware simultaneously (local versus global system)?: For example, does the software control a single air lock, all the air locks, or all the air locks and all the radiation sensors at entry ports?

7. Identification of whether and to what degree fail-safe design approaches have been used in developing or specifying its requirements.

8. Determination of the degree to which software failures will be mitigated by other safety systems: These devices include automatic devices or human intervention.

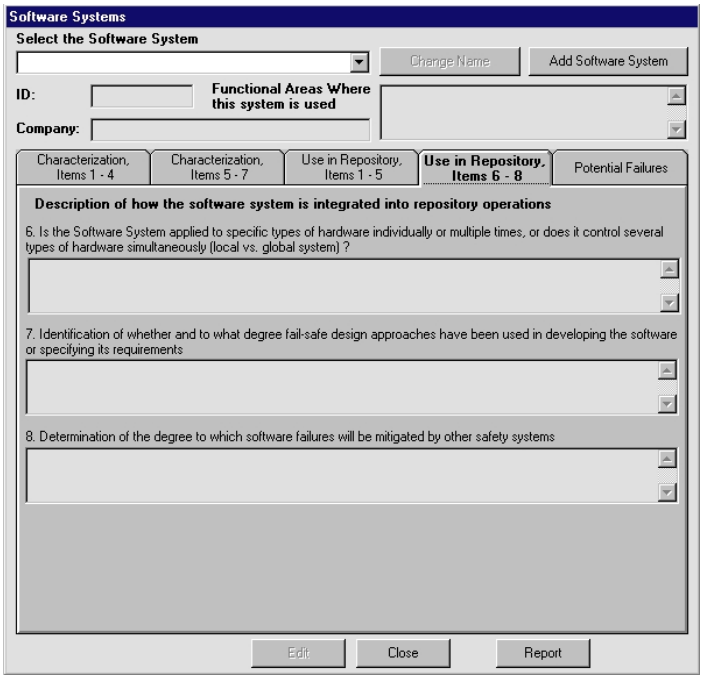


Figure 3.11-4. Software Systems Window and Use in Repository, Items 6–8

- Potential Failures

1. What previously identified initiating events produced by hardware malfunctions (identified by FMEA or What-if analysis) could be produced by software failures, because the identified equipment malfunctions could be generated by software failures?

2. What previously unidentified equipment malfunctions could be produced by software failures and lead to an initiating event?

3. What synergistic interactions between hardware, human actions, and software failures could lead to additional initiating events?

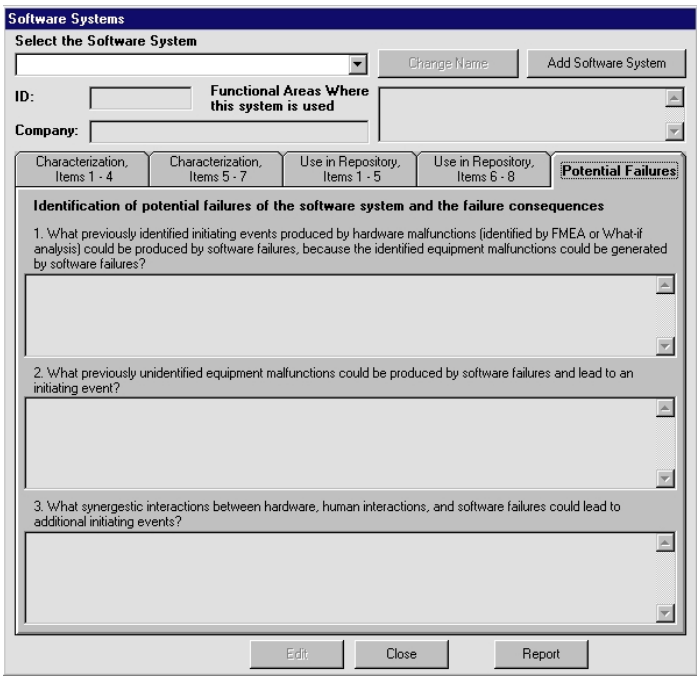


Figure 3.11.1-5. Software Systems Window and Potential Failures

The following Action Commands correspond to Figures 3.11.1-1 through 3.11.1-6:

Action Commands

Select the Software System: Allows selection, by name, of a previously entered software system.

Add Software System: Permits addition of a new software system name, with all fields blank; this selection displays a **Add New Software System** window (Figure 3.11.1-6) with three fields to be filled in: ID, Description, and Company (Figure 3.11.1-6). Every software system is given a unique identification in the ID text field. Once entered, the ID cannot be edited. The name of the software system and description is provided next in the Description text field. The Description may be edited by selecting **Edit** then **Change Name**. The name of the developer of the software system is provided in the Company text field. The Company name can be edited by selecting the **Edit** button.

Change Name: Permits revision of the name and description of the software system, while retaining the entries in all other fields. This button is activated by **Edit** button.

Report: Displays the information in report format.

Edit/Update: Allows the user to modify all fields in folder (tab) and some fields in **Add New Software System** window.

Close/Cancel: Returns user to the main project window screen, automatically saving any changes; Cancel returns to the **Software Systems** screen, without changing any edited fields.

Tabs to Access Fields:

Tab 1 Characterization, Items 1–4
Tab 2 Characterization, Items 5–7
Tab 3 Use in Repository, Items 1–5
Tab 4 Use in Repository, Items 6–8
Tab 5 Potential Failures

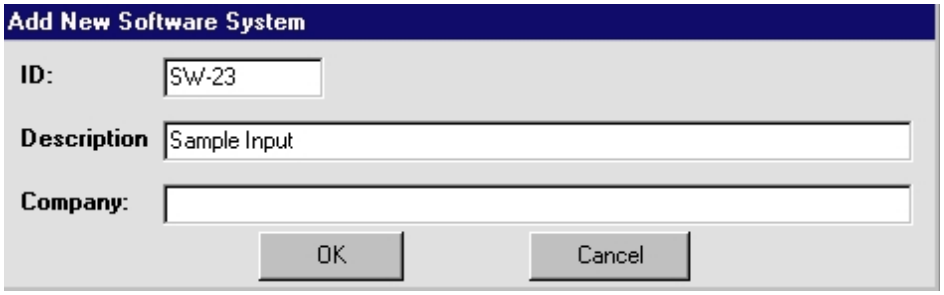


Figure 3.11.1-6. Add New Software System Input Form

3.12 *Failure Rate*

The ***Failure Rate*** menu contains *View Taxonomy*, *Search Database*, *Failure Calculator*, and *Human Error Probability Generation* submenus. A database was developed that contains failure rates of several components based on the actuarial data. A user can search for the data using either the *View Taxonomy* or *Search Database* submenus. These data have been categorized in an industry standard taxonomical structure.

3.12.1 *View Taxonomy*

The *View Taxonomy* submenu opens a **Taxonomy** window that contains a tree view that shows a listing of all current components and categories (Figure 3.12.1-1). After expanding the nodes of the tree, the user can search for the component. Double-clicking on a component or selecting a component and clicking **Display Data** will display a dialog box that contains the failure rate for that component, the references from where the data were acquired, and a brief description of the available statistical basis. In the **Search Results** window (Figure 3.12.1-2), the user can input the Letter ID or the Number ID from the reference column to retrieve and display the primary and secondary references, and the corresponding data will be displayed in the bottom part of the **Search Results** window as shown in Figure 3.12.1-2. To start a new search, click **New Search** and enter as many as three keywords. Clicking on **Close** will close the **Search Results** window and return to the **Taxonomy** window.

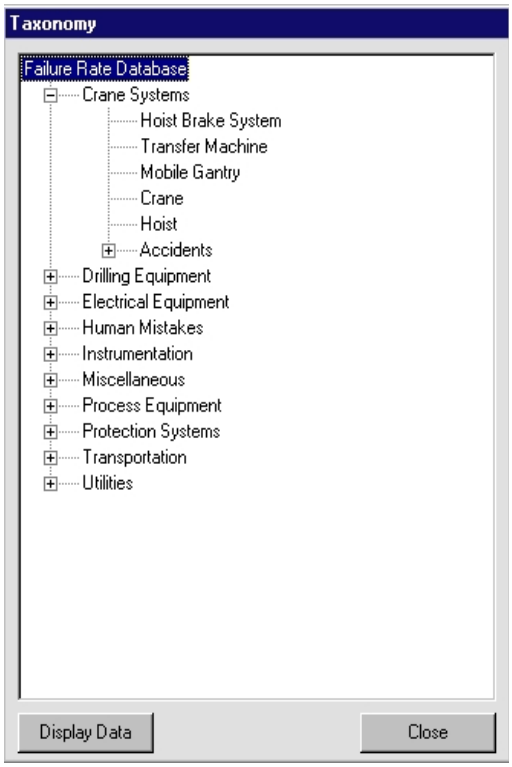


Figure 3.12.1-1. Taxonomy Window

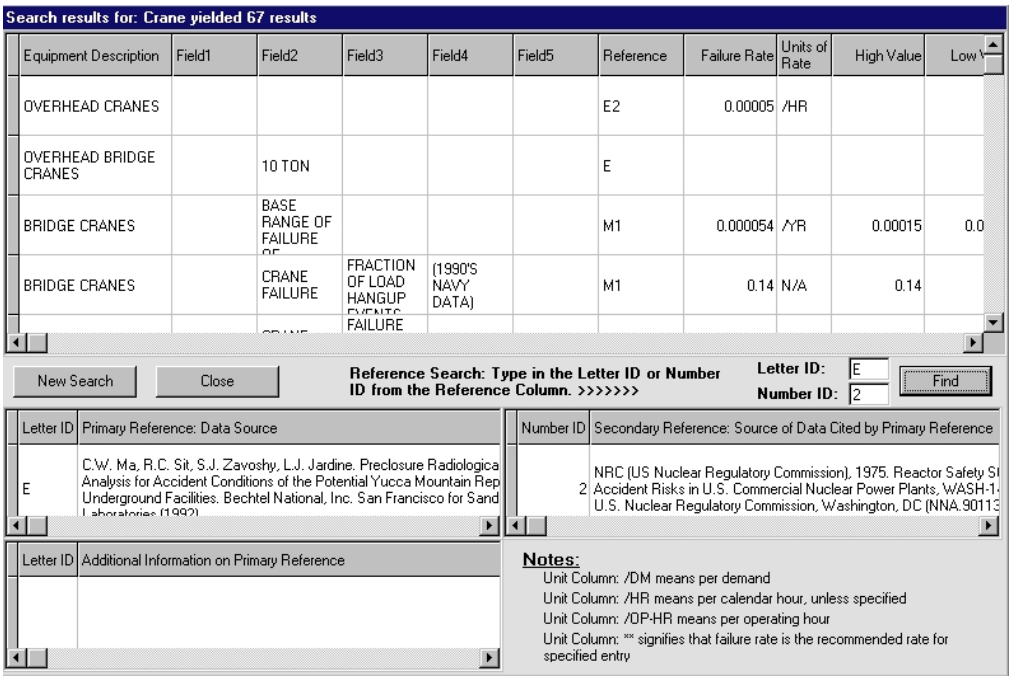


Figure 3.12.1-2. Search Results Window

3.12.2 *Search Database*

The *Search Database* submenu displays a dialog box in which the user can type the component name and field to perform a search. The result of the search will display the **Search Results** window (Figure 3.12.1-2).

3.12.3 *Failure Calculator*

Selecting the *Failure Calculator* submenu will display the **Frequency Calculation** window, which is shown in Figure 3.12.3-1. The Failure Calculator enables the user to make a quick frequency of failure calculation after inputting the failure rate and number of hours or demands.

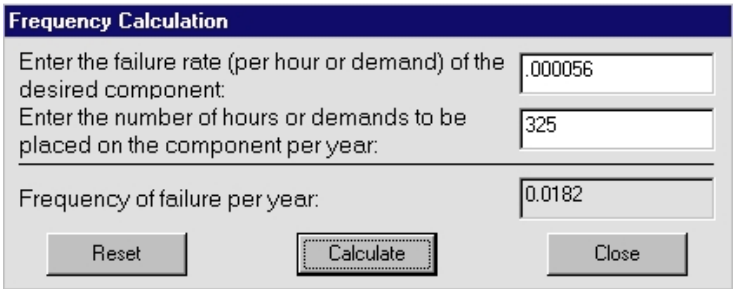


Figure 3.12.3-1. Failure Calculator

3.12.4 *Human Error Probability Generator*

The Human Error Probability is estimated using the Human Error Probability Generator.

The ***Human Error Probability Generator*** is opened in the PCSA Tool by selecting *Human Error Probability Generator* in the ***Failure Rate*** menu.

There are three main functions of the ***Human Error Probability Generator*** that are accomplished in three steps:

(1) Selection of the appropriate Table for Human Error Probability by traversing a logic tree (Figure 3.12.4-1).

(2) Selection of the appropriate entry in a given Table of Human Error Probability (Figure 3.12.4-2).

(3) Application of the appropriate performance shaping factors, if the analyst chooses to apply them (Figure 3.12.4-3).

Step 1. The logic tree is that suggested by Swain and Guttman (1983), but simplified somewhat, as shown in Figure 3.12.4-4, Parts A and B. The initial part of this module steps the analyst through the logic tree by asking a series of questions (four questions for primary operational activities, and three questions for maintenance and checking activities). By selecting the answers appropriate to the human error being analyzed, the code will lead the analyst to the appropriate Table. For the convenience of the analyst, the previously answered questions and the analyst's responses are shown at each step.

Step 2. Once the appropriate Table of Human Error Probability's is selected, the analyst is led through a second sequence of questions to select the Table entry appropriate to the human error being analyzed. The number of questions varies depending on the Table and previous answers. The end result of this process is the selection of a Human Error Probability from the Table.

Step 3. Once the Human Error Probability value is selected, the user may use it or apply performance shaping factors (PSF). If the user chooses to use performance shaping factors, another sequence of three questions is asked to select the appropriate performance shaping factor.

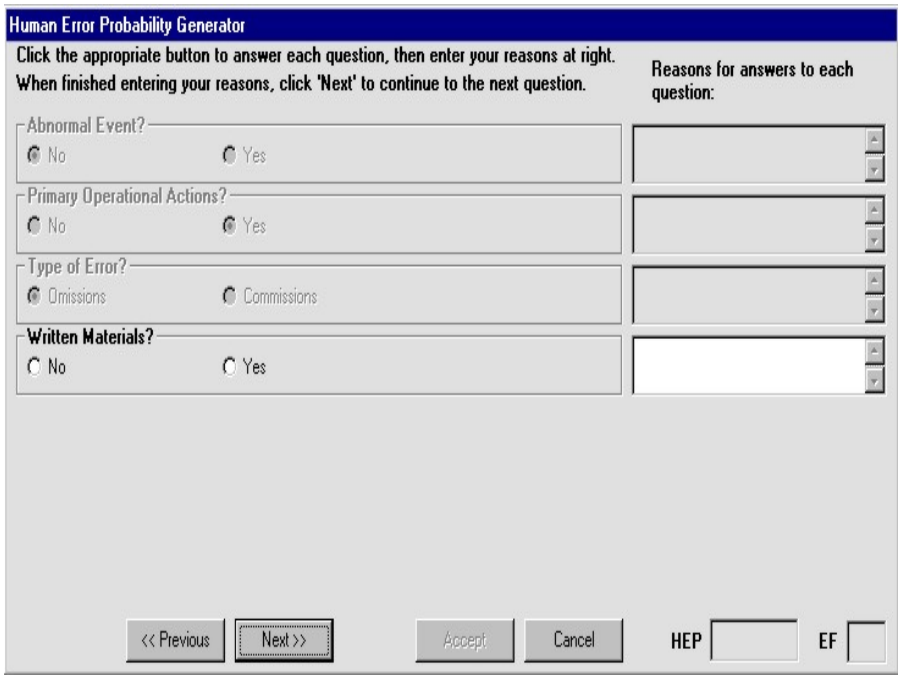


Figure 3.12.4-1. Human Error Probability Generator, Step 1

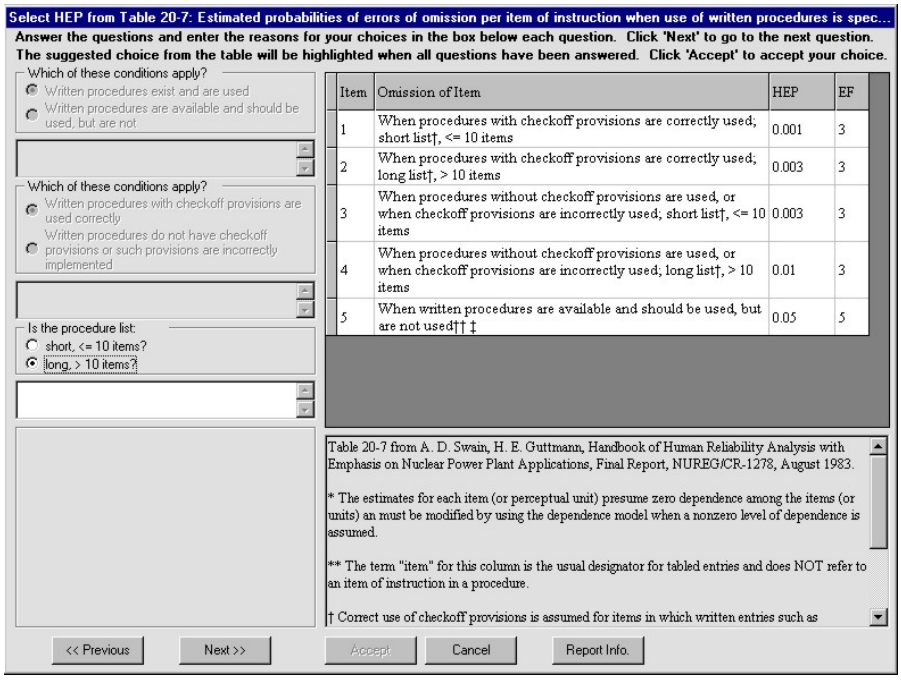


Figure 3.12.4-2. Human Error Probability Generator, Step 2

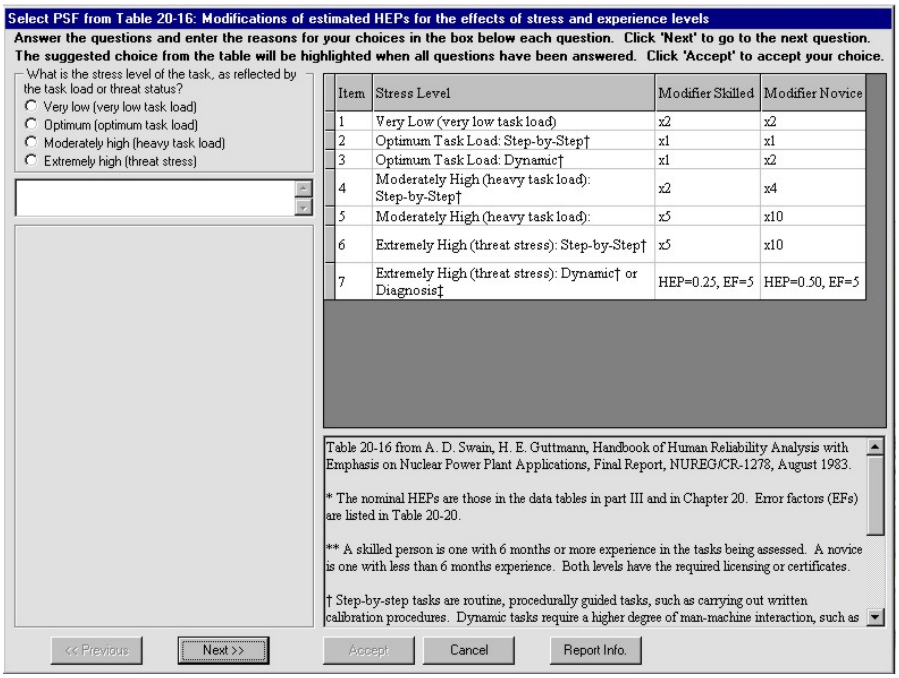


Figure 3.12.4-3. Human Error Probability Generator, Step 3

Action Commands

Previous: Deselects the current choice (if made) and returns to the previous choice in the sequence of questions.

Next: Moves to the next question or to the next screen, using the current selection.

Accept: Confirms numerical choice of Human Error Probability or PSF from Table. Also confirms numerical choice of Human Error Probability with PSF applied.

Cancel: Allows the user to return to a previous screen, when the **Previous** command is not available; if a previous screen is not available, the user is returned to the main menu.

Report Info.: Displays the bibliographic information on NUREG/CR–1278, the source of the methodology, Table entries, and evaluations.

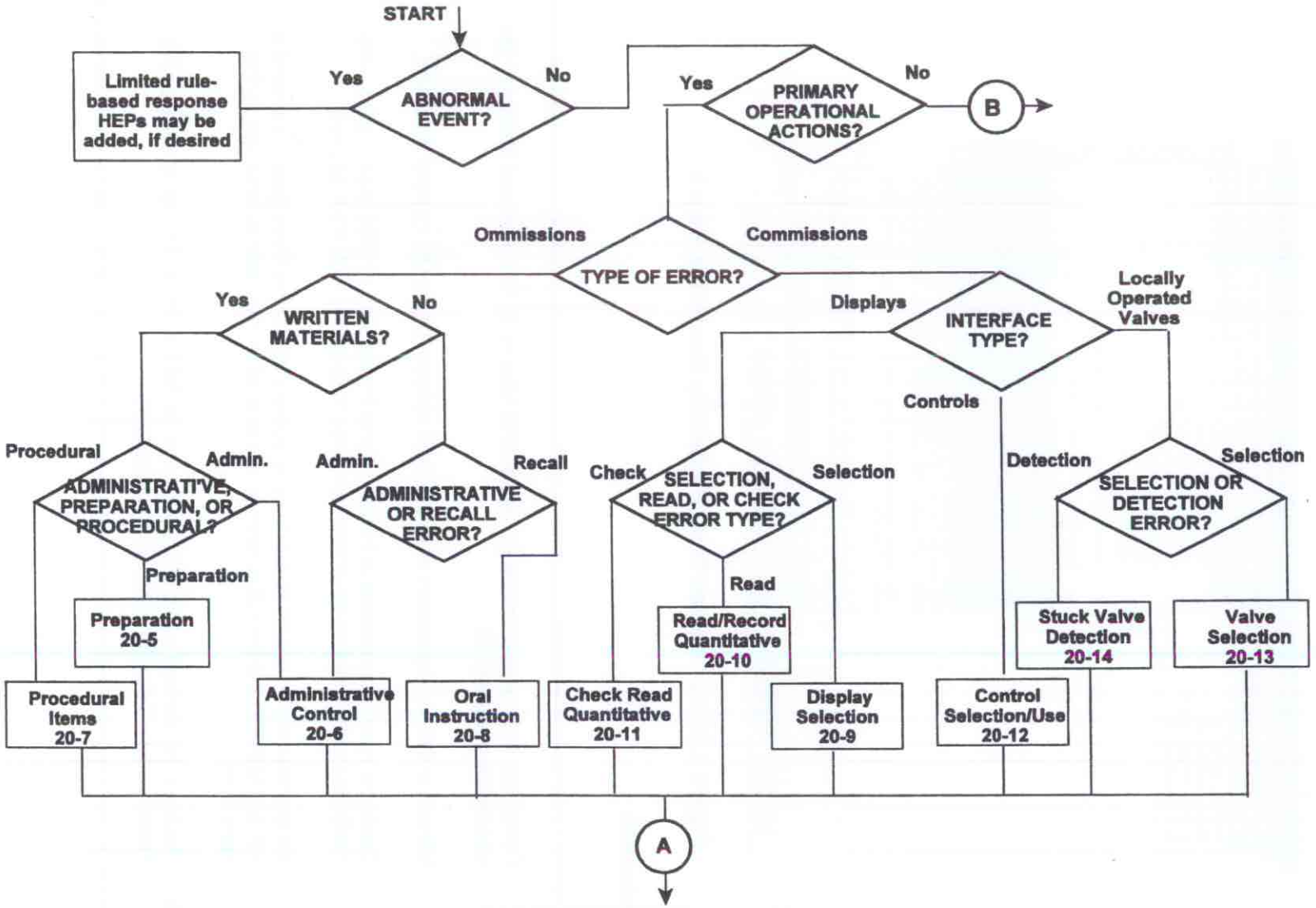


Figure 3.12.4-4. Part A: Selection of Primary Human Error Probability Tables Using NUREG/CR–1278 Methodology

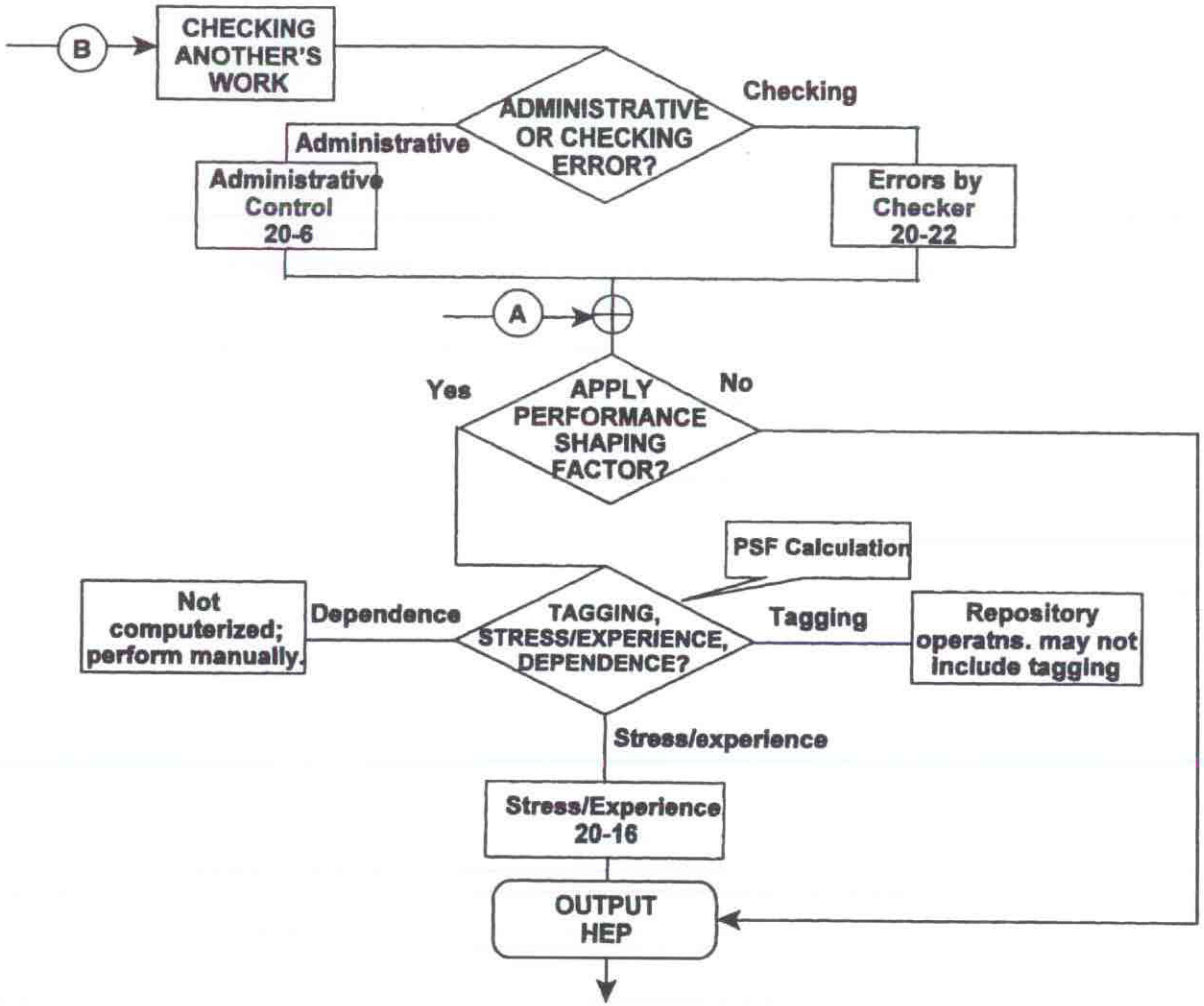


Figure 3.12.4-5. Part B: Selection of Primary Human Error Probability Tables and Application of Performance Shaping Factors

3.13 *Checklist*

The Component Failure Mode Checklist submenu in the ***Checklist*** menu displays the **Component Failure Mode Checklist** window containing a checklist of component failure modes.

3.13.1 *Component Failure Mode Checklist*

The checklist may be used during failure modes and effects analysis. The user can browse through the entire database or use the search option for a component. Figure 3.13.1-1 illustrates the default setting for the Component Failure Mode Checklist, while Figure 3.13.1-2 is an example of a crane component search.

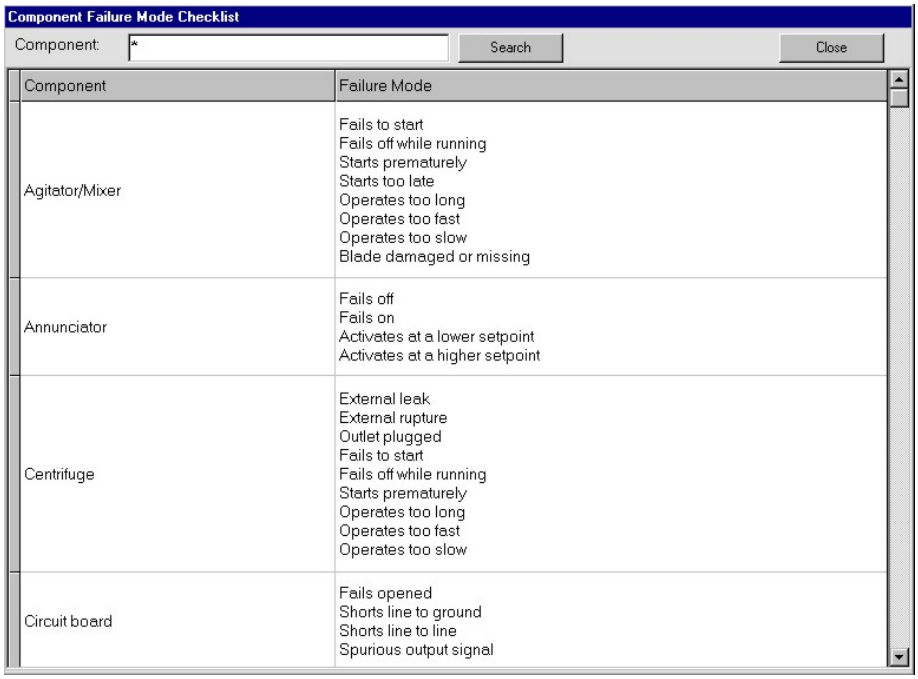


Figure 3.13.1-1. Component Failure Mode Checklist Default Setting

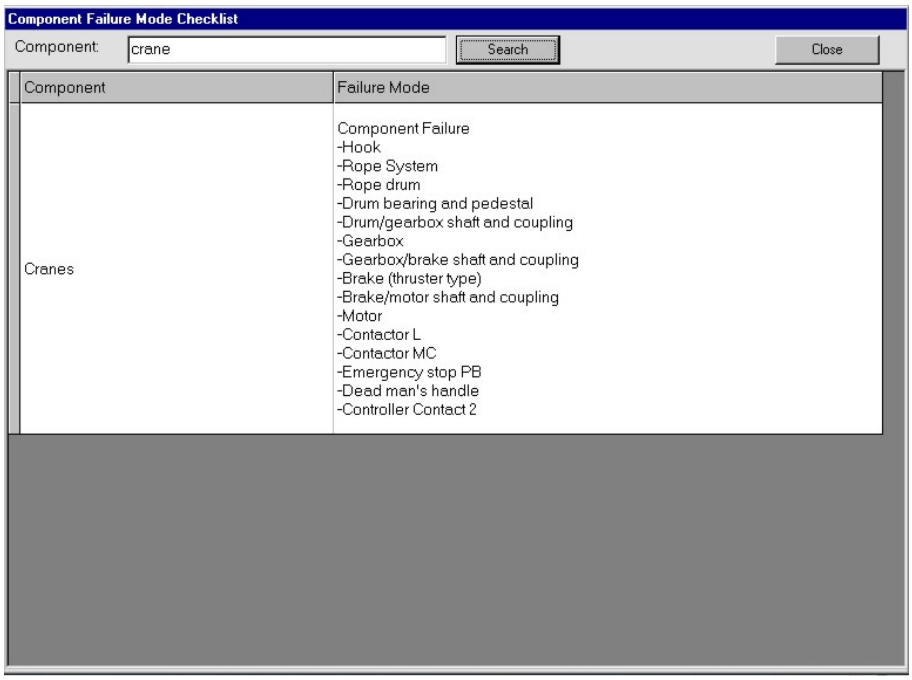


Figure 3.13.1-2. Component Failure Mode Checklist Example

Action Commands

Search: Searches the database for the component input by the user. If the user input is not found in the database, the window will return blank.

Close: Exits the **Component Failure Mode Checklist** window and returns the user to the main project screen.

3.14 *Regs.*

The **Regulation** (*Regs.*) menu displays two submenus, *10 CFR Part 63* and *10 CFR Part 20*. Both regulations have been stored as hypertext markup language (HTML) files, and the respective menus display the regulations through the default web browser in the user's computer. An HTML file allows the user to browse through the document using the hypertext links. Both 10 CFR Part 20 and 10 CFR Part 63 were downloaded from the NRC website <www.nrc.gov>.

3.14.1 *10CFR63*

The *10 CFR Part 63* submenu displays the text in 10 CFR Part 63: Disposal of High-Level Wastes in a Geologic Repository at Yucca Mountain, Nevada.

3.14.2 *10CFR20*

The *10 CFR Part 20* submenu displays the text in 10 CFR Part 20: Standards for Protection Against Radiation.

3.15 *Images*

The ***Image*** menu contains two submenus: *DOE* and *Review*. Selecting the *DOE* and *Review* submenus will display the **Images DOE** and **Images Review** windows. The functionality of the **Images DOE** and **Images Review** windows is identical. Using the Action Commands, the user has the option of either viewing existing images contained within the PCSA Tool/Drawing/DOE or Review subdirectory or adding new image files. When an image is added to the DOE or Review subdirectory, the user must select an image name that will represent the file in the **Images Review** window. However, the original file name will not change in the DOE or Review subdirectory. The **Images DOE** window is illustrated in Figure 3.15-1.

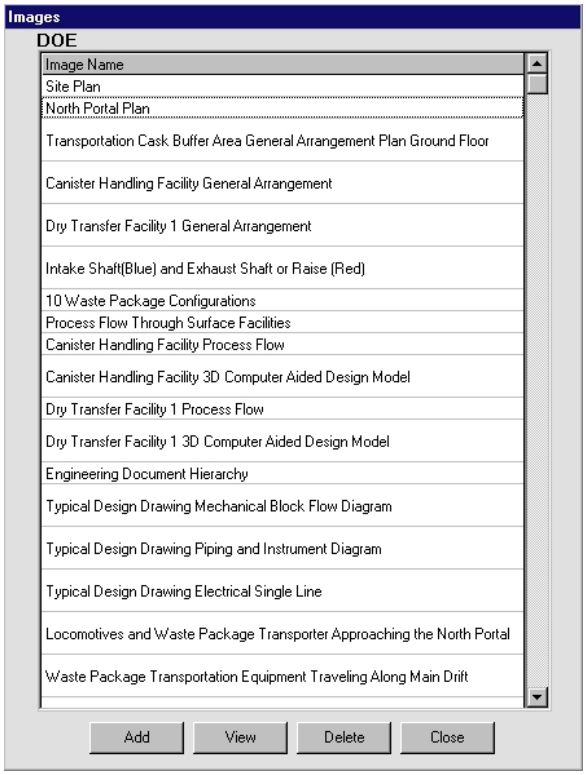


Figure 3.15-1. Images Window

Action Commands

Add: Allows the user to insert a graphics file into the DOE subdirectory. The user-selected name will appear in the **Images** window.

View: Displays the selected image in a separate graphics software.

Delete: Deletes the selected image from the DOE subdirectory.

Close: Exits the **Images** window and returns the user to the main project screen.

3.16 ***Help***

The ***Help*** menu displays *About*, *Disclaimer*, and *Menu Help* submenus. The Menu Help submenu is not currently active.

4 REFERENCES

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