Safety Analysis Report

Revision 4

November 2017

EXECUTIVE SUMMARY

SRB Technologies (Canada) Inc. (SRBT) is the world's leading producer of gaseous tritium light sources (GTLS) – flame-sealed borosilicate glass capsules, internally coated with a phosphorescent powder, and vacuum back-filled with elemental tritium gas.

The low-energy beta particles emitted during the decay of the tritium gas interact with the phosphorescent powder and produce visible light. These light sources are then installed into various devices that require a reliable light source without electrical power or other extraneous power source.

As part of our operating licence, SRBT is required to document and maintain a Safety Analysis Report (SAR) that demonstrates to the Canadian Nuclear Safety Commission (CNSC) that the facility is safe to operate.

The SAR represents an important component of the licensing basis of the SRBT facility. It contains (or refers to) accurate and precise information on the safety requirements, processes and limits to which SRBT adheres when processing tritium for the purposes of making gaseous tritium light sources, and devices that rely on these sources for illumination.

The SAR provides a comprehensive description of the physical facility, the operating organization and management, and the processes implemented in manufacturing our products and assuring the safety of people and the environment. The information presented herein is intended to present sufficient assurance that nuclear and radiological safety is assured in all facets of facility operation.

SRBT Safety Analysis Report

Revision 4

November 2017

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Report reviewed by:	Ross Fitzpatrick Vice President	Nov 2, 2017 Date
Report accepted by:	Stephane Levesque President	Nov 10, 2017 Date

Revision History

Release Date	Reviewed By	Revision Notes
November 21, 1990 – November 8, 2000	Various	Several iterations of safety analysis were developed and tabled to the AECB / CNSC during this period which cumulatively represented the safety case for facility operation.
July 4, 2006	Ross Fitzpatrick Stephane Levesque Shane MacDougall	Revision II. Formatted to align with available guidance. Integration of previous safety analyses, with update on various characteristics and processes at the facility.
January 15, 2016	Mary-Ann Demers Ross Fitzpatrick Katie Levesque Stephane Levesque Jamie MacDonald Tanya Sennett	Revision 3. Major update in format and content to align with IAEA guidance document GS-G-4.1 in a graded fashion. Expansion of information describing the facility and processes, as well as organizational structures. Incorporation of operating limits and conditions.
November 10, 2017	Mary-Ann Demers Ross Fitzpatrick Katie Levesque Stephane Levesque Jamie MacDonald Tanya Sennett	Revision 4. Revised to incorporate CNSC staff comments on previous revision. New management system processes and structure incorporated. Updated all hypothetical incident scenarios using HOTSPOT modelling software and CSA modelling parameters for dose coefficients. Other minor corrections and updates, as well as disposition of CNSC staff comments (ref: letter from R. Rashapov to S. Levesque, October 31, 2017) on proposed original Revision 4 submitted August 25, 2017.

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Acronyms and Abbreviations

AC	Alternating Current
ACR	Annual Compliance Report
AECB	Atomic Energy Control Board
AHU	Air Handling Unit
ALARA	As Low as Reasonably Achievable
Bq	Becquerel
CCL	Conditional Clearance Level
CED	Committed Effective Dose
Ci	Curie
CLC	Canada Labour Code
CNSC	Canadian Nuclear Safety Commission
CPM	Counts Per Minute
CSA	Canadian Standards Association
CVC	Compliance Verification Criteria
DCF	Dose Conversion Factor
DEL	Derived Emission Limit
DPM	Disintegrations Per Minute
DRL	Derived Release Limit
DSL	Dosimetry Services Licence
DU	Depleted Uranium
ECR	Engineering Change Request
EIP	Eddy Industrial Products
EMP	Environmental Monitoring Program
EP	Emergency Plan
ERO	Emergency Response Organization
FHA	Fire Hazards Assessment
FPP	Fire Protection Program
GTLS	Gaseous Tritium Light Source

Acronyms and Abbreviations (cont'd)

HIS	Hypothetical Incident Scenario
HT	Elemental Tritium Gas
HTO	Tritium Oxide
HVAC	Heating, Ventilation, Air Conditioning
IAEA	International Atomic Energy Agency
IC	Incident Commander
ICRP	International Commission on Radiation Protection
IEMP	Independent Environmental Monitoring Program
ISO	Internationals Organization for Standardization
LCH	Licence Conditions Handbook
LLC	Limited Liability Corporation
LPM	Litres Per Minute
LSC	Liquid Scintillation Counting
masl	metres above sea level
mbgs	metres below ground surface
MOU	Memorandum of Understanding
MSP	Management System Procedure
NCR	Non-Conformance Report
NEW	Nuclear Energy Worker
NFCC	National Fire Code of Canada
NFPA	National Fire Protection Association
NRC	National Research Council
NSCA	Nuclear Safety and Control Act
NSN	Nuclear Safety Note
NSPFOL	Nuclear Substance Processing Facility Operating Licence
OPP	Ontario Provincial Police
PDP	Preliminary Decommissioning Plan
PFD	Pembroke Fire Department

Acronyms and Abbreviations (cont'd)

PIE	Postulated Initiating Events
PIP	Public Information Program
PMT	Photo-Multiplier Tube
PPCC	Pembroke Pollution Control Centre
PUTT	Pyrophoric Uranium Tritium Trap
QA	Quality Assurance
RDU	Remote Display Unit
REGDOC	Regulatory Document
RP	Radiation Protection
SAR	Safety Analysis Report
SAT	Systematic Approach to Training
SCA	Safety and Control Area
SRD	Saunders-Roe Developments
SSC	Structures, Systems and Components
TAM	Tritium in Air Monitor
TASC	Tritium in Air Sample Collector
VAC	Volts of Alternating Current
WMP	Waste Management Program

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1. Introduction and Basis of Safety Analysis Report

a. Purpose

The SRBT Safety Analysis Report (SAR) is intended to comprehensively document the key information which demonstrates and assures the nuclear and radiological safety of the facility in all expected operating conditions, as well as in the unlikely event of a facility emergency.

The SAR represents a key source of information used by the Canadian Nuclear Safety Commission (CNSC) when independently evaluating the safety and licensing of the SRBT facility.

b. Objectives

SRBT operates a nuclear substance processing facility for the purpose of manufacturing gaseous tritium light sources (GTLS), and self-luminous safety products, such as exit signs, which rely on GTLS as their source of illumination.

The objective of the SAR is to capture and present all relevant safety-related information in a sufficiently detailed fashion in support of continued SRBT facility operation and licensing, in a format that is acceptable to the CNSC.

c. Scope

The SAR is intended to encompass all nuclear and radiological aspects of the SRBT facility and operations. In addition, those conventional aspects which may intersect with the nuclear and radiological safety of the facility are also deemed to be within the scope of the SAR.

d. Guidance and Structure of SRBT SAR

The format and content of the SAR is mainly derived from the guidance contained within Safety Guide GS-G-4.1, *Format and Content of the Safety Analysis Report for Nuclear Power Plants,* published by the International Atomic Energy Agency (IAEA) in 2004 [1].

This is the fourth major revision of the SAR as currently employed in the licensing basis, and the second in a span of two years.

It has been initiated as part of the Safety Analysis Review Process, as described in Section 16 of this report. The last comprehensive review of the facility SAR was performed in February 2008.

e. Graded Approach – GS-G-4.1

The SRBT facility is not a nuclear power plant – it is a Class 1B nuclear substance processing facility. As such, certain elements of GS-G-4.1 do not necessarily apply or fully align with the type of operations conducted at SRBT.

A review of the available guidance for SARs for facilities such as SRBT determined that GS-G-4.1 could be effectively applied using a graded approach. As such, the format and content of this SAR, as well as the methodology utilized to perform the safety analyses, will not perfectly meet the guidance of GS-G-4.1, but will instead follow it as closely as reasonable.

f. IAEA NS-R-5 Consideration

During the review and acceptance of Revision 3 of the SRBT SAR, CNSC staff assessed the content of the report against the guidance provided in IAEA Safety Standards Series NS-R-5, *Safety of Nuclear Fuel Cycle Facilities*. Comments provided based upon this review have been addressed and incorporated into this revision of the SAR.

g. Existing Facility Authorization Status

As of the revision date of this document, SRBT operates a nuclear substance processing facility under CNSC operating licence NSPFOL-13.00/2022. This licence is valid from July 1, 2015 for a period of seven years, expiring on June 30, 2022, unless otherwise suspended, amended, revoked or replaced.

The owner of the property and building in which the facility is located (898702 Ontario Inc.) is fully aware and familiar with the business activities conducted by SRBT. Documented evidence to this fact is retained as part of the licensing basis of the facility [2].

SRBT has been licensed by the CNSC since December 1990 to process tritium gas for the purposes of manufacturing GTLS and associated products.

h. General Description of Operating Organization

SRBT operates as an incorporated company within the province of Ontario and is 100% Canadian owned and operated.

The President and Vice-President of SRBT represent senior management and are officers of the corporation. The President is the designated holder of the operating licence issued by the CNSC. Senior management is ultimately responsible for the overall safety of the facility, and employ sufficient staff in order to operate the facility in the manner described by the SRBT Management System.

Several managers are employed by senior management in order to support safe and efficient operation of the facility. Each key aspect of facility operation is overseen by these managers, including Radiation Protection, Environmental Protection, Security, Fire Protection, Emergency Management, Engineering, Conventional Health and Safety, Waste Management, Import / Export, Maintenance and Production.

SRBT implements several committees comprised of management and staff, in order to effectively communicate and achieve a high standard of operational safety and manufacturing quality and efficiency.

Detailed information pertaining to the SRBT operating organization can be found in Sections 3 and 9 of this report, as well as throughout the report in general.

2. General Plant Description

a. Applicable Regulations, Codes and Standards

The following regulations, codes and standards are applicable to SRBT operations by virtue of it being a nuclear facility in Canada:

- Nuclear Safety and Control Act (NSCA), including the regulations pursuant to the Act.
- Canada Labour Code (CLC), including regulations pursuant to the code.
- Regulations pertaining to the environment by the Ontario government, as relating to the emission of gaseous hazardous substances.
- Applicable codes and standards that are included as part of the compliance verification criteria (CVC) within the in-force Licence Conditions Handbook (LCH) which supports NSPFOL-13.00/2022.

NOTE: This list only consists of regulations, codes and standards that apply to SRBT due to the specific nature of our business and facility. It is not intended to capture regulations, codes and standards which apply to all Canadian businesses or corporations.

There are no specific regulations, codes or standards that provide general or specific design criteria for a facility such as SRBT.

b. Basic Technical Characteristics

SRBT uses vacuum-based processing equipment in order to process tritium gas (T_2) for the purposes of manufacturing GTLS.

A GTLS consists of a hermetically sealed borosilicate glass capsule, internally coated with a phosphorescent powder and filled with tritium gas. The low-energy beta radiation emitted by the tritium gas upon decay interacts with the powder and causes it to emit visible light. These ‘Betalights’® are then installed into various devices which provide a reliable, uninterrupted source of light when conventional power sources are unfeasible or suboptimal.

SRBT operates several ‘processing rigs’ in order to create these GTLS. These rigs are vacuum-based systems of valves, pumps and tubing, and are designed to have a pyrophoric uranium tritium trap (PUTT) attached in order to fill light sources.

A PUTT is a specialized vacuum device that contains up to 30 grams of uranium (typically depleted uranium (DU)). Uranium is used as an adsorbent material for the tritium gas under vacuum conditions. At typical room temperatures, tritium gas will adsorb onto the DU and be retained as a hydride. This property of DU allows for the safe and secure storage of significant quantities of tritium gas over time. When the DU is heated to around 400 degrees C, tritium gas will begin to be released from the DU hydride matrix. When these processes are performed at vacuum pressures in the absence of air or other gaseous contaminants, tritium gas can effectively be processed and used to fill light sources. This is the principal technical characteristic of the processing facility with respect to tritium.

Tritium processing equipment is located in Zone 3 of the facility, denoting the radiological zone with the greatest potential for exposure to hazards posed by the use of tritium gas. Processing takes place in an area known as the Rig Room.

Within the Rig Room, four double-sided ventilated cabinets house the main filling stations where light sources are filled with tritium. A total of eight processing rigs may be installed and in service depending on operational requirements.

A second area within Zone 3 is known as the Laser Room. In this area, laser cutting equipment is used to process long, thin GTLS known as ‘laser sticks’. These sticks are cut to specification using specialized lasers. Up to three laser systems may be employed at any point in time depending on operational requirements.

Finally, within Zone 3 is the Tritium Laboratory, which houses equipment known as the Bulk Splitter. This system is used to take bulk amounts of tritium purchased by SRBT on specialized containers and subdivide it onto containers that will interface with the processing rigs. The principles of operation of the bulk splitter are the same as those used on the processing rigs.

The Tritium Laboratory used to house a rig dedicated to the reclamation of tritium from expired or non-conforming GTLS; however, this equipment has been shut down and rendered inoperable as SRBT no longer executes reclamation processes.

More information on the technical characteristics of the facility (both nuclear and non-nuclear) can be found in Section 6 of this report.

c. Facility Description and Layout

SRBT’s facility is located at 320 Boundary Road, Pembroke, Ontario. Pembroke is located approximately 150 km northwest of Ottawa on the south shore of the Ottawa River at the mouth of the Muskrat River.

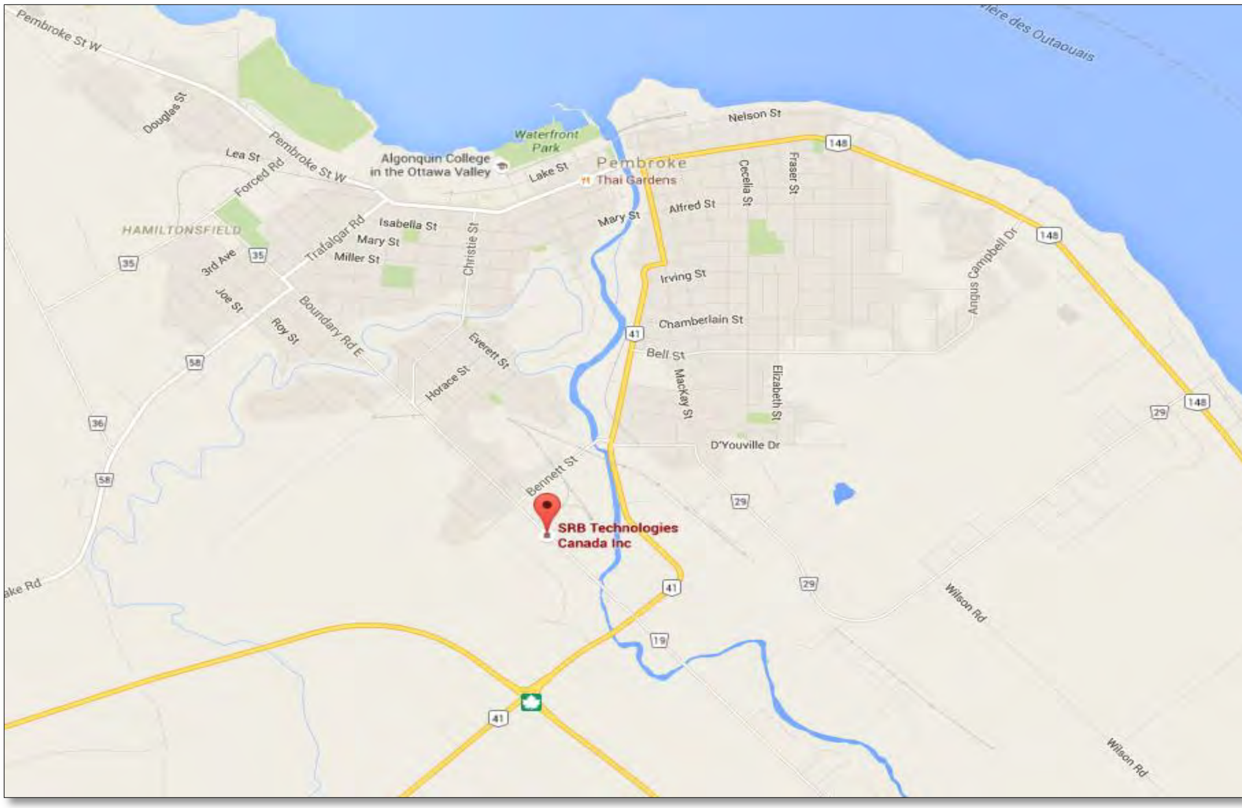

FIGURE 1: SRBT FACILITY LOCATION

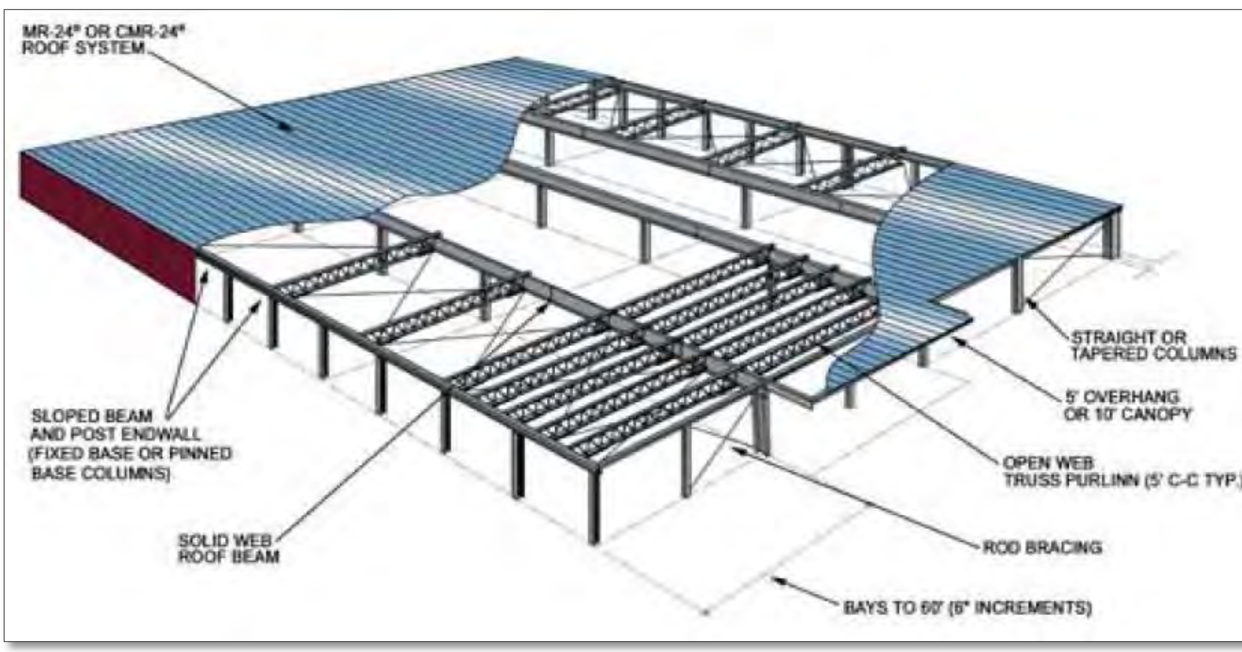

FIGURE 2: SRBT FACILITY CONSTRUCTION TYPE

The facility is located in an industrial park in the southern part of the city of Pembroke, and is housed in a three-unit Butler Building complex owned by 898702 Ontario Inc. The complex is comprised of a steel frame with a metal and block exterior.

The building is divided into four main parts that are separated by cinderblock firewalls, which are located:

- Between Zone 3 and the rest of the facility.
- Between the original main facility and the first expansion (what is now the shipping area and south offices).
- Between the first expansion and the latest expansion in 2016.

The wall between the SRBT facility and the sole neighbouring building tenant is a fire separation with a fire resistance rating of one hour. SRBT occupies the end unit at the northern end of the building (Unit 140).

SRBT is typically accessed by vehicular traffic via Boundary Road. Road access is provided at two points. In addition, access from Upper Valley Drive is provided to the southwest via a roadway to the south side of the complex.

All building services are provided by conventional means. The City of Pembroke provides water and sewer systems, and electricity and natural gas supply is provided by the common publically accessible utilities.

The facility is divided into several main areas that support the manufacture of GTLS and associated devices:

- Office areas both at the front end of the facility, as well as in the south and west ends.
- The Glass Shop where borosilicate glass capsule preforms are made.
- The Coating Room where the phosphorescent powder coating is applied to the internal surfaces of the glass preforms.
- The Rig Room where tritium gas is processed into the capsules, which are then sealed as a GTLS.
- The Assembly area where GTLS are inspected for quality and assembled into devices.
- Shipping and receiving where packages of GTLS and devices are prepared and shipped in accordance with requirements.
- A Machine Shop area where cases for specialized safety devices are manufactured from raw plastics.
- The Stores area where materials are kept until required by process.

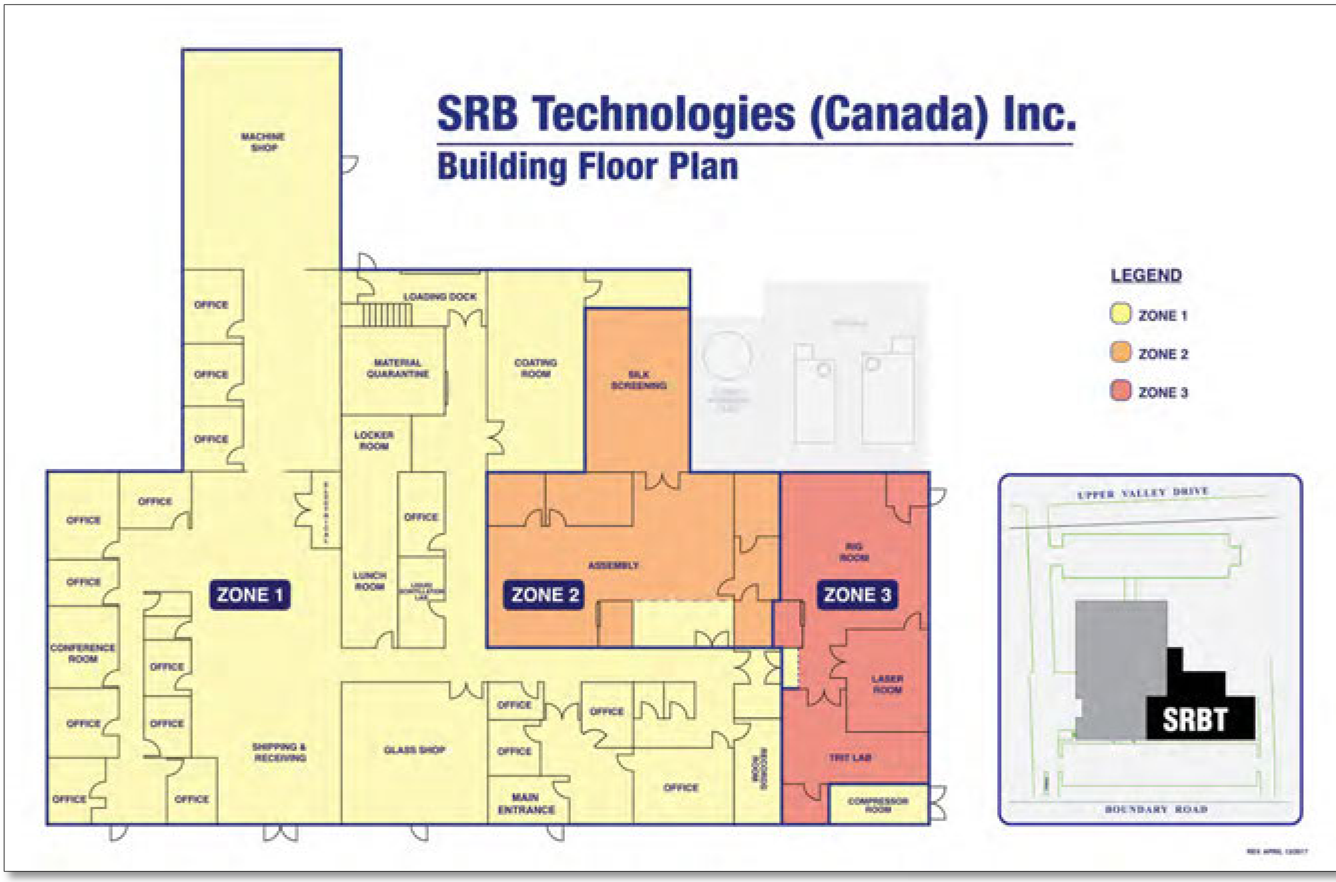

FIGURE 3: SRBT FACILITY FLOOR PLAN

Radiologically, the facility is divided into three zones as outlined in the Radiation Safety Program. These zones are depicted in the above floor plan. See Section 11 for a detailed description of the zoning of the facility.

d. Operating Modes

There are two facility operating modes that are considered to be relevant to the safety analysis:

- Tritium Processing – the mode of operation where tritium is being processed in the Rig Room: GTLS filling operations, bulk splitting operations, and / or laser cutting operations are being conducted.
- Tritium Processing Shut Down – the mode of operation where tritium is not being processed in the Rig Room.

Typically, tritium processing is conducted between the hours of 0700h and 1900h. Depending on production requirements, processing may be conducted during any day of the week, including weekends. Processing may also occur outside of the typical

0700h – 1900h timeframe subject to senior management approval, and depending on production requirements.

Tritium processing is not permitted during times where precipitation is occurring. This restriction is in place in order to provide protection of groundwater resources. Further information on the subject of groundwater protection is provided in Section 13 of this report.

e. Additional Referenced Analyses

The following list of references constitutes the majority of the analysis of the safety of the SRBT facility since operation began in 1990. Several of these documents are referred to within this report. It is not intended to be a comprehensive list.

- Nuclear Safety Note NSN-SRD-071, Population Densities and Estimated Doses from Accidental Releases for the SRB Tritium Lamp Plant, Pembroke (1990)
- Atomic Energy Control Board Member Document 90-192, Saunders-Roe (Canada) Inc. Licensing for a Gaseous Tritium Light Source Manufacturing Facility, 1990
- Safety Analysis Report, Potential Radiological Impact from Hypothetical Release of Tritium at the SRB Technologies, Canada Facility, Prepared by Alpha-Dyne LLC (1996)
- CRWS Report 6523-03, A Revised DEL Calculation for the Pembroke Facility (1996)
- Safety Analysis Report for Potential Radiological Impact from Hypothetical Release of Tritium from a Smouldering Fire Incident at the SRB Technologies, Canada Facility, Prepared by Alpha-Dyne LLC (2000)
- Canadian Environmental Assessment Act Screening Report – Operation of SRB Technologies (Canada) Inc. Pembroke, Ontario (2000)
- SRBT Safety Analysis Report Rev. II (2006)
- Derived Release Limits (DRLs) for the SRB Pembroke Facility (2006)
- Systematic and Quantitative Analysis of Tritium Sources and their Potential Contribution to Groundwater Contamination (2007)
- Comprehensive Report – Groundwater Studies at the SRB Technologies Facility, Pembroke, ON (2008)
- Review of Hypothetical Incident Scenarios (2008)
- Release Limit Rationale in Support of Licence Renewal Application (2009)

- SRBT Conceptual Model Document in Support of the Annual Status Report to the Commission (2011)
- CNSC Environmental Assessment Information Report: SRBT NSPFOL Licence Renewal (2015)
- Derived Release Limits (DRLs) for the SRB Pembroke Facility – 2016 Update (2016)

3. Management of Safety

a. Organizational Structure

The following organizational chart represents the current organizational structure (as of the revision date of his document) at the company that ensures SRBT meets the Nuclear Safety and Control Act, Regulations and conditions of the Licence.

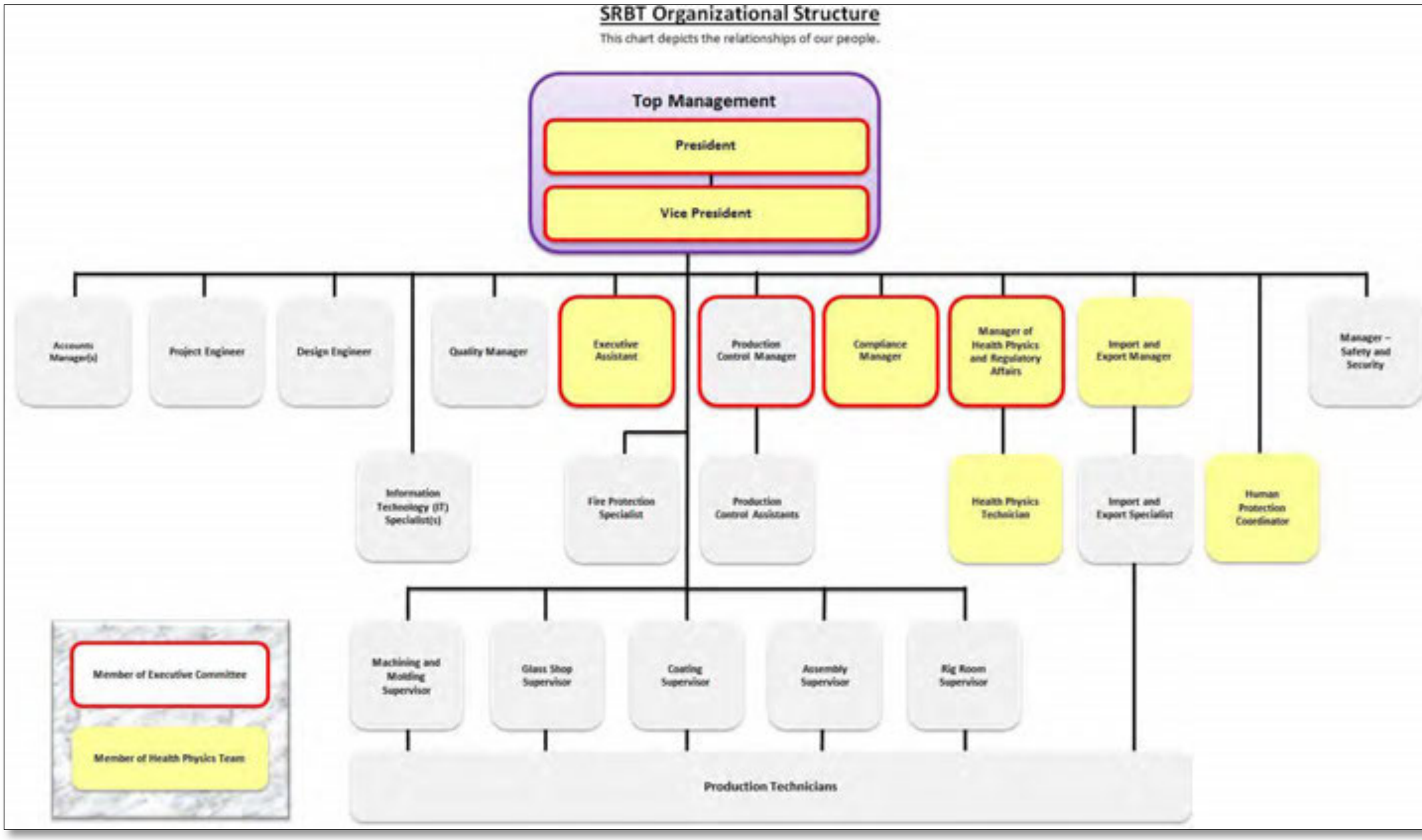

FIGURE 4: SRBT ORGANIZATIONAL CHART

This organization is in place to ensure that SRBT is qualified to carry out the licensed activities, and, in carrying on those activities, SRBT makes adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security.

The President and Vice President comprise the Senior Management team, with the President representing the facility authority and licence holder. Senior Management is supported by several managers who are responsible to oversee all key elements of facility operation and safety. SRBT management is responsible and accountable for compliance with the NSCA and associated regulations, with the ultimate accountability being held by the President.

Each production area includes assigned supervisors who possess an extensive amount of expertise and experience in their particular area. Production technicians perform processing and manufacturing operations under the guidance and oversight of supervision.

Detailed descriptions of each titled organizational unit are provided for within the descriptive document *Organizational Structure and Responsibilities.*

b. Operational Management Philosophy

SRBT implements a management system that complies with the requirements of Canadian Standards Association (CSA) N286-12, *Management system requirements for nuclear facilities.*

The chief operational management philosophy of SRBT is contained within the Quality Manual - *Quality Policy*, where the company vision, mission, goals, values and policy are documented.

The Quality Policy represents the main statement of SRBT on our safety, health and environmental policies. The Quality Policy is provided below in its entirety, is posted on our website, and is posted throughout the facility for all staff to refer to. Workers are informed of the policy upon hiring, and it is emphasized that all personnel are committed to compliance with our management system, including all safety programs and procedures.

SRBT QUALITY POLICY

OUR VISION

Strive to maintain or exceed the standing required to allow our company to process tritium and manufacture life safety devices to fulfill the needs of our customers.

OUR MISSION

Continuously improve company programs in order to meet or exceed the requirements of the Nuclear Safety and Control Act, Regulations and conditions of the licence in order to strive to achieve higher grades in all safety areas.

OUR GOALS

1. To promote a strong safety culture throughout the organization by having all employees continuously assess and analyze any impact the operations may have on the public and the environment.

2. To reduce any risk to the public and the environment due to the operations to ensure that requirements of the Nuclear Safety and Control Act, Regulations, conditions of the licence and ISO 9001 requirements are met or exceeded.

3. To be transparent, visible and open with our community, our regulators, and our staff.

4. To ensure that the products are supplied to customer requirements and specifications and to the requirements of the Nuclear Safety and Control Act, Regulations, conditions of the licence and ISO 9001 requirements.

5. To continue to lower emissions and improve the effectiveness of our programs and processes.

OUR VALUES

We will achieve our goals by acting with integrity with the regulators, the members of the public and our employees, and by respecting their input and contribution by making improvements based on this input.

OUR POLICY

It is the policy of the company and its employees to learn from our operational experience and research, to consider the input of all stakeholders and be conservative in our decision making to ensure the protection of the public and the environment to achieve the goals that we have set to meet our ultimate vision.

Compliance to the Quality Management System is an obligation throughout the company for all employees; all workers are committed to adhere with all requirements of the Quality Management System, and are encouraged to contribute to the continual improvement and upgrading of the company’s Quality Management System.

c. Safety Culture

As required by N286-12, SRBT management uses our management system to understand and promote a strong, positive and healthy safety culture. A safety culture monitoring process is implemented in order to provide management with a consistent methodology of evaluating the safety culture of the organization, and to take action to ensure that it remains healthy and strong. As clearly shown by the Quality Policy, the safety of persons and the environment are the overarching priority of the operation of the facility at all times, and by all employees.

d. Quality Assurance

SRBT implements an overall Quality Manual that acts as the top-tier document of our Management System. All programs, processes and procedures must comply with the provisions of the Quality Manual.

Numerous processes contribute to the assurance of quality and safety, including (but not limited to):

- Internal audits are independently performed by the Compliance Manager to ensure that all requirements are being met, and improvement is driven continuously. The requirements of QAS-007, *Audits* govern these activities.
- Management review processes are conducted on a periodic basis in order to ensure consistent review of all aspects of operations. The requirements of MSP-008, *Management Review* govern these activities.
- Self-assessment processes are also in place to ensure that managers routinely reflect on their areas of responsibility in a self-critical fashion in order to drive continuous improvement. The requirements of MSP-010, *Self-assessment* govern these activities.
- Procurement of goods and services are controlled in order to ensure that an acceptable level of quality is achieved. The provisions of the Contractor Management Program govern all aspects of external services, while MAT-013, *Vendor/Contractor Approvals for Essential and Non-Essential Suppliers* and MAT-014, *Vendor/Contractor Appraisal for Essential Suppliers* ensures that vendors are vetted and approved for safety-significant goods that are purchased by SRBT, and that goods received are properly assessed for quality.

The reader should consult with the in-force revision of the SRBT Quality Manual for further detailed information on the Quality Assurance processes implemented by SRBT.

e. Committees

SRBT implements a comprehensive set of committees that are tasked with ensuring that safety issues relating to all aspects of the operation of our facility are understood and addressed.

Committees are often made up of representatives of both management and worker-level employees, in order to provide perspectives from all levels of the organization. These committees are staffed in a way that ensures that a wide range of experience and knowledge is available and focused on the issues which a particular committee is responsible for.

The process by which committees are formed and operate is fully detailed in the descriptive document *Committee Process and Descriptions.* The following committees in particular play key roles in ensuring the safe operations of the facility:

- Executive Committee
- Health Physics Team
- Mitigation Committee
- Workplace Health and Safety Committee
- Fire Protection Committee
- Maintenance Committee
- Training Committee
- Waste Management Committee
- Safety Culture Committee

These sub-organizations ensure that a level of independent oversight is applied in all pertinent areas relating to safe operations.

f. Monitoring and Review of Safety Performance

As noted above, SRBT implements a comprehensive internal audit program that provides independent assurance that the safety policies of the organization are being implemented effectively, and that lessons are learned from experience of both our organization and external parties in order to continuously enhance safety performance.

Management system process MSP-012, *Corrective Action* ensures that issues are identified, corrected and documented in order to help the organization continuously improve. Non-Conformance Reports (NCR) represent a key tool when management review and self-assessment takes place. Any staff member may request that a NCR be raised to document a problem, issue or event that is out of conformance with expectations or requirements.

4. Site Characteristics

a. Site Location – Area Under Control of Licensee

The SRBT facility is located at 320 Boundary Road in Pembroke, Ontario. The building which houses the facility is situated on parts of lots 28 and 29 of Concession 1, and was constructed in 1990 with a slab-on-grade floor.

The current zoning of the facility is M3 (Industrial Park Zone) as designated under municipal by-law 88-17. This zoning excludes residential use.

SRBT fully controls approximately 1,400 square metres of the interior floor space of the building, as well as the immediate surrounding grounds outside of the facility.

A fenced compound is maintained on the northwest corner of the facility, housing the primary active ventilation system components (fans, motors, stacks).

The floor plan diagram in Section 2 illustrates the area of the building and property that are under the direct control of SRBT.

b. Site Location – Surrounding Area

The SRBT facility resides within an area known as TransCanada Corporate Park – an industrial park within the boundary of the City of Pembroke.

Within the same building as the SRBT facility are two other commercial / industrial businesses. The adjacent business is a company that specializes in the manufacture of personal protective equipment and clothing intended for such application as bomb disposal and military special operations. A third tenant provides various industrial process gas and equipment to local customers.

Directly across the road from SRBT is a commercial pool and spa services vendor, as well as a small local propane distribution facility.

Next door to the facility are several businesses, including engineering services, disaster restoration services, and a do-it-yourself brewery.

Farmland is generally to the west of the facility, extending out approximately 300-500 metres. To the southwest there are two major-chain hotels as well as a tourist centre. Further to the west is the local detachment of the Ontario Provincial Police (OPP), as well as the Renfrew County District Health Unit.

To the northeast of the property is the Pembroke and Area Community Centre, which houses a full size skating rink. Several other businesses are located within 500 metres to the north and north east.

To the south of the facility, a commercial building is located about 250 m away. To the south east, a lumber yard and mill is present.

The nearest zoned residential area is called Johnson's Meadows, which was originally developed in the 1970s but has expanded since. From the location of the active ventilation system stacks, the nearest residential area is approximately 250 metres to the northwest. In addition, a narrow band of land along Boundary Road to the southeast is zoned residential.

The main portion of the City of Pembroke lies north of the facility.

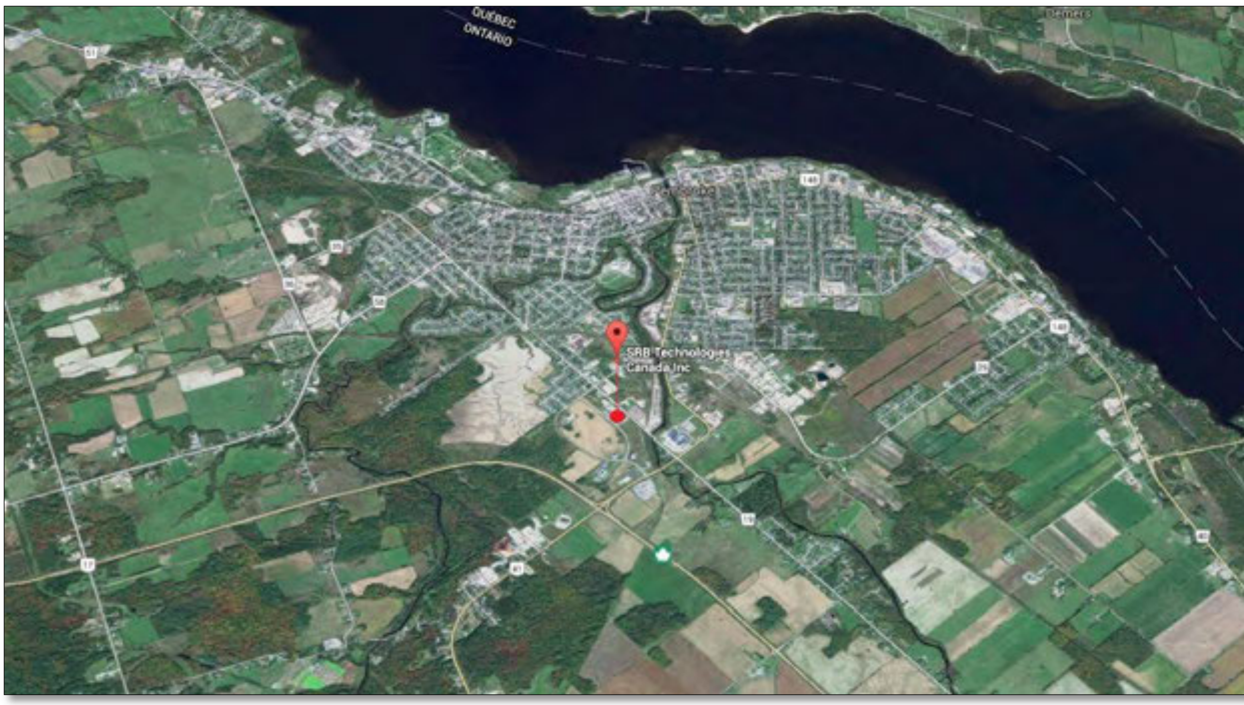

FIGURE 5: SRBT FACILITY LOCATION – SATELLITE IMAGE

c. Geological Characteristics

The facility is located on the oldest part of the Canadian Shield, in the Central Metasedimentary Belt Boundary and the Central Gneiss Belt of (tectonic) Grenville Province. The dominant crust is the "Algonquin Terrane" and the most common deposit is the Opeongo domain. The Ottawa Valley Clay Plain and the Petawawa Sand Plain are the physiographic regions present.

The soils in the area of the facility are generally clay silt, silty clay and clayey silt mixtures, and for the most part are characterized by relatively poor drainage.

Additional detailed information pertaining to the site geology is available in the 2008 Comprehensive Report – Groundwater Studies at the SRB Technologies Facility, Pembroke, ON, prepared by EcoMetrix Inc. [3]

d. Seismological Characteristics

The SRBT facility lies within the Western Quebec Seismic Zone, which constitutes a vast territory that encloses the Ottawa Valley from Montreal to Temiscaming, as well as the Laurentians and Eastern Ontario.

For the period of December 1990 – April 2017, a total of 942 recorded earthquakes greater than 2 on Richter scale have been recorded by the National Research Council (NRC) within a radius of 200 km from Pembroke.

All earthquakes recorded within a 20 km radius of Pembroke were less than 3.5 in magnitude, except for one instance on October 20, 2015 (magnitude of 3.7). NRC defines earthquakes between 3.5 and 5.4 on the Richter scale to rarely cause damage, with earthquakes of a magnitude less than 3.5 not generally being felt.

More information on the seismological characteristics of the Pembroke area can be found at www.earthquakescanada.nrcan.gc.ca. [4]

e. Volcanic Characteristics

The area where the SRBT facility is located is extremely stable volcanically, with no known activity or hazard potential requiring special design consideration.

f. Hydrological Characteristics

There are no large bodies of water that interface with the facility or the property upon which the facility resides.

To the south and east of the property lies the Muskrat River, which flows in a north direction through the City of Pembroke, ultimately meeting the Ottawa River.

The Muskrat River is approximately 420 m away from the site of licensed activity at its nearest point, due directly east of the facility. The smaller Indian River lies to the north and west of the facility, being approximately 1,000 m away from the facility at its nearest point due directly north.

The Muskrat River is quite narrow and its elevation is approximately 20 meters below the elevation of the SRBT facility. It is extremely unlikely that this river could present a flooding hazard to the facility.

The Ottawa River lies north of SRBT, approximately 4 km due north. This river delineates the northern boundary of the city of Pembroke. At this distance it is also extremely unlikely that this river could present a flooding hazard to the facility.

g. Hydrogeological Characteristics

The local characteristics of the hydrogeology of the area are well understood, and are documented within the 2008 Comprehensive Report – Groundwater Studies at the SRB Technologies Facility, Pembroke, ON, prepared by EcoMetrix Inc. [3]

An extensive amount of research has been invested in understanding the hydrogeology and groundwater conditions at the SRBT facility. Overburden typically includes a thin layer of topsoil, underlain at some locations by silty sand or gravel fill with underlying native material consisting mainly of grey silty clay, generally compact above the water table. Bedrock ranges between 5.2 to 7.5 metres below ground surface (mbgs), and consists of shaley limestone. The upper 1 to 3 metres of bedrock exhibits fracture, with rock quality designation values between 0% and 75%.

The direction of groundwater flow is generally to the east toward the Muskrat River, and water levels in the area range between 120-130 metres above sea level (masl), with seasonal variations ranging over 7 metres.

For a detailed picture of the hydrogeology of the area upon which the facility is located, the reader is encouraged to consult the 2008 Comprehensive Report – Groundwater Studies at the SRB Technologies Facility, Pembroke, ON, prepared by EcoMetrix Inc [3].

h. Meteorological Characteristics

Data tables are presented here from the Chalk River weather station based on 30 years of data from www.climate.weather.gc.ca [5] as well as the latest version of the SRBT DRL [6] which uses data from 2011-2015. These measurements are considered to be sufficiently representative of the meteorological characteristics of the area where the SRBT facility is located.

Temperature												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily Average (°C)	-11.8	-9.2	-2.9	5.5	12.5	17.8	20.3	19.1	14.4	7.6	0.7	-6.9
Standard Deviation	3.6	2.6	2.0	1.8	1.7	1.4	1.1	1.3	1.5	1.4	1.7	3.4
Daily Maximum (°C)	-6.7	-3.5	2.7	11.2	18.7	24.0	26.2	24.8	19.6	12.0	4.2	-2.8
Daily Minimum (°C)	-16.8	-14.9	-8.5	-0.3	6.2	11.6	14.2	13.3	9.1	3.1	-2.9	-11.0
Extreme Maximum (°C)	11.1	15.0	23.9	31.7	34.0	36.0	**39.4**	37.2	34.5	29.5	22.2	14.5
Date (yyyy/dd)	1975/ 11	1994/ 19	1977/ 30	1976/ 18	1978/ 28	1988/ 14	**1977/ 20**	1975/ 01	2002/ 08	2005/ 05	1961/ 03	2001/ 05
Extreme Minimum (°C)	**-39.0**	-35.6	-32.0	-19.4	-8.9	-1.7	3.3	-3.0	-2.0	-9.0	-21.0	-38.0
Date (yyyy/dd)	**1981/ 03**	1962/ 02	1980/ 02	1965/ 01	1966/ 07	1964/ 05	1965/ 06	1982/ 29	1978/ 26	1992/ 20	1989/ 29	1980/ 20

Chalk River Station Data

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5-yr Avg	Temp (°C)	-11.3	-9.7	-2.8	5.0	14.3	18.1	20.7	19.2	15.1	8.6	1.4	-4.9

SRBT Weather Station Monthly Average Temperature Data

FIGURE 6: TEMPERATURE STATISTICS

Precipitation													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	14.9	9.8	29.1	50.1	85.0	86.8	84.8	80.7	89.4	79.8	53.0	18.9	682.2
Snowfall (cm)	42.3	34.2	28.1	9.4	1.7	0.0	0.0	0.0	0.0	3.6	22.7	40.1	182.0
Precipitation (mm)	55.2	43.7	56.8	59.3	86.7	86.8	84.8	80.7	89.4	83.4	75.3	57.3	859.3
Extreme Daily Rainfall (mm)	27.8	25.8	36.1	36.5	58.7	70.2	68.6	**71.1**	65.2	43.8	38.6	22.6	
Date (yyyy/dd)	1997/ 04	1983/ 02	1980/ 21	1998/ 16	2000/ 08	2002/ 11	1994/ 08	**1965/ 02**	2005/ 25	1979/ 05	1999/ 02	1971/ 15	
Extreme Daily Snowfall (cm)	28.5	35.9	**40.1**	26.0	13.0	0.0	0.0	0.0	0.3	16.0	31.4	28.0	
Date (yyyy/dd)	1979/ 13	1997/ 21	**1973/ 17**	2005/ 02	1997/ 03	1963/ 01	1961/ 01	1961/ 01	1992/ 29	1997/ 26	1989/ 27	1986/ 02	
Extreme Daily Precipitation (mm)	28.5	35.9	49.0	36.5	58.7	70.2	68.6	**71.1**	65.2	43.8	41.1	29.0	
Date (yyyy/dd)	1979/ 13	1997/ 21	1973/ 17	1998/ 16	2000/ 08	2002/ 11	1994/ 08	**1965/ 02**	2005/ 25	1979/ 05	1974/ 20	1984/ 28	
Extreme Snow Depth (cm)	55	64	**68**	30	1	0	0	0	0	0	18	43	
Date (yyyy/dd)	2006/ 30	2006/ 24	**2001/ 14**	2001/ 01	2005/ 02	1983/ 01	1983/ 01	1983/ 01	1983/ 01	1983/ 01	2002/ 30	2004/ 24	

FIGURE 7: PRECIPITATION STATISTICS [5]

Days with Precipitation													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
>= 0.2 mm	15.5	11.8	11.3	11.7	13.6	13.7	13.9	12.9	14.4	15	15.8	15.8	165.3
>= 5 mm	3.9	2.9	3.9	4.2	5.3	5.3	5.3	4.8	5.5	5.4	5.2	4.1	55.7
>= 10 mm	1.4	1.2	1.7	1.8	3.1	2.8	2.4	2.7	2.9	3	2.3	1.3	26.4
>= 25 mm	0.04	0.08	0.12	0.15	0.48	0.58	0.54	0.56	0.42	0.46	0.27	0.12	3.8

FIGURE 8: AVERAGE DAYS WITH PRECIPITATION [5]

Wind frequency is generally characterized by west → east patterns (roughly 40% of the time based on 12 hour SRBT data). Data from the 2016 SRBT Derived Release Limits [6].

Wind Direction		Petawawa 1989-2004[1]	SRB 2011 to 2015[2]	
From	To		24-hr	12-hr
N	S	4.16%	6.03%	5.90%
NNE	SSW	2.45%	6.55%	6.10%
NE	SW	2.53%	5.34%	5.20%
ENE	WSW	2.38%	5.01%	4.43%
E	W	3.79%	5.75%	5.56%
ESE	WNW	10.58%	5.02%	5.32%
SE	NW	12.17%	6.10%	5.72%
SSE	NNW	4.64%	6.11%	5.86%
S	N	3.49%	5.08%	5.26%
SSW	NNE	3.69%	5.18%	5.66%
SW	NE	4.86%	6.01%	6.49%
WSW	ENE	6.26%	7.34%	8.16%
W	ENE	9.41%	7.24%	7.74%
WNW	ESE	10.68%	9.75%	9.19%
NW	SE	11.35%	8.05%	7.80%
NNW	SSE	7.55%	5.44%	5.59%

1 - wind data collected at CFB Petawawa, used for the 2006 DRL calculation
2 - wind data collected on-site at SRBT, used for the 2016 DRL calculation

FIGURE 9: WIND DIRECTION PROBABILITY DISTRIBUTION

Monthly average wind speeds based upon data from the monitoring station at the National Research Forestry near Petawawa, Ontario are presented below.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
WIND SPEED (km/hr)	10.4	10.4	11.6	11.8	10.5	10	9.1	8.7	9.3	10.2	10.7	10.1
WIND SPEED (m/s)	2.9	2.9	3.2	3.3	2.9	2.8	2.5	2.4	2.6	2.8	3.0	2.8

FIGURE 10: MONTHLY AVERAGE WIND SPEEDS

According to the Atlas of Canada, more than 70 tornadoes strike on average in a given year within the country. Approximately one-third of these typically occur in the province of Ontario, although the vast majority of these tend to happen in the extreme southern part of the province.

There have been no known categorized tornadoes in the Pembroke area going back to 1879. This includes nearby and neighbouring towns of Cobden, Eganville, Renfrew or Petawawa.

The following extreme meteorological conditions are on record for the area:

Condition	Value	Date
High Temperature	39.4 °C	July 20, 1977
Low Temperature	-39.0 °C	January 3, 1981
Daily Precipitation	71.1 mm	August 2, 1965
Daily Snowfall	40.1 cm	March 17, 1973

FIGURE 11: WEATHER EXTREMES

From the perspective of radiological and nuclear safety, extreme weather conditions such as heat, cold or precipitation are not expected to result in an increase in the level of risk presented by facility operation. In the history of SRBT, there have been no safety events that were attributed to meteorological conditions affecting the facility.

There are no active systems (such as cooling pumps or emergency electrical power supplies) that can be negatively affected by extreme weather causing an external safety consequence.

Ventilation systems have historically continuously operated as required in the extreme cold and heat, as well as during significant precipitation. If the loss of ventilation were to occur due to extreme weather, the safety of the facility is assured through fail-safe design of tritium processing systems (just as it is during a conventional power outage).

Should a local emergency situation be declared due to extreme meteorological conditions, the tritium processing systems at SRBT can be easily shutdown and placed into a passive safe state, with no active safety features being needed to ensure safety of the environment, workers or the public.

i. Present and Projected Surrounding Population Distribution

The 2016 population of the City of Pembroke was assessed by Statistics Canada [7] to be 13,882 persons. Adjacent to the City of Pembroke is Laurentian Valley Township, which is considered a census subdivision of Pembroke. The township lies to the south and west of the SRBT facility. The 2016 population of the township was assessed to be 9,387 persons.

The representative ‘critical group’ of public residents is hypothetically located in the north-northwest direction from the facility, approximately 250 – 300 metres from the site. A subdivision known as Johnson Meadows exists in this area. Public residences are also located to the south-southeast of the facility on the opposite side of the Muskrat River.

Expansion of the municipality is underway with the approval for building of Golfview subdivision to the northwest of the facility, with planned occupation beginning sometime in the next decade [8].

j. Present and Projected Surrounding Land Use

The facility and immediately surrounding areas are zoned for industrial and commercial use. In addition, a community centre is located to the direct north of the facility.

There are currently no major developments underway or projected within the surrounding land, other than the Golfview subdivision to the northwest approximately 700 m away.

k. Evaluation of Site Specific Hazards

There are no known site-specific hazards associated with the area where the SRBT facility lies, other than any hazard that may present itself in a stable, industrial setting near an urban centre.

Potential hazards are documented and outlined within the document “Review of Hypothetical Incident Scenarios” [9]; this document is included as an appendix to this report.

l. Proximity of Industrial Facilities

Several small businesses and industrial facilities operate in proximity to the SRBT facility. Two industrial facilities within 250 m of SRBT maintain hazards analyses and emergency plans, as per applicable regulatory requirements. These facilities present potential hazards that, if realized, could have an impact on facility operations and the physical facility itself.

A small compressed industrial process gas retail supplier (Linde Canada Ltd.) occupies the southernmost unit of the building within which the SRBT facility resides. A number of compressed gas cylinders are stored and distributed from this facility, containing gases including oxygen, nitrogen, argon, and acetylene. A 3,000 gallon bulk liquid nitrogen filling station is also present and used to fill smaller cylinders for sale.

On the opposite side of Boundary Road, a recently upgraded bulk liquid propane storage depot is operated by Superior Propane as a truck filling station for distribution of propane to customers in the area. This facility is approximately 200 metres to the east of SRBT, and includes an above-ground 49,000 USWG capacity propane storage tank.

The emergency plans and available hazard assessments for both of these industrial facilities were requested; where made available, they have been reviewed in order to understand the potential impacts on SRBT should an emergency situation arise.

In the case of the industrial process gas retailer, the emergency plan in place includes provisions for the Emergency Coordinator to notify neighbours when an emergency situation develops. Examples of potential emergencies at this location include building fires, atmospheric hazardous materials releases, gas cylinder fires, and cryogenic releases or spills.

In the case of the propane distribution facility, a Level 2 Risk and Safety Management plan has been documented and accepted by the independent safety authority for this sector. SRBT has assessed key elements of this plan in order to determine the risks presented by this facility, and any potential impact on our facility.

The SRBT facility resides within the analyzed impact zone for five worst-case scenarios, including fatality due to a boiling liquid expanding vapour explosion (BLEVE), loss of containment accidents, and flash fire / vapour cloud explosion.

The hazard assessment shows that the expected risk probability at the distance that the SRBT facility is located relative to the propane storage facility falls within the Major Industrial Accidents Council of Canada (MIACC) acceptance threshold established for the zone, correlating to less than a 10 in a million chance for a fatality, per year.

For both neighbouring industrial facilities, the worst-case hypothetical accidents do present the potential for physical interactions with the SRBT facility should they occur (i.e. blast wave; thermal radiation effects from a fireball; explosion of compressed gas cylinders with accompanying projectiles).

Although there may be resultant building damage and conventional safety impacts to staff, the risks presented by these effects are not anticipated to increase the probability or consequences relating to nuclear, environmental or radiological safety beyond those already established for postulated initiating events of internal origin, for the following reasons:

- The probability of any significant accident occurring at either site is extremely low; in the case of the propane distribution facility, it has been shown to be below established acceptance criteria for this type of installation.
- If an emergency situation were to develop at either of these facilities, the respective emergency plans both include provisions for SRBT to be notified. Due to the nature of the possible accidents, there is a high probability that a warning will be given prior to the accident taking place, allowing personnel to put the facility and all nuclear substances into safe state (i.e. no tritium processing, all containers shut and sealed).
- The probability of possible physical interactions decreases with both distance and with the presence of physical obstructions between the accident location and the facility of concern. The gas retailer and the SRBT facility tritium processing areas are separated by several walls, including another business between the two facilities. The propane distributor is 200 metres in distance from SRBT, and there is a building directly in the line of sight of the propane storage tank and the SRBT facility that would shield any blast wave or instantaneous thermal radiation effects.
- Any blast wave, projectile or fireball from a worst-case accident will be de-energized to an extent by the SRBT building itself upon impact, thus reducing the probability of an effect being realized on the storage and containment of nuclear substances.
- Any interaction between the physical effect of the worst-case accident and nuclear substances in the facility is expected to be bounded by the analysed worst-case scenarios for the SRBT facility alone, from the point of view of radiological hazards to workers, the environment and the public.

Based upon the review and assessment of the available hazards analysis of other nearby industrial facilities, SRBT concludes that there are no probable or improbable hazards that are presented by these facilities that require special consideration in the design and operation of our facility, in order to mitigate nuclear, radiological or environmental consequences stemming from the nuclear substances processed in our facility.

m. Proximity of Transport Facilities

There are no major rail lines, airports, ports or other transport facilities within several kilometers of the SRBT facility which would present a hazard that requires special consideration in the design and operation of the facility, based upon the lack of historical events of this nature in the area near the facility.

n. Proximity of Military Facilities

The closest military facility is Garrison Petawawa, one of the major military bases in Canada. The base is approximately 17 kilometers away from the SRBT facility, and its presence is not expected to present a hazard that requires special consideration in the design and operation of the facility, based upon the lack of historical events of this nature in the area near the facility.

o. Radiological Conditions due to External Sources

There is one other major nuclear facility in the area surrounding SRBT. The Canadian Nuclear Laboratories in Chalk River, Ontario, is located north-west of the facility, approximately 35 km to the north-west. Just as with SRBT, this facility is authorized by licence by the CNSC to release radioactive substances to the environment, including tritium; however, the existence of this facility nearby does not present a hazard that requires special consideration in the design and operation of the facility.

p. Site Related Issues in Emergency Management

SRBT relies upon both internal and external support in the event of emergency. In the history of operations, there has not been an identified site-related issue that could adversely affect emergency response capabilities of support organization.

Refer to Section 12 for a detailed description of the provisions in place for the management of emergency situations.

q. Monitoring of Site Related Parameters

There are several parameters that are monitored in order to support safe operation of the facility.

SRBT employs an extensive Environmental Monitoring Program that evaluates the level of tritium in a wide variety of media in the affected area surrounding the facility. Detailed information is presented in Section 13 of this report.

In addition, gaseous and liquid effluent parameters are monitored closely through an Effluent Monitoring Program to ensure that SRBT meets and exceeds all requirements and expectations with respect to releases of nuclear substances.

Precipitation is monitored in real time in order to provide Rig Room staff with immediate feedback when rain or snow begins to fall. This ensures that processing operations are shut down at the soonest possible juncture, thus ensuring the optimized safety of groundwater and the environment in general.

The weather station collects data pertaining to wind speed and direction, relative humidity, temperature and other meteorological data in order to support analysis of environmental and effluent monitoring data.

5. General Design Aspects

a. Facility Safety Objectives

Context for Safety Objectives – Normal Operations

For normal facility operations, the primary safety objective that governs the design and operation of the facility is to ensure that all regulatory limits relating to radiation dose (both nuclear energy worker (NEW) and members of the public) are not exceeded, and that doses are maintained as low as reasonably achievable (ALARA) at all times.

- Public Dose

As of 2016, typical annual doses to the most-exposed member of the public have been calculated as well below regulatory limits since operational improvements were instituted in previous years.

Based upon EMP data, highly conservative dose calculations show that no member of the public is expected to be exposed to greater than around 10 µSv in any given year – a dose that has been noted by the IAEA to correspond to a trivial level of risk [10].

Annual targets are set on the quantity of tritium emitted via gaseous effluent streams, as well as the ratio of tritium emitted versus processed, in order to track the achievement of these objectives and identify issues that may need attention in order to ensure the ALARA principle is maintained.

Depending on production, it would not be unexpected that the value of 10 µSv may be exceeded; however, the continuing objective remains to achieve less than this value year-to-year.

- Worker Dose

Doses to NEWs have also been continuously driven down in recent years due to operational improvements. All workers at SRBT are designated as NEWs; in 2016, the highest exposed member of the workforce received a committed effective dose (CED) less than the regulatory limit for exposure to a member of the general public.

Targets are set in order to track the achievement of dose objectives and to identify issues that may need attention in order to ensure the ALARA principle is maintained. Depending on production, it would not be unexpected that the value of 1 mSv for worker dose may be exceeded; however, the continuing objective remains to achieve less than this value year-to-year.

- Environmental Risk

SRBT operation results in small quantities of tritium being released to the environment. These releases are restricted by licence, and action limits are set in order to ensure that control over these releases is maintained at all times, and to drive corrective and improvement actions.

The environmental safety objective of normal facility operations is to minimize our environmental impacts and maintain releases ALARA. Routine operation of SRBT shall not cause any measureable biological effects in people or the environment.

Context for Safety Objectives – Emergency / Upset Conditions

In 2008 a comprehensive analysis of worst-case hypothetical scenarios that could credibly occur at SRBT was compiled [9]. This report concluded that in all cases, regulatory limits for routine operations were not expected to be exceeded in the event of a multitude of initiating events or emergency situations.

In 2017, a review and update to these scenarios was conducted, in order to incorporate the latest meteorological data, and to reflect the latest parameters used for the calculation of the consequences of exposure to tritium (such as inhalation rates, dose coefficients, etc.). Both the 2008 report and 2017 update are referred to extensively in Section 7 of this SAR, and are included as appendices to this report.

The maximum doses to the public and workers assessed in this report are presented in the table below:

Scenario		Maximum Dose (mSv)	Receptor	Distance (m)
A	Release of the entire contents of a tritium trap (‘pyrophoric unit’)	0.0337	Member of the public	99
B	Release of the entire contents of a bulk container	0.304	Member of the public	99
C	Release from a tornado	0.140	Member of the public	100
D	Release from impact of a large rogue vehicle	0.180	Member of the public	99
E	Smoldering fire within the controlled area of the facility	9.28	Staff	
F	Release from breakage during handling	3.95	Staff	
G	Release from breakage during packing	3.02	Staff	

FIGURE 12: MAXIMUM DOSE IN HYPOTHETICAL WORST-CASE SCENARIOS

Based upon these analyses, and upon the operating history of the facility, SRBT establishes that the primary safety objective guiding the design of the facility is to ensure that during all phases of operation, including under worst-case credible accidents or emergencies, the established regulatory limits for acceptable worker and public radiation doses are not expected to be exceeded.

b. Design Principles and Criteria

As part of the design measures implemented when establishing protection against potential nuclear, radiological, environmental or conventional safety hazards, the general philosophy is to follow a hierarchical approach:

1. Where feasible, a hazard-generating process or activity should not be chosen if another adequate alternative is available that will generate less of a hazard, or preferentially, none at all – in other words, the hazard should be eliminated or reduced.
2. If incorporating specific features that are designed to protect against a hazard, the feature should preferentially be passive in nature (i.e. does not require active interaction with a person in order to provide protective function.
3. Where passive design features are unavailable or prohibitive, active design features should be incorporated.
4. Finally, administrative controls should be implemented to ensure an additional layer of defense in depth.

Consult ENG-003, *Design Control* for specific requirements pertaining to the measures taken with respect to the design of protective features of the facility.

The following specific design principles and criteria are implemented as part of the overall nuclear and radiation safety of the facility:

- Where tritium presents a hazard to workers, ventilation and air extraction with a pressure differential favouring low to high areas of contamination shall be put in place.
- Tritium processing is always performed under ventilation and fume hoods, within Zone 3, where the highest level of radiological controls are in place.
- Large quantities of tritium are divided into smaller quantities and batches, instead of using a large amount at any one time. This principle is behind the use of PUTTs on the processing rigs.
- Processing equipment is designed to be leak-tight, and air ingress into processing systems is always minimized to a practical extent in order to limit the generation of tritium oxide (HTO).

- Prior to any processing operation, a leak check of the system being operated is performed to ensure that the system is in a state ready for processing.
- Internal volumes of process lines and equipment shall be minimized to the extent possible in order to ensure that residual tritium that is ultimately released to the ventilation system is as low as possible.
- PUTT bases are limited to a defined number of cycles of use. This is to ensure that the readsorption of residual tritium in processing equipment is efficient, thus minimizing tritium losses. Previous to 2017, the number of cycles was limited to 13; however, beginning in January 2017 a research plan was initiated to investigate the extension of this limit due to a valve design change. The new style of bellows valve is expected to increase the life of each base; however, as of the revision date of this report, the cycle limit has not yet been formally defined. CNSC staff has been informed of this research, which is being performed in line with our Engineering Change process, as well as ENG-027, *Research and Development Process.*
- Valve selection (i.e. normally open, normally closed) on processing rigs is such that loss of pressurized air results returns the valves to the safe state.
- Where tritium may potentially be released into the workplace, real-time tritium-in-air monitors are employed to alert workers and prompt quick and effective action.
- When processing equipment and tritium containers are not in use, they are drawn down to vacuum pressure, isolated or closed and kept in an inherently safe state.
- Real time data on facility emissions is provided to staff processing tritium, and they are required to routinely assess and record the concentration of tritium in the gaseous effluent.

The above listed principles are not meant to be an exhaustive list; however, these principles have been proven to be effective in ensuring that safety objectives are continuously met during facility operation.

c. Defence in Depth

SRBT follows the defence in depth principle by implementing numerous processes and practices that contribute to the overall level of safety:

- Robustly designed and constructed processing rigs that are highly reliable.
- Minimizing the amount of free tritium gas that is in process at any given time to the extent possible.
- A management system that conforms to the requirements of CSA N286-12.
- Strong supervisory and management presence in the workplace.
- Procedures that govern all aspects of safety-critical operations.

- Independent verification where assurance is needed that an activity or operation is performed correctly.
- A systematic approach to training (SAT) is applied for all activities where human error could potentially lead to unacceptable safety-related consequences.
- A comprehensive approach to maintenance of key structures, systems and components, as documented in the Maintenance Program.
- The use of Committees to review issues and recommend improvements in the operations from all perspectives of the business.
- Highly effective change control processes that ensure that changes are safe, and that those that should be aware of the changes are made aware.

Through these processes and practices defence-in-depth is achieved at SRBT.

d. Design Approach - Radiation Protection

As a nuclear substance processing facility, the overall design principles cited above are in fact mainly aimed at ensuring that radiation protection (RP) of workers and the public is optimized and assured at all times.

The facility layout with respect to RP is such that there are three main zones of control:

- Zone 1 is the commonly accessible area (from the point of view of RP) and includes all offices, break areas, washrooms, the Glass Shop, the Coating Room, the Liquid Scintillation Counting Laboratory, Machine Shop, Shipping and Receiving, and Stores. Radiological controls are minimal in this area; the shipping area is routinely monitored for tritium in air, and contamination assessments are performed weekly in this zone.
- Zone 2 consists of the Assembly area and attached rooms. Radiological controls are heightened in this zone, with additional requirements for protective equipment and clothing by workers in the area. Contamination assessments are typically conducted three times a week.
- Zone 3 consists of the Rig Room, Laser Room, Tritium Laboratory, Tritium Lab Storage Room, and the Waste Room. Radiological controls are highest in this zone, with multiple tritium in air monitors in operation continuously. Staff are required to wear a complete set of standard protective clothing at all times (shoe covers, lab coat, gloves, safety glasses). Contamination assessments are performed daily during weekday operations.

All aspects of operation are designed to ensure that radiation exposures are kept ALARA at all times.

e. Conformance with Design Principles and Criteria

Based on the above listed design principles and criteria, the facility is well within conformance of the design principles and criteria.

f. Classification of Structures, Systems and Components

Key structures, systems and components (SSC) that influence or maintain safety are classified in a manner prescribed by the Maintenance Program. Refer to Section 9 for a description of this program.

Using a graded approach, SSCs are evaluated and classified to establish the level of maintenance that needs to be applied in order to continue to provide assurance of operability and reliability.

The following list details the SSCs that are important to safety at SRBT:

- Fire detection and alarm systems, including the fire panel.
- Sprinkler system and portable fire extinguishers.
- Emergency lights.
- Facility security system.
- Active ventilation systems servicing tritium processing equipment, including air handling units (AHU) and stacks in the compound.
- Real-time stack monitoring systems, including remote display units.
- Tritium-in-air sample collectors for stack monitoring (‘bubblers’).
- Tritium-in-air monitors – stationary and portable.
- Gas leakage detection equipment – stationary and portable.

The above listed SSCs are all maintained and serviced in a graded fashion, as part of the preventative maintenance program.

Each is designed or selected in order to withstand the effects of extreme environmental conditions (temperature, humidity, etc.) that would be reasonably expected to arise in the course of operations, while still performing their safety function during operations.

Historical data supports the assertion that in the range of conditions experienced in the 27+ years of operation of the facility, key equipment (for example, the air handling units located in the compound outside of the facility) have maintained their serviceability to an acceptable degree.

An important note is that SRBT does not feature any SSC where its failure would be reasonably expected to immediately result in an appreciable hazard to workers, the public or the environment. The listed SSCs are important to safety, but not in the sense of direct harm being prevented in an active way.

g. Civil Engineering Aspects of Facility Design

The facility and associated civil structures comply with the National Building Code of Canada. The ‘Butler’ style of building uses a ‘Widespan’ structural system that is broadly used in industrial settings. There are no requirements for the SRBT facility structure to be seismically qualified.

The building consists of a single story consisting of a concrete block and steel I-beam frame, with a metal clad on metal framework roof. The interior walls separating building tenants are of concrete block construction, while interior walls within the suite occupied by SRBT are generally steel frame with gypsum hardboard. Interior ceilings are either Armstrong ceiling tile or gypsum hardboard. The main floor is concrete, and tile covered in some areas.

Throughout the facility, engineered fire protection systems have been emplaced in line with the requirements of the National Fire Code of Canada (NFCC) and CSA standard N393-13, *Fire protection for facilities that process, handle, or store nuclear substances.* Details on these engineered SSCs are included in the Fire Protection Program, and are further discussed in this report in Section 12, and additional details can be found in the latest version of the Fire Hazards Analysis (FHA) document.

h. Equipment Qualification and Environmental Factors

This section is not applicable to this report, as SRBT does not require equipment to be qualified to seismic or environmental standards outside of normal workspace operations.

Typically daily workplace temperatures and humidity varies depending on the season and weather. All safety-related equipment has proven to be adequately functional and reliable in all experienced environmental conditions.

i. Human Factors Engineering

Tritium processing equipment is built in a way that is intended to be easy to use, and to minimize the potential for human error due to poor engineering.

Filling rigs include a diagrammatic representation of the processing system with pneumatically-actuated valves activated and deactivated through pushbuttons on the diagram. The panel allows the operator to visualize the sequence of valve operations needed to process tritium into GTLS.

All instrumentation is easily visible and decipherable, and valve status is displayed using illuminated indicators.

j. Protection Against Internal and External Hazards

One of the primary systems is in place to protect against internal hazards is the fire protection and suppression system. SRBT has deployed a comprehensive array of smoke and heat detectors, audible and visual alarms, sprinklers and portable fire extinguishers in order to ensure that the highest level of protection against hazards posed by fire is afforded. The system is assessed annually by an independent third party for compliance with requirements and readiness for service and use, and is frequently tested during fire drills.

SRBT also has an internal security system that ensures the physical security of the business, including all nuclear substances, at all times. The description of this system is considered sensitive information and is not presented within the context of this report; however, the system in place has been inspected, assessed and accepted by CNSC staff as meeting or exceeding all requirements and expectations.

Active ventilation systems provide the main element of radiological protection to workers due to process leakage, light breakage, and other tritium-related hazards. Two trains of ventilation service the main tritium processing areas of the building, identified as the Rig and Bulk stack systems.

The Rig stack provides ventilation to all processing rigs in the Rig Room, as well as the Waste Room, and the ventilated cabinets on the west end of the room. The Bulk stack services the laser units, the bulk splitter and the cabinet that previously housed the reclaim rig. Two ventilated cabinet spaces are also serviced by the Bulk stack in the Tritium Laboratory.

The SRBT facility structural design is not specifically built nor intended to offer protection against external hazards above and beyond that afforded by a conventional industrial production facility.

k. On-site Transport

As opposed to a larger-scale nuclear facility such as a nuclear power station or research complex, SRBT does not implement a dedicated organization to the on-site transportation of radioactive or hazardous materials.

6. Description of Facility Systems and Components

a. Nuclear Systems and Components

i. Tritium Processing Equipment – Filling Rigs

A filling rig consists of an arrangement of stainless steel tubing, pneumatically and manually operated valves, and pressure sensing instrumentation that is serviced by a dry-scroll vacuum pump.

The systems in use have remained the same in general design since operation began in 1990, although improvements in individual components have been incorporated as technology has advanced.

VACUUM PUMP: Commercially available dry-scroll type or equivalent, capable of delivering a minimum ultimate pressure of 6.6E-02 mbar.

TUBING: Commercially available stainless steel tubing, of varying dimensions. Tubing internal volumes are minimized to the extent practical in order to minimize associated tritium emissions on pump out.

CONNECTORS: Where required, connectors implemented are commercially available stainless steel fittings of various types depending on the application.

VALVES: Commercially available stainless steel bellows-sealed valves, either manually or pneumatically operated. Valve stem tips are either polychlorotrifluoroethlyene- or polyimide-based.

FILTERS: Commercially available filter elements are installed where required in order to protect PUTTs from particulate contamination.

INSTRUMENTATION: One digital pressure sensing digital programmable logic controller provides the operator with real-time pressure information on the main processing header space, in units of cm of Hg (atmospheric pressure = 76 cm Hg).

Two pirani gauges and associated active gauge displays provide pressure readings of the manifold prior to processing (for leak check) and of the ultimate vacuum pressure being delivered by the pump.

VENTILATION: Each rig occupies one half of a ventilated steel enclosure specifically built to house the equipment. The Rig stack services this equipment.

ELECTRICAL: 120 V AC conventional power supply is provided to each rig and pump; the rig instrumentation operates off stepped-down 24 V AC power generated via an on-board transformer.

PNEUMATICS: Valves to individual filling heads (connection points for up to 20 GTLS preforms), as well as valves used to isolate the PUTT, vacuum pump and manifold gauges operate using pneumatic pressure delivered by the main facility air compressor.

PURGING: An inert gas-based purging system also interfaces with each processing rig in order to ensure complete removal of residual tritium gases to the ventilation system at the conclusion of a processing operation. The system is isolated from the main rig using two manually operated bellows-sealed valves in series.

PUTT CONNECTION: Filling rigs include a male connection port where PUTTs are attached as required in order to deliver tritium to GTLS preforms.

LIQUID NITROGEN TANK: Several rigs also are equipped with an adjustable insulated tank that can be filled with liquid nitrogen. This tank permits the filling of light preforms under low-temperature conditions (around -196 degrees C), thus permitting GTLS to be filled and sealed while containing tritium pressures greater than atmospheric.

ii. Tritium Processing Equipment – Bulk Splitter

The bulk splitter is located in the Tritium Laboratory, and is contained within a ventilated 'fume-hood' cabinet. The principle of operation of the unit is much the same as with the processing rigs; however, all valves are manually operated toggle-type valves.

The system is designed to allow complete operator control over the dispensation of tritium gas from the bulk containers (up to around 925,000 GBq) onto smaller PUTTs (limited to 111,000 GBq).

VACUUM PUMP: Commercially available dry-scroll type, capable of delivering a minimum ultimate pressure of 6.6E-02 mbar.

TUBING: Commercially available stainless steel tubing, no greater than 3/8" internal diameter.

CONNECTORS: Where required, connectors implemented are commercially available stainless steel fittings of various types depending on the application.

VALVES: Commercially available stainless steel bellows-sealed valves, manually operated. Valve stem tips are either polychlorotrifluoroethlyene- or polyimide-based.

FILTERS: Commercially available filter elements are installed where required in order to protect PUTTs and bulk tritium containers from particulate contamination.

LARGE VOLUME MEASUREMENT VESSELS: Three calibrated stainless steel vessels are attached to the bulk splitter. The amount of tritium within any given vessel is directly proportional to the measured gas pressure within, as measured by individual gauges for each vessel. This allows an indirect but precise measurement of the quantity of tritium being dispensed during processing.

INSTRUMENTATION: 'Digitec' pressure sensing digital programmable logic controllers provides the operator with real-time pressure information for each measurement vessel.

A pirani gauge and associated active gauge display provides pressure readings of the system prior to processing (for leak check) and of the ultimate vacuum pressure being delivered by the pump.

VENTILATION: A ventilated fume hood houses the processing system, as well as the pump in the cabinet space below. The Bulk stack services this equipment.

ELECTRICAL: 120 V AC conventional power supply is provided to the pump while instrumentation operates off stepped-down 24 V AC power generated via an on-board transformer.

PURGING: An inert gas-based purging system also interfaces with the bulk splitting rig in order to ensure complete removal of residual tritium gases to the ventilation system at the conclusion of a processing operation.

iii. Tritium Processing Equipment – Laser Cutting Units

Various designs of laser cutting units have been implemented over the operating history of the facility, with similar designed functions.

The following information pertains to the ‘EIP’ laser unit in operation:

CUTTING VESSEL: A high-grade stainless steel vessel is mounted in place and aligned with the beam line of the laser, with a lens port installed to permit the laser to enter the vessel chamber.

Laser ‘sticks’ are inserted into the vessel from the top through a port, with the inserted stick providing the ultimate atmospheric seal required when cutting. A removable collection container is located at the bottom of the cutting vessel that allows the removal of laser-cut GTLS.

LASER: A CO_2 laser (350W, 10.6 μm wavelength) provides the cutting beam for the rotating laser stick.

LASER COOLING: A liquid chiller system delivers heat-removal capacity to the laser during operation.

MOTOR DRIVEN ROTATION: A small electrically driven motor and drive belt system permits the laser stick to be rotated inside the cutting vessel at a high rate of speed during laser beam activation, in order to ensure a smooth and concentric cut of the GTLS.

VERTICAL INDEXING DRIVE: A programmable stepper motor permits a laser stick to be moved in a programmed distance downward as the stick is rotating and laser cutting is performed. The distance moved downward corresponds to the required length of the GTLS being manufactured.

ELECTRICAL: 120V AC power is delivered to the system, with control and safety interlocks fed by stepped-down 24V AC power.

PNEUMATICS: Slightly greater than atmospheric pressure using compressed air can be introduced to the cutting vessel during GTLS manufacture in order to ensure sealing of the light source and prevent outward expansion due to pressure differential.

CONTROL: A digital control system is provided with touch-screen display and control of all parameters relating to the cutting of GTLS, including index length, rest times, and laser power. The control panel includes a safety switch that shuts down the system immediately.

SAFETY INTERLOCK: Sensors on the two access port doors ensure that the system cannot be operated if the ventilated cabinet is open; this ensures that operators are safe during laser activation, and that the laser cannot be fired if the system is open.

VENTILATION: The entire system is housed within a sealed polycarbonate plastic enclosure that provides protection from tritium during operation. The cabinet is ventilated to the Bulk Air Handling Unit (AHU).

iv. Tritium Processing Equipment – PUTTs

PUTTs consist of two main parts: a manually operated bellows-valve provides effective sealing and isolation of tritiated uranium hydride from the atmosphere or processing equipment which is contained within a welded stainless steel vessel – the PUTT base.

The PUTT base typically contains about 30 g of uranium or depleted uranium that provides the adsorbent bed for the tritium gas, and can be heated manually using open flame in order to release the tritium gas as required by processing.

VALVE: A manually operated bellows-sealed valve is used to effectively seal the PUTT when not in use.

CONNECTORS: A female threaded connection nut is provided on the horizontal plane of the PUTT as the connector for the component to be attached to processing rigs and the bulk splitter. An O-ring on each connecting component provides an effective seal. Connectors are used between the valve and the base.

PUTT BASE: A small cylindrical volume welded to a length of stainless steel tubing houses approximately 30 g of depleted uranium which acts as the adsorbent bed for the tritium gas at room temperatures. The tubing between the base and the valve contains a small quartz fibre filter that prevents the migration of uranium from the base during vacuum pumping, and precludes particulate contamination from entering. The base is heated manually under closed vacuum conditions whenever tritium processing is executed.

v. Tritium Processing Equipment – Bulk Tritium Containers

Tritium is delivered to SRBT within certified containers owned by the supplier. These 'Amersham' containers are used worldwide where safe transport of moderate quantities of tritium is required. Details on these containers are available from GE Healthcare (formerly Amersham Health Logistics) within document *Operating Instructions Package Design Number 3605D.*

The containers used are designated as 0035 tritium beds, and are certified in Canada for transport under certificate number CDN/E204/-96 (CNSC file 30-10-3-128). Connections provide the capacity to attach a bulk container onto the bulk splitting rig for tritium dispensing.

The container is isolated using a bellows-sealed valve, and connected to the bulk splitter by way of a standard connector much the same as with PUTTs.

Heat is applied and carefully controlled during processing using a heating band activated by a variable power controller, with a thermocouple installed between the band and the surface of the bulk container. Heating is applied to around 500 degrees C, up to a maximum of approximately 550 degrees C, in order to release tritium gas into the measuring volumes of the bulk splitting rig.

vi. Active Ventilation Systems

Two trains of active ventilation systems are used to ensure the radiation safety of workers in areas where tritium can present a hazard, including Zones 2 and 3. Maintenance is performed on these systems on at least a quarterly basis.

The Rig stack / extract AHU handles air supply and exhaust for the Rig Room. The unit is a Temprite model HRP 28-61/76 providing an exhaust capacity of 7,600 cubic feet per minute (cfm). The Rig AHU provides exhaust for the following:

- Filling rig cabinets (four)
- Muffle fume hood
- Stub crushing fume hood
- Wash fume hood
- Waste room
- Waste drum ventilation cap

The Bulk stack / air extract AHU is a Temprite model HRP 15-36/45 providing an exhaust capacity of 4,500 cfm. The Bulk AHU provides exhaust for the following:

- Bulk Splitter fume hood
- Disassembly fume hood
- Reclamation unit fume hood and glove boxes
- Tritium lab storage room
- Laser room inspection fume hood
- Laser cutting unit fume hoods
- GTLS storage cabinet (laser room)
- Inspection preparation room
- Inspection room

Ductwork stems from each AHU located within the exterior fenced and secured compound, into the main facility, and is distributed as per the diagram below:

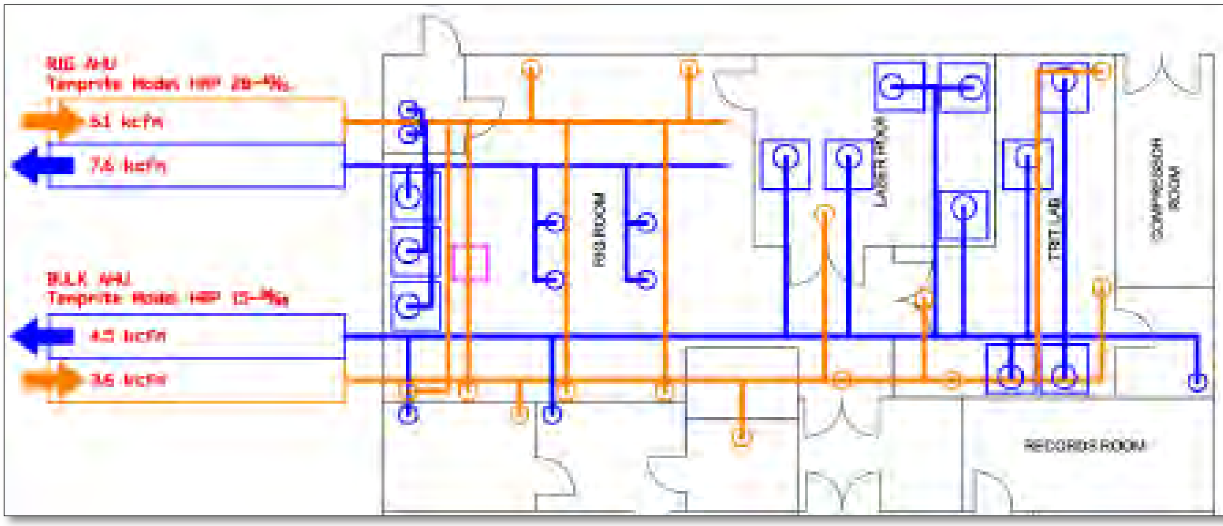

FIGURE 13: ACTIVE VENTILATION SYSTEM FLOW DIAGRAM

The AHUs consist of belt-driven fans operated by motors on 240 VAC electrical circuits, with associated filtration on the inlet flow path for particulate elimination.

Each AHU ejects exhausted air through an individual stack. The operating parameters of each AHU are carefully monitored and controlled to ensure that minimum effective stack heights are achieved during processing operations. Daily readings of the differential pressure are obtained prior to tritium processing taking place, in order to ensure that a minimum effluent exit velocity is achieved.

The following table summarizes the characteristics of each AHU / stack, as well as the parameters that must be minimally achieved in order for tritium processing to occur:

PARAMETER	Rig AHU	Bulk AHU
Height of Stack above ground level	11.86 m	11.09 m
Inside radius at pitot tube (measurement point for differential pressure)	0.28 m	0.20 m
Inside radius at exit	0.23 m	0.18 m
Minimum differential pressure reading required for tritium processing (corresponding to an effective stack height of 27.8 m at a wind speed of 2.2 m/s).	0.27” wc	0.38” wc

FIGURE 14: TABLE OF AHU / STACK CHARACTERISTICS

vii. Stationary Tritium in Air Monitors

SRBT deploys tritium-in-air monitors (TAM) as part of the overall approach to radiation protection in the facility, where the potential for tritium hazards exist.

These monitors consist of several integrated components within a commercially available system, including:

- An ionization chamber to collect the ionization current introduced by tritium gas decay within the chamber
- A sampling system to circulate the sample air through the ionization chamber
- An electrometer to amplify the weak ionization current
- Electronics to process the signal and display the proportionally-derived measurement of the concentration of tritium gas per unit of air circulated.

These monitors operate on conventional 120 VAC power supply, and include audible alarm capabilities with user-selectable set points.

In Zone 3, three of these units are deployed in order to provide effective protection and early detection of upset conditions. Alarm points are set to 10 μCi/m^3, with a flow rate of 5 L/min.

In Zone 2, one of these units are deployed in order to provide effective protection and early detection of upset conditions. Alarm points are set to 5 μCi/m^3, with a flow rate of 5 L/min.

In Zone 1 within the Shipping and Receiving area, one of these units are deployed in order to provide effective protection and early detection of upset conditions. Alarm points are set to 5 μCi/m^3, with a flow rate of 5 L/min.

Additional detailed information on these units is provided in the Radiation Safety Program document, as well as the associated operating and technical manuals provided by the manufacturer.

Each TAM is calibrated on an annual basis in order to confirm continued accuracy and reliability, and to identify the need for adjustment or repair. Members of the Health Physics team are authorized to adjust or otherwise manipulate stationary TAMs in order to achieve a high level of safety.

viii. Portable Tritium in Air Monitors

SRBT deploys portable tritium in air monitors for the use of staff where the potential for tritium hazards exist.

These units operate under the same principles as the stationary TAMs noted above, but may include the capacity to operate using battery power.

All trained and qualified staff members are authorized to use portable TAMs as required during the course of daily operations. Members of the Health Physics team are authorized to perform adjustments and otherwise manipulate portable TAMs in order to achieve a high level of safety.

ix. Real-time Stack Monitoring Equipment

The real-time stack monitoring system consists of the following physical components:

- Two stationary tritium-in-air monitors (TAMs) with 4-20 mA output capability;
- One electronic data recorder;
- One analog paper strip chart recorder;
- Two Remote Display Units (RDUs), one connected to each TAM, and mounted in the Rig Room / Tritium Laboratory.

In addition, the electronic data recorder is supported by manufacturer-provided software.

The system is arranged such that a representative sample of ventilated air is drawn from the ductwork to each active ventilation stack (‘Rig’ and ‘Bulk’ stacks) at the point where the ducting exits the building. The sampled air is drawn by the TAMs at a rate between 4-6 litres/minute, and the concentration of tritium is measured in real time. This information is then relayed to the two recording devices located in the Ante Room area outside of Zone 3.

The 0-10 V output posts on each TAM are connected to the dual-pen analog strip chart recorder, resulting in a trace of the concentration of tritium in each stack.

The 4-20 mA output posts on each TAM are connected to the electronic data recorder; the recorder logs and stores information relating to concentration of tritium in each stack, and displays trend lines on the display. All information stored can be downloaded and analyzed using the Companion software, either by directly obtaining the data from the compact flash memory card in the unit, or from a network connection.

The J2 connectors on each TAM are connected to a corresponding RDU mounted in Zone 3. This connection relays the real-time concentration of the exhaust gas and displays the reading in units of $\mu Ci/m^3$. The RDUs include two separate alarms (low level and high level) that audibly and visually alert staff of potential upset conditions.

Key parameters for each physical component of the real-time stack monitoring system are listed below:

TAMs:

- Flow rate: 4-6 LPM
- Alarm set point: OFF
- Noise suppression: ON

Analog Strip Chart Recorder

- Upper pen: Bulk stack (red)
- Lower pen: Rig stack (black)
- Pens: 5 V
- Zero: REC
- Chart speed: 1 cm/hr

The maximum input voltage for the Analog Strip Chart Recorder is 5 V, which corresponds to 10,000 $\mu Ci/m^3$ from the TAM; this results in a chart scale of 0 – 10,000 $\mu Ci/m^3$.

Electronic Chart Recorder

The following are key parameters in the set up and programming of the unit.

Channel 2 is the input port for the Rig stack, and displays info via Point 2. Channel 4 is the input port for the Bulk stack, and displays info via Point 4. Pens and charts are set up to display both stacks on the same chart, on a scale of 0 – 20,000 $\mu Ci/m^3$.

Connections are made from the rear panel on the TAM to the appropriate channel on the back of the electronic chart recorder. Refer to section 2.3.3 of the Monarch DC2 manual for explicit instructions on making the 4-20 mA connection.

Programming of the electronic chart recorder is described in full detail within the user manual [11], and is not repeated here except for the key parameters for accurately translating the signal to a concentration value.

For more explicit technical detail on how to use and program the electronic chart recorder 2000, consult the operating manual (Monarch DC2 Manual rev1.7.pdf) and the software manual (Companion Manual Hyperlink.pdf).

Remote Display Units

These units take an electrical signal from the TAM via the J2 connection and an associated cable, and process it to a secondary numerical display and alarm system.

Each system operates using standard 120 VAC power supply, with a two-stage alarm that can be user-set for a low- and high-level alarm capability. Both alarms have audible and visual components.

x. Tritium in Air Sample Collectors for Emissions Monitoring

SRBT deploys tritium-in-air sample collectors (TASC) in order to collect and measure a proportional sample of exhaust gases from both active ventilation AHUs.

The TASC operates by drawing a sample stream of air, and trapping any tritium in that air within vials containing absorbent material. The exhaust sampling line is connected to the inlet barb on the front of the unit.

To ensure virtually total collection, each main vial is succeeded by a second and third vial whose purpose is to trap any of the material which was missed by its predecessor.

Six vials are used to trap tritium oxide and elemental tritium; three vials for each species.

For the collection of tritium, the vials are filled with a mixture of clean water and glycol, in a 1:1 ratio. Between 17-18 ml of this mixture is added to the sample vials, and acts as the absorbent material.

The sampled air is first filtered for dust and then passes directly through the first three vials where all tritium oxide is collected. The sampled air is then treated in the catalytic converter where elemental tritium is converted to oxide. This tritium is then collected in the next three vials.

The remnant air stream passes through the flow moving system, which consists of the rotameter, the flow controller and, finally, the pump. The flow rate is adjusted at the factory to exactly 100 cubic centimetres per minute, and is set by a needle valve associated with the flow controller. The relatively tritium-free outlet gas is then routed to the exhaust system attached to the fume hood.

The critical user-controlled parameter on the TASC is the temperature of the catalytic converter. The ideal temperature for efficient conversion of elemental tritium to tritium oxide using the platinum/palladium catalyst is between 600-650 degrees Celsius. Lower temperatures will not allow the catalytic reaction to proceed at an effective rate, leaving elemental tritium to pass through the bubblers and fail to be collected. This would result in significant underestimation of the emissions of this type of tritium.

The controller on the front of the unit displays the set-point in green, and the actual measured temperature in red. The controller cycles the heater on and off periodically in order to maintain a consistent temperature at the set-point.

A resettable digital timer is also included to track the elapsed sampling time, in hours.

In-use TASC systems are verified on an annual basis by an independent third party. Maintenance processes relating to TASCs are defined in accordance with the SRBT Maintenance Program.

The system is supported by mass-flow meters which accurately measure the amount of air sampled over time. This parameter is a key component in the calculation of tritium emissions from the facility.

Additional detailed information on these units is provided in the Radiation Safety Program document, as well as the associated operating and technical manuals provided by the manufacturer [12].

xi. Liquid Scintillation Counters

Tritium is an extremely low-level beta radiation emitting isotope, and is not detectable using conventional radiation instruments.

As a result, samples must be prepared and measured using a special instrument called a Liquid Scintillation Counter (LSC). SRBT owns two such counters.

Sample material is prepared and loaded into small vials specifically designed for LSC. A fluid called ‘liquid scintillation cocktail’ is added to the prepared vial, and the vial is sealed and mixed by shaking.

The vials are then loaded into the counter, and the assay process is activated. In sequence, each vial is loaded by the counter into a chamber that is sealed from all external light, and is heavily shielded to eliminate background radiation interference.

The cocktail interacts with any radioactive particles or rays to produce light. This light is of a frequency that is detected by photo-multiplier tubes (PMT) located next to the counting chamber. The detection creates a signal which is amplified by the PMTs and associated circuitry. The signal is further processed and a determination made of the number of light events per unit time (counts per minute, or CPM).

The number of CPM is proportional to the number of radioactive disintegration events inside the vial (disintegrations per minute, or DPM), depending on the efficiency of counting. The LSC units are programmed to automatically determine the amount of tritium in a given sample vial by way of designed assays.

The two LSC units are maintained on an annual basis by qualified third-party technicians, typically personnel from the manufacturer. A weekly calibration assay is run to confirm that instrument performance continues to meet requirements, and that measurements are of a sufficient quality and accuracy.

Maintenance processes are defined in accordance with the SRBT Maintenance Program. Consult the manufacturer’s operating manual for detailed information on this equipment [13].

b. Non-nuclear Systems and Components

i. Fire Protection Systems

SRBT employs several SSCs that are focused on ensuring the fire protection of the facility at all times, in all areas.

A single stage fire alarm system monitors smoke and heat detectors located throughout the facility, with manual pull stations installed at each exit door. An alarm panel includes complete system information in real time, including the status of all detectors as well as flow, pressure and tamper alarms for the sprinkler system. Loss of municipal water supply could adversely affect the operation of the sprinkler system; however, a specific alarm is programmed into the system in case of low sprinkler water pressure.

An automatic sprinkler system is installed throughout the facility. This system was designed for an Ordinary Hazard Group 2 Occupancy, requiring a sprinkler density of 0.20 gpm / ft^2 over a design area of 900 square feet. This design criterion is in accordance with the requirements of NFPA 13, and has been approved by the Pembroke Fire Department.

All fire protection systems employed by SRBT feed into an integrated monitoring panel that has been installed, commissioned and accepted for use.

The fire protection systems in place within the facility meet all applicable requirements, including the provisions identified in the LCH. Additional details on this system can be found in the FHA for the facility, as well as the Fire Protection program document and associated procedure set.

ii. Security Program and Systems

Physical security of the facility is supported by the implementation of a Security Program. This program documents the provisions and controls emplaced by SRBT to prevent security events from occurring and to ensure a system is in place and maintained in an operationally ready state at all times when the facility is not occupied.

Details on these aspects of operation are confidential and as such are not discussed further in the context of the SAR. CNSC staff has assessed the physical and administrative security measures put in place by SRBT and determined them to be in compliance with requirements.

iii. Electrical Systems

The facility is supplied electricity from the City of Pembroke electrical distribution grid, supplied by Ottawa River Power Corporation. 600 V power is stepped down to 240/120 V using transformers, feeding into breaker panels that control the facility electrical circuits. The breaker panel room is located near the Shipping and Receiving area, and is secured against unauthorized entry.

Pembroke and the surrounding area are subjected to power failures every few months, with failures typically lasting less than an hour, sometimes up to 2-3 hours. A power outage is not expected to result in any nuclear or radiological hazard, as tritium processing cannot occur without electrical power supply, and the systems revert to the safe state after electrical and pneumatic power is lost.

iv. Heating, Ventilation, Air Conditioning Systems

The facility is heated when required primarily through commercially available natural gas heating systems, with integrated blowers.

Non-active ventilation systems are provided to ensure adequate air exchange, and to provide worker protection for conventional hazards such as particulates that may be present when performing coating or painting operations. Air conditioning is provided both using central and local units as required during summer months.

v. Process Gas Systems

The following process gases are distributed through the facility as required:

- Natural gas lines extend through the facility in order to supply fuel for heating, as well as for manufacturing processes in the Glass Shop and Coating Room. Gas is sourced from subsurface distributed services, with the main facility connection point located on the exterior northeast corner of the Coating Room near the nitrogen tank.
- Compressed air is supplied from an industrial compressor located in the Compressor Room located on the northeast corner of the facility. This area is only accessible from outside the facility. The compressor is started up during operating days when facility manufacturing is ongoing, and supplies the pneumatic power to the valves on the processing rigs, as well as compressed air for several other manufacturing processes.
- Oxygen is distributed from a common head tank containing pressurized liquid oxygen. This tank is stored in the compressed gas storage room and connects to a distribution network that delivers oxygen gas to the Glass Shop and Coating Room.

- Oxygen and acetylene gases are also distributed to manually operated hand 'torches' used to end-seal GTLS once filled with tritium gas on the processing rigs. Bottles of each type of gas are attached via a regulator in the Rig Room Ante Room, with process side pressures set to approximately 15 psi(g) for oxygen, and 5 psi(g) for acetylene. Lines are clearly marked at the point of bottle connection, as well as on the physical distribution system.
- Inert gas is delivered to tritium processing equipment via a distribution system. A compressed inert gas bottle is attached via a regulator in the Rig Room Ante Room, with a process side pressure set at approximately 15 psi(g). Distribution lines extend into the Rig Room to each processing rig, as well as the bulk splitter, in order to provide the motive force behind the purge processes at the conclusion of any processing run. Lines are clearly marked at the point of bottle connection, as well as on the physical distribution system.

All compressed bottles and tanks of process gases are stored securely when not in use inside the gas storage room near the east shipping bay. This room is kept locked, and all bottles (empty or full) are chained in place at all times.

Bottles that are in use are also chained in a manner which prevents them from tipping over. Staff are trained to leave safety chains in place at all times unless changing bottles, and to ensure that safety caps are kept securely in place over compressed gas valves when moving bottles.

vi. Gas Leakage Detection Systems

The Rig Room includes a flammable gas detection unit on the north interior wall, centrally located in order to detect any acetylene or natural gas leakage and to alert staff of the leak. A natural gas leak detector is located in the Glass Shop as well, with a portable unit also available for precise determination of leak location if needed.

vii. Weather Station

A weather station is operated and maintained by SRBT at the northeastern most point of the property where the facility is located. The station measures multiple variables relating to local weather conditions, including wind speed and direction, humidity, temperature, the presence of precipitation, and dewpoint.

Data is saved on file every five minutes to provide information that can be used to support the Environmental Protection Program, as well as future modelling of local weather for refinement of public dose calculations and other environmental elements such as risk assessments.

viii. Precipitation Detection System

A subcomponent of the weather station is the precipitation detection system, which interfaces with an alarm circuit (visual and audible) located on the ceiling of the entrance area to Zone 3.

The system is extremely sensitive, and is able to detect very small levels of precipitation. When detected, precipitation events result in an audible and visible alarm in the Rig Room, alerting staff that tritium production must cease as soon as can be safely achieved.

ix. Water Systems

Municipal water services are integrated throughout all areas of the facility, with numerous sinks and fixtures in place to support business operations, processes and sanitation. Hot water is delivered to the north, central and south sections of the facility using electrically heated hot water tanks.

x. Waste Water and Sewer Systems

The building is serviced by the network of waste water works operated by the City of Pembroke. The sewer system represents the other significant effluent pathway for the release of tritium to the environment.

Water-soluble tritium is generated as part of decontamination processes, GTLS leak check activities, and groundwater monitoring well purging. A limit of 200 GBq per year of tritium is authorized by licence to be discharged to the municipal sewer system.

On average, approximately 10,000 L/day of waste water flow is discharged from the premises at 320 Boundary Road, including all SRBT facility waste water. This fluid is routed to the west using subsurface sewer lines, and then northwest toward the Bennett Street line which moves the fluid toward the Town Line Lift Station, for final pumping and ultimate conventional treatment at the Pembroke Pollution Control Centre (PPCC).

Past measurements of tritium concentration in the outfall at the PPCC showed conclusively that there is no significant risk to the environment or persons due to routine annual releases via this effluent pathway For the last full year of sampling (2012), an average tritium concentration in effluent of 19.4 Bq/L was observed, with the measurement being less than 27.8 Bq/L 95% of the time.

As such, it is clear that the annual limit of 200 GBq of water soluble tritium to the sewer system is safe and highly conservative.

xi. Liquid Nitrogen Storage and Supply

Liquid nitrogen is stored in an industrial tank in a fenced and secured area adjacent to the compound in which the Rig and Bulk AHUs are located.

This fluid is used as a process liquid for submerging GTLS preforms during tritium filling operations, in order to fill to higher amounts of activity at sub-atmospheric pressures, thus allowing manual flame sealing under active ventilation.

The tank is owned and operated by a commercial supplier of liquid nitrogen, and is filled on an as-needed basis. An insulated line runs from the discharge of the tank, and onward into the building into the ceiling space above Zone 3, parallel to the Bulk AHU main duct line. The line then branches to two separate lines beside the Rig 5/7 and Rig 6/8 ventilated cabinets, and then down through the ceiling to the main Rig Room area where valves are used to control the flow of liquid.

Flexible hoses are used to fill tanks attached to these Rigs as required by process. As the liquid nitrogen heats up, it is ventilated to the AHU.

Staff are trained to take conventional health and safety precautions to protect themselves from exposure to this liquid (-196 degrees C), as well as noise hazards presented by the system when in use.

xii. Information Technology Network

A common computer server network is used to manage information at SRBT. The main components of this network are located within the Records Room near the office of the President, in an engineered cabinet that affords protection from fire and water.

Several computer stations are in place in offices and the main manufacturing areas of the facility in order to allow employees access to the information needed to perform their work. The SRBT network includes both hard-wired and wireless connection technologies that are managed and controlled according to MSP-004, *Information Management.*

Key information is retained on the server at all times, and the system is backed up on a frequent basis to ensure that loss of data and records would be minimal should failure occur.

There are no safety-related systems or components that directly interface with the information technology network at SRBT.

7. Safety Analyses

a. Safety Objectives and Acceptance Criteria

As noted in Section 5, the overarching facility safety objective and design acceptance criterion is to ensure that during all phases of operation, including under worst-case credible accidents or emergencies, the established regulatory limits for acceptable worker and public radiation doses are not expected to be exceeded.

Any assumptions made in relation to the analysis of the nuclear or radiological safety consequences of any given event shall be conservative.

b. Identification of Postulated Initiating Events

Consult the document *Review of Hypothetical Incident Scenarios* [9] for a detailed description of the methodology behind the identification of postulated initiating events (PIE), also termed ‘hypothetical incident scenarios’ (HIS).

For the purposes of the SAR, a review of all PIE/HISs previously identified has been conducted and determined to continue to be valid for the current operational state of the facility.

In 1990, SRBT contracted the services of Atomic Energy of Canada Ltd. to perform assessment of the dose to a member of the public from a hypothetical worst case scenario. In this assessment [14], two PIEs were identified (the release of 100% of the inventory of a PUTT and a bulk container, 100% HTO conversion).

In 1996, SRBT contracted the services of Alpha-Dyne LLC to define additional scenarios and assess the dose to a member of the public. Several other PIEs were identified for analysis [15], including the impact of a tornado, the impact of a large rogue vehicle, and the total destruction of the building by fire.

In 2000, Alpha-Dyne LLC once again assessed additional PIEs as part of licence renewal, including a smoldering fire within the controlled area of the facility [16], and a smoldering fire that causes structural failure of the mezzanine [17]. CNSC staff also conducted analysis of additional PIEs in support of the licence renewal [18].

Several improvements were effected to the operations and the facility in general in order to reduce or eliminate the probability of the occurrence of analysed PIEs beginning in 2000 as a result of the findings to date.

- Fire protection processes and programs were implemented and improved.
- Storage practices in the mezzanine area were optimized.

- New real-time tritium monitoring equipment was put in place on the active ventilation systems.
- Ventilation system performance verification was initiated routinely.
- A maintenance program was implemented.
- Operation of the bulk splitter required direct supervisory oversight.
- The maximum acceptable activity load on any PUTT or bulk container was reduced.

In 2008, a comprehensive analysis of PIEs was initiated to establish the credibility and consequences of any given scenario with process improvements having been established. These analyses are documented within SRBT's *Review of Hypothetical Incident Scenarios* document [9], attached as an appendix to this SAR.

In addition, several other PIEs were identified for analysis based upon the 2007 report titled *Systematic and Quantitative Analysis of Tritium Sources and Their Potential Contribution to Groundwater Contamination* [19]. A systematic approach was implemented through an analysis of the movement of tritium through the entire facility and individual processes, a review of historical records relating to events and work practices, and interviews with staff.

The *Review of Hypothetical Incident Scenarios* identified several additional PIEs that warranted analysis for credibility and consequence, including:

- The receipt of a bulk container.
- The receipt of GTLS and devices containing GTLS.
- The operation of the reclamation rig (was already shut down at the time).
- The operation of the stub crusher in Zone 3.
- Laser cutting operations.
- GTLS leak testing.
- Sewer line leakage.
- Releases from GTLS breakage during handling.
- Releases from GTLS during packing.

In 2017, a review of the total set of PIEs identified to date finds that there are no PIEs that have gone unidentified in the latest set of analyses that are not bound already by other analyses.

The seven most significant PIEs were re-analyzed in order to account for (where appropriate) the latest meteorological data for the site, as well as the latest understandings of human-related parameters for the calculation of dose, such as inhalation rates and dose coefficients. This update is also included as an appendix to this SAR.

c. Human Actions

During the 2008 review, an assessment of the layers of protection in place guarding against the release of the entire contents of a PUTT and a bulk container was included in the report.

As well, in the development of the SRBT Training Program Manual (which establishes a systematic approach to training (SAT)), additional analyses were performed where it was determined that where human error could lead to significant radiation and environmental protection consequences, those activities shall be trained in a systematic way that is in line with the guidance of CNSC REGDOC 2.2.2, *Personnel Training.*

SRBT ensures that the consequences of human actions are considered in all aspects of our operations, through training, verification, supervision and design.

d. Analyses

For a complete and detailed assessment of the safety analyses that apply to SRBT facility, refer to the appendix.

e. Summary of Results of Analyses

The current results of the safety analyses relating to the SRBT facility show that both workers and members of the public are not expected to exceed the radiation dose limits published in the *Radiation Protection Regulations* in any accident scenario or hypothetical worst case condition or event.

A summary table of the calculated dose consequences for credible PIEs is provided below:

Scenario		Maximum Dose (mSv)	Receptor	Distance (m)
A	Release of the entire contents of a tritium trap ('pyrophoric unit')	0.0337	Member of the public	99
B	Release of the entire contents of a bulk container	0.304	Member of the public	99
C	Release from a tornado	0.140	Member of the public	100
D	Release from impact of a large rogue vehicle	0.180	Member of the public	99
E	Smoldering fire within the controlled area of the facility	9.28	Staff	
F	Release from breakage during handling	3.95	Staff	
G	Release from breakage during packing	3.02	Staff	

FIGURE 15: MAXIMUM DOSE IN HYPOTHETICAL WORST-CASE SCENARIOS

Based on the most recent data, as well as continuous improvements that have been effected since these analyses were complete, it is concluded that SRBT is meeting the overall safety objective identified in Section 5, whereas in all credible scenarios, including emergency or accidents, SRBT NEWs are not likely to receive a dose greater than the annual limit of 50 mSv, and members of the public are very unlikely to receive a dose greater than the annual operational limit of 1 mSv.

Refer to the appendix for details on all aspects of the analysis for each PIE.

8. Commissioning

a. Historical Description of Facility Commissioning

The SRBT facility was built in 1990, and was initially authorized for operation under Atomic Energy Control Board (AECB) radioisotope licence [20] that did not require provision of a detailed process for commissioning as a component of the licence basis.

The facility was built, tested and placed into service using best practice and experience from previous GTLS manufacturing facilities. A formal commissioning plan was not required at that time.

The requirements pertaining to the control of Commissioning in nuclear facilities have become more advanced and formally detailed since the facility was put into operation.

b. Current Commissioning Processes

As part of SRBT processes that control Engineering Change, new or modified SSCs that have a significant effect on the safety of the facility, the workers or the public must be subjected to controlled commissioning prior to being put into service.

ENG-026, *Commissioning Process* outlines the requirements associated with these activities. The Engineering Change Request (ECR) process includes commissioning as an integrated consideration, and ensures that physical changes within the facility are controlled, and documented provisions and criteria are put in place to test and place into service new or modified systems or components.

Refer to the ENG-series of procedures for more detailed information on Commissioning.

9. Operational Aspects

a. Organization

Refer to the organizational chart in Section 3 of this report.

The organization that operates the SRBT facility includes Senior Management (comprising of the owners of the facility), with a team of managers that report directly to them. Each critical element of operation of the facility and the management of safety is addressed by the management team.

Supervisors for each unique manufacturing / processing area report directly to the Production Control Manager, who is tasked with overseeing the processes that ensure that our products are manufactured to quality specifications in a timely and cost-effective manner.

A complete description of the organization, including the specific job description and responsibilities of each individual organizational unit, are included within the descriptive document *Organizational Structure and Responsibilities.* Refer to the in-force revision of this top-tier management system document for more information.

In addition to the responsibilities held by individual managers in overseeing production and safety-related processes, the concept of Committees has been implemented to ensure that issues and improvements are addressed in a fashion that promotes teamwork and collective effort of the organization as a whole. Committees may include both management and workers in order to achieve their goals.

Refer to the in-force revision of the descriptive document *Committee Process and Descriptions* for additional details.

b. Management System Procedures

Directly subordinate to the overall Quality Manual (which is the top-tier management system document) are a set of Management System Procedures that govern high level activities that are key to facility safety and control.

All managers implement these processes to ensure that there is a consistent application of requirements in several areas that affect all aspects of our operations, such as document control, management review, self-assessments, communication and information management, as well as others.

Refer to the MSP-set of processes for more information on these elements of our management system.

c. Administrative Procedures

It is the responsibility of each internal organization to develop and maintain controlled processes that ensure continued conformance to the requirements of the NSCA, associated regulations, conditions of the operating licence, ISO 9001 and our customers.

Administrative procedures stem from the requirements of the SRBT management system, as described within the Quality Manual. Procedures are controlled as per MSP-001, *Document Control.*

A complete list of procedures and programs that are used to ensure the effective management of the facility can be obtained from the company network. A list is retained on file and is updated as required when procedures or programs are revised, or new procedures or programs are created and implemented.

d. Operating Procedures

Operation of the facility is performed in support of the manufacture of quality products that contain and use GTLS for illumination purposes.

Procedures govern all aspects of the work that occurs at the facility in support of this business goal, as well as the execution of safety-related activities such as maintenance and health physics.

The following sets of production procedures are in place at SRBT, and can be obtained from the company network at any time:

- 100-series (Glass Shop)
- 200-series (Coating Room)
- 300-series (Extrusion Process)
- 400-series (Rig Room)
- 450-series (Tritium Laboratory)
- 500-series (Laser Cutting)
- 600-series (GTLS testing)
- 900-series (Machine Shop)

In particular, the 400-, 450-, 500- and 600-series procedures are those that have the most significant bearing on nuclear and radiological safety at the facility. These procedures are developed in a way that ensures that the facility safety objectives are met at all times.

Safety and operational programs typically include subordinate procedures that control associated activities. The following sets of programmatic procedures are in place at SRBT, and can be obtained from the Quality Manager at any time:

- EFF-series (Effluent Monitoring)
- EMP-series (Environmental Monitoring)
- ENG-series (Engineering)
- FPP-series (Fire Protection)
- GMP-series (Groundwater Monitoring)
- HAS-series (Health and Safety)
- LSC-series (Liquid Scintillation Counting)
- MAT-series (Materials Control)
- MTC-series (Maintenance)
- PLA-series (Production Planning)
- QAS-series (Quality)
- RSO-series (Radiation Safety Operations)
- SHP-series (Shipping and Receiving)
- WMP-series (Waste Management)

Programs and procedures are in place in order to ensure the achievement of safety objectives, and compliance with the requirements of the operating licence.

e. Emergency Procedures and Accident Management

SRBT has implemented and documented an Emergency Plan (EP) that complies with the requirements of CNSC REGDOC 2.10.1, *Nuclear Emergency Preparedness and Response.*

As documented within the plan, the declaration of an emergency will result in the engagement of both internal and external response organizations in order to effectively manage the situation and return the facility to the safe state.

The SRBT Emergency Response Organization (ERO) is headed by the President of SRBT, who holds the overall responsibility for the design, management and implementation of the EP, and acts as the incident commander (IC) during any emergency or exercise. In the absence of the President, the Vice-President will assume these duties.

The following SRBT organizational managers hold positions and associated responsibilities within the ERO:

- President
- Vice-President
- Manager of Health Physics and Regulatory Affairs
- Executive Assistant
- Production Control Manager
- Manager – Safety and Security

The main emergency response is expected to be provided by conventional response organizations, including the Pembroke Fire Department (PFD) and the Ontario Provincial Police (OPP). Training and familiarization with the nature of the SRBT facility is provided as required, and SRBT retains memoranda of understanding (MOU) with both organizations.

A complete description of the provisions in place for the effective management of an emergency at SRBT can be found in the in-force revision of the SRBT Emergency Plan.

f. Maintenance, Surveillance, Inspection and Testing

In order to ensure that the facility remains fit for service at all times, and that corrective and preventive maintenance is scheduled, performed and controlled, SSCs that have been evaluated and graded as being important to safety or business processes are captured within the scope of the SRBT Maintenance Program.

This program was developed based in part on the guidance of CNSC Regulatory Document RD/GD-210, *Maintenance Programs for Nuclear Power Plants,* and has contributed to the CNSC grading SRBT as fully satisfactory in the safety and control area (SCA) of Fitness for Service during licence renewal in 2015 [21].

The program establishes the responsibilities and key elements that ensure that risks associated with failure or unavailability of safety-related SSC are limited to the lowest reasonable extent.

The required intervals for periodic testing and inspection of key SSCs important to safety is also defined as part of the program. A preventive maintenance schedule is implemented in order to document and drive these activities, and detailed procedures are in place to govern the specific maintenance of these SSCs.

g. Ageing Management

As part of the overall maintenance strategy of the facility, ageing of SSCs is managed using conventional oversight. A specific program or process on ageing management is not viewed as a key element of the SRBT maintenance program.

h. Change Control Process

Changes and modifications to both SSCs and management system documents are governed using management system process MSP-007, *Change Control.*

The Project Engineer is responsible for ensuring the implementation of these controls as the steward of this procedure, as well as the forms that control changes within the facility.

As early in the process as possible, and prior to any change being implemented, an Engineering Change Request (ECR) is documented on a controlled form. An ECR may be raised by any organizational manager in order to address problems or drive improvement, or for any other reason. The rationale for the change is explicitly documented on the form in order to ensure a record of the reasons behind the change is captured and retained.

Each individual SCA is reviewed against the proposed change to determine if the implementation of the change could result in an effect in a given safety area.

Design requirements are included on the ECR where applicable, and any supporting documentation must be kept on file with the ECR. The ECR circulates to those members of the organization that should be aware of the change, and may have feedback, suggestions or a significant stake in the change. This ensures that changes are effectively communicated throughout the organization.

i. Qualification and Training of Personnel

SRBT maintains and implements a SAT program in order to ensure that human performance is acceptable and that human error is limited in both frequency and consequence.

CNSC REGDOC 2.2.2, *Personnel Training* establishes the requirements relating to training of workers at SRBT.

In 2014, a comprehensive analysis was conducted of all activities performed by workers as part of the operation of the facility, in order to define the scope of the training program, and where a SAT-based methodology needed to be applied.

This analysis determined seven specific activities and tasks where human error could lead to safety-significant consequences:

- Tritium Processing – Filling and End-Sealing Light Sources
- Bulk Splitter Operations
- Handling PUTTs
- Advanced Health Physics Instrumentation
- Liquid Effluent Management and Control
- Weekly Stack Monitoring
- Bioassay and Dosimetry

As a result, the above seven activities are required to be designed, developed, implemented and evaluated in a cyclical fashion, in line with the guidance of REGDOC 2.2.2.

Training at SRBT is controlled and governed by the requirements and processes within the CNSC-accepted [22] SRBT Training Program Manual.

j. Human Factors

Although human factors are considered where applicable, the expected interactions of workers with the SSCs and processes implemented at the SRBT facility do not require the implementation of a Human Factors management program as would be expected for a nuclear power plant.

SRBT does not house any area that could be construed as a ‘main control room’, nor does the facility operate under a shift rotation basis where hand-off or debriefing is required to be controlled.

As well, SRBT does not fall within the scope of the proposed requirements relating to worker fitness for duty, as documented in the draft REGDOC 2.2.4, *Fitness for Duty*.

k. Feedback of Operational Experience

A system of routine management reviews is required by the SRBT management system, as detailed in MSP-008, *Management Review*.

Management meetings are held at least annually, and more frequently depending on circumstances, in order to discuss several areas of operation from which operational experience can be gathered and fed back into improvement processes. Such information includes:

- the status of actions from previous management reviews;
- review of the quality policy for adequacy.
- changes in external and internal issues that are relevant to the quality management system (the awareness of changes in its business environment);
- information on the performance and effectiveness of the quality management system, including trends in:
    - customer satisfaction and feedback from relevant interested parties;
    - the extent to which quality objectives have been met;
    - process performance and conformity of products and services;
    - nonconformities and corrective actions;
    - monitoring and measurement results;
    - audit results;
    - the performance of external providers;
    - self-assessment activities
    - benchmarking activities
- the adequacy of resources;
- the effectiveness of actions taken to address risks and opportunities;
- opportunities for improvement.

In addition, all committee meetings held at SRBT offer an opportunity to share and learn from operational experiences, and to take effective action in order to drive continuous improvement.

l. Documents and Records

Management system documentation, including programs, procedures and forms, are retained on file and managed by the Quality Manager. Record retention times are described within these documents, and important information is retained both electronically and in hard copy.

MSP-004, *Information Management* documents the processes and strategies implemented by the management at SRBT to ensure that information is managed in a fashion that complies with the requirements of the management system.

10. Operational Limits and Conditions

The following list of operational limits and conditions (OLCs) relate to those requirements that are to be met or adhered to in order to ensure with a high degree of confidence that the facility safety objective identified in Section 5 (a) will be met for all operating modes and conditions.

Several of these OLCs are also listed within the operating licence and LCH for the facility.

a. Tritium Possession Limit

SRBT is authorized by licence to possess up to 6,000 TBq of tritium in any form.

b. Tritium Processing – Permitted Hours of Operation

Tritium processing operations consist of the filling and sealing of GTLS on processing rigs, laser cutting of GTLS, or bulk splitting operations.

Tritium processing operations are restricted to 0700h – 1900h, seven days a week, unless specifically approved by senior management.

c. Tritium Processing – Precipitation

Tritium processing shall not occur during measurable periods of precipitation, as detected by the precipitation detection system or equivalent.

d. Tritium Releases to Atmosphere – Tritium Oxide

SRBT shall not release in excess of 6.72E+13 Bq of tritium oxide to atmosphere in any year.

e. Tritium Releases to Atmosphere – Tritium Oxide + Elemental

SRBT shall not release in excess of 4.48E+14 Bq of total tritium as tritium oxide and tritium gas to atmosphere in any year.

f. Minimum Differential Pressure Measurements for Tritium Processing

Tritium processing operations shall not occur unless the following differential pressures are achieved, as measured by the gauges on each of the active ventilation system stacks:

- Rig Stack: 0.27 inches of water column
- Bulk Stack: 0.38 inches of water column

These measurements correspond to an average effective stack height of 27.8 metres, assuming a wind speed of 2.2 m/s.

g. Tritium Releases to Sewer – Water-soluble Tritium

SRBT shall not release in excess of 2.00E+11 Bq of water soluble tritium to the municipal sewer system in any year.

h. PUTT Filling Cycles

Any PUTT base is limited to 30 complete bulk splitter filling cycles, after which it is no longer permitted to be used for further tritium processing.

i. PUTT / Bulk Container Tritium Loading Limit

PUTTs are limited to less than 111,000 GBq of tritium loading at any time.

Bulk containers are limited as follows:

- SRBT shall request no more than 925,000 GBq per bulk container when submitting a purchase order to an approved supplier of tritium gas.
- No bulk container shall exceed 1,000,000 GBq of tritium loading at any time.

j. Bulk Container Heating Limit

Bulk tritium containers are limited to a heating temperature of approximately 550 °C, as measured by the thermocouple placed between the heating band and the container surface. Brief and small exceedances of this value are tolerable so long as they are not sustained and the temperature is returned below this value as soon as possible.

k. On-site Depleted Uranium Inventory

The on-site physical inventory of depleted uranium (virgin, in use and decommissioned bases) is limited to 10 kg.

l. Facility Action Levels and Administrative Limits

Consult SRBT descriptive document *Licence Limits, Action Levels and Administrative Limits* for the most current set of action levels and administrative limits used to ensure control of radiation and environmental protection.

The following action levels and administrative limits were in place at the time of the acceptance of this SAR:

PERSON	**PERIOD**	**ACTION LEVEL (mSv)**
Nuclear energy worker	Quarter of a year	1.0
	1 year	3.0
	5 year	15.0
Pregnant nuclear energy worker	Balance of the pregnancy	2.0

FIGURE 16: RADIATION PROTECTION ACTION LEVELS – DOSE

PARAMETER	**ACTION LEVEL**
Bioassay result	1,000 Bq/ml for any period

FIGURE 17: RADIATION PROTECTION ACTION LEVELS – BIOASSAY RESULT

PARAMETER	ADMINISTRATIVE LEVEL
Effective dose for worker	2.25 mSv/year 0.75 mSv/quarter
Bioassay result	500 Bq/ml for any period in Zone 3 100 Bq/ml for any period in Zone 1 or 2

FIGURE 18: RADIATION PROTECTION ADMINISTRATIVE LIMITS

NUCLEAR SUBSTANCE AND FORM	ACTION LEVEL
Tritium as tritium oxide (HTO)	840 GBq/week
Total tritium as tritium oxide (HTO) and tritium gas (HT)	7,753 GBq/week

FIGURE 19: ENVIRONMENTAL PROTECTION ACTION LEVELS – RELEASES TO ATMOSPHERE

PARAMETER	ACTION LEVEL
Measure on the chart recorder	≥ 0.37 GBq/m^3 for a duration of one hour*

FIGURE 20: ENVIRONMENTAL PROTECTION ACTION LEVELS – CHART RECORDER

NUCLEAR SUBSTANCE AND FORM	ACTION LEVEL
Tritium water soluble	0.15 GBq/day

FIGURE 21: ENVIRONMENTAL PROTECTION ACTION LEVELS – RELEASES TO SEWER

11. Radiation Protection

a. Application of ALARA Principle

SRBT implements a comprehensive Radiation Protection Program, titled *Radiation Safety Program.* This program has continually formed a part of the licensing basis of the facility, and was last revised and accepted by CNSC staff in September 2014 [23].

Within the program, the application of the principle of keeping radiation doses as low as reasonably achievable (ALARA) is detailed in section 4.12.5, where it is noted that SRBT strives to achieve ALARA through the implementation of management control over work practices; personnel qualifications and training; the control of occupational and public exposure to radiation; and planning for unusual situations.

The Health Physics Team is comprised of a specialized group of management that are very well-versed in the nature of the facility, and the particular hazards that tritium present with respect to Radiation Protection. The team frequently reviews dose levels to ensure that radiation exposure is maintained ALARA at all times, as well as environmental monitoring results to ensure that tritium releases are minimized and the effect of the facility on the environment and the public is ALARA.

b. Sources of Radiation

The primary source of radiation hazards in the facility is tritium in its elemental and oxide state.

Tritium gas is processed during the manufacture of GTLS, resulting in internal exposure to ionizing radiation in workers who inhale, ingest or absorb the substance.

Low, chronic exposures are experienced by staff who perform tritium processing operations, while infrequent exposures may be experienced by those in other parts of the facility, such as in the Assembly area should GTLS be broken during device assembly or packing.

Tritium may also present a hazard during the handling and storage of waste.

The small quantity of depleted uranium retained on site represents the only other source of radiation exposure to workers; however, due to the infrequent handling of the material, as well as the limitation of such a small quantity, expected doses are negligible. Confirmatory surveys are performed after any operation where DU is handled.

c. Design Features for Radiation Protection

The active ventilation AHUs are the primary design feature of the facility that provides a radiation protection function. The AHUs have been detailed extensively in Section 6(a)(vi). Air flow is designed to flow from areas of low levels of contamination through higher (i.e. from Zone 1 to Zones 2 and 3; and from Zone 2 to 3).

There are several ventilated cabinets in Zones 2 and 3 that support safe work with tritium. Constant flow fume hoods are typically employed with closing glass sashes that permit effective isolation of contaminated items from the breathing space of workers.

The selection of dry-scroll vacuum pumps is in the interest of radiation protection. Oil-based vacuum pumps have been used in the past for tritium processing operations; however, the radiation dose consequences associated with pump operation and maintenance are significantly greater than that afforded by modern scroll pump technology. As a result, beginning in 2005 all oil-based vacuum pumps were removed and replace with scroll pumps.

Tritium processing equipment is designed and built in a fashion that is intended to minimize internal process volume. This leads to two distinct radiation protection advantages. First, if the internal volumes are minimized, then the amount of tritium that must be desorbed during a given processing run is also minimized, as is the consequence should leakage occur. Second, at the conclusion of processing there is a residual amount of tritium that cannot be readsorbed back onto the PUTT. This is the primary source of routine tritium emissions. If the internal volume of the system is minimized, then so is the amount of tritium that is released through the ventilation system when the processing equipment is pumped down again.

Contamination control barriers are in place to ensure that any spread of contamination by way of personnel transitioning through zones is effectively eliminated. Radiological Zones are clearly delineated by doors and rooms. Tritium-in-air monitoring equipment is available throughout the facility.

d. Radiation Monitoring

Three stationary TAMs provide continuous monitoring and alarm capability in Zone 3, while one stationary TAM provides monitoring in each of Zone 2 and Zone 1 (in the Shipping Area). Portable TAMs are also widely available for localized monitoring of tritium process equipment and GTLS.

Real-time stack monitors continuously assess the concentration of tritium in each active ventilation stack / AHU. This information is recorded using a digital data recorder.

Refer to the Radiation Safety Program for additional detail on TAMs at SRBT.

e. Radiation Protection Program

SRBT implements a comprehensive Radiation Protection Program, titled *Radiation Safety Program*.

The program documents the governing principles that contribute to effective radiation protection at the facility, the responsibilities of members of the organization with respect to RP, and a description of the Health Physics team and its role in ensuring the RP of all staff and the public.

The zoning strategy is described in the program, as well as the required protective equipment and clothing that must be donned by personnel entering Zones 2 and 3.

The program also describes the training requirements for RP at SRBT. All staff members who work at SRBT are designated as NEWs, and thus require an understanding of the expected risks associated with exposure to ionizing radiation. Staff are provided this indoctrination training at the earliest opportunity upon hiring, prior to any active work, and training is provided on an annual basis that is focused on the radiation safety practices in place at SRBT, as well as the risks associated with expected doses.

Contamination control provisions are described, and the frequency of checks established. Procedures are also referenced relating to the leak checking of GTLS prior to exit from Zone 3. Expected staff responses to audible alarms due to tritium in air are outlined. All items being removed from Zone 3 or 2 into Zone 1 are assessed for contamination prior to removal.

The methods and processes used to establish radiation doses for workers at SRBT are described. SRBT has maintained a Dosimetry Service Licence (DSL), issued by the CNSC, and conducts in-house routine bioassay testing of all NEWs in order to establish radiation exposures. Reports are filed with the National Dose Registry on a quarterly basis as required by the DSL, and SRBT participate in independently administered performance testing every year as a condition of the DSL.

Action levels and administrative limits are included in the program in order to drive corrective actions and ensure that control is maintained over the hazards, and radiation exposures remain ALARA.

Overall, SRBT implements a robust and mature program that fosters a high level of radiation protection in all aspects of facility operation.

For additional detail on RP at SRBT, consult the Radiation Safety Program and associated procedures.

12. Emergency Preparedness

a. Emergency Plan

SRBT has implemented and documented [24] an Emergency Plan (EP) that complies with the requirements of CNSC REGDOC 2.10.1, *Nuclear Emergency Preparedness and Response.*

This plan has been accepted as part of the CVC of the facility in the LCH [25], and has been improved to reflect the lessons learned from the nuclear disaster at the Fukushima-Daiichi Nuclear Power Station in Japan in 2011, as well as the results of a full-scale emergency exercise conducted by SRBT in 2015.

b. Emergency Response Facilities

As documented within the plan, the declaration of an emergency will result in the engagement of both internal and external response organizations in order to effectively manage the situation and return the facility to the safe state.

The SRBT Emergency Response Organization (ERO) is headed by the President of SRBT, who holds the overall responsibility for the design, management and implementation of the EP, and acts as the incident commander (IC) during any emergency or exercise. In the absence of the President, the Vice-President will assume these duties.

The following SRBT organizational managers hold positions and associated responsibilities within the ERO:

- President
- Vice-President
- Manager of Health Physics and Regulatory Affairs
- Executive Assistant
- Production Control Manager
- Manager – Safety and Security

The main emergency response is expected to be provided by conventional response organizations, including the Pembroke Fire Department (PFD) and the Ontario Provincial Police (OPP). Training and familiarization with the nature of the SRBT facility is provided as required, and SRBT retains memoranda of understanding (MOUs) with both organizations.

A complete description of the provisions in place for the effective management of an emergency at SRBT can be found in the in-force revision of the Emergency Plan.

c. Fire Protection Program

As part of the licensing basis of the facility, SRBT implements a comprehensive Fire Protection Program (FPP) that has been accepted by CNSC staff [25]. This program meets the requirements of CSA Standard N393-13, *Fire protection programs for facilities that process, handle or store nuclear substances.*

The program details the responsibilities associated with ensuring the protection of the facility from fire hazards. The Vice-President of SRBT is responsible for the FPP, with the support of staff members with extensive experience in fire protection and suppression.

The FPP discusses procedures that ensure safety, how fire is prevented from occurring, and how systems are tested, inspected and maintained.

Requirements are documented relating to impairments of systems or components associated with fire protection, emergency provisions, and safe fire design considerations and requirements.

Fire protection systems and equipment are detailed within the FPP, and the special hazards that may be present in the facility due to its nature are itemized.

The FPP includes several plans that contribute to safety and preparedness in case of fire. A Site Plan provides a detailed set of maps that guide the reader to the location of fire safety equipment and emergency egress paths. A pre-incident fire plan documents the critical information pertaining to fire protection. Finally, a detailed fire safety plan is in place to describe the expected response of workers should fire be detected.

Consult the in-force revision of the FPP for additional details on fire protection at SRBT.

13. Environmental Aspects

a. Radiological Impacts

Tritium processing results in small quantities of elemental tritium gas and tritium oxide being released via the active ventilation stacks at the northwest corner of the facility. These two stacks are described in Section 6 of this report, and are located within a fenced secure compound area.

The amount of tritium that may be released to atmosphere via the gaseous effluent stream is limited by licence. On a weekly basis, stack monitoring using the TASCs discussed in Section 6 allows for the quantification of emissions of both forms of tritium over the previous period. The quantity of tritium released in any week is compared against a set of action levels in order to provide assurance that an adequate level of control is being maintained during facility operation.

Small amounts of water-soluble tritium is released to the municipal sewer system, ultimately being diluted by several orders of magnitude before being released after waste water treatment processes have been completed at the Pembroke Pollution Control Centre.

As a result of these emissions, tritium is dispersed into the environment in quantities that are expected to represent a trivial level of risk to the public and the environment over any given year [10].

SRBT verifies that the risks remain acceptably low by implementing a comprehensive Environmental Protection Program, which includes a wide variety of sample media:

- Passive air samplers collect tritium in air, allowing a monthly integrated representation of the average tritium concentration in air in that area.
- Precipitation monitors are located in eight wind sectors; rain and snow is collected monthly and assessed for tritium concentration.
- Groundwater monitoring takes place on a routine frequency – residential, commercial and dedicated monitoring wells are sampled and assessed for tritium concentration.
- Monitoring of the nearby Muskrat River is performed on a frequent basis at a point downstream of where any effects due to SRBT operations are expected to be measured.
- Locally produced milk is collected and sampled for tritium concentration.
- Wine produced at a nearby do-it-yourself brewery is assessed on an annual basis.
- Produce monitoring of both local residential and commercial gardens is conducted during the harvest season.

Various other measurements and samples have been conducted of a wide variety of media in order to determine if there was any significant risks associated with the operation of the facility. Such samples may be routinely performed, or are performed on an ad-hoc basis when possible.

Such samples include:

- Sampling of runoff water from the facility roof during periods of precipitation.
- Sampling of stagnant water pools at the conclusion of precipitation events.
- Sampling of the outfall waters at the Pembroke Pollution Control Centre.
- Sampling of the dewatered sludge ‘cake’ that is generated as a by-product of the processes at the Pollution Control Centre.
- Soil sampling in the surrounding area of the facility where development has taken place.
- Sampling of water located in municipal services ‘manholes’ over a period of several years.

Independent third party expert contractors provide sampling and measurement of EMP media throughout the year.

As part of the annual compliance report (ACR), routinely collected EMP data is used to calculate the expected public dose due to SRBT operations. These calculations incorporate conservative assumptions of such parameters as breathing rate, produce and water consumption, and residence times. Four distinct classes of critical group members are analysed based upon methodologies documented in the CSA N288-series of standards.

Public doses have trended down over the past several years due to significant facility process improvements, as well as equipment optimization. At current rates of production, public doses are expected to trend at around 10 μSv per year or less, a dose that corresponds to a trivial level of risk. Doses to the public are expected to remain around this magnitude going forth.

In summary, environmental data continues to support the determination that the current design and operation of the SRBT facility results in a limited, if not negligible impact on the environment.

This determination is supported by the work of the CNSC under their Independent Environmental Monitoring Program (IEMP). Results between the SRBT and CNSC programs are generally quite comparable, thus providing independent verification that the public and the environment around SRBT are safe, and that our environmental monitoring program is working.

The expected magnitude of the radiological impact to the environment is not expected to change during eventual facility decommissioning.

Up until 2015, SRBT documented a comprehensive report to the CNSC on a quarterly basis that summarized the EMP data for each calendar quarter, and included the raw data that contributed to the analysis. This data will now be compiled on an annual basis and will be included with the ACR.

In 2015, SRBT performed a comprehensive gap analysis [26] of the Environmental Protection Program and Environmental Management System in place at SRBT against the requirements of several applicable CSA Standards, including:

- REGDOC 2.9.1, *Environmental Protection: Policies, Programs and Procedures*
- N288.4-10, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*
- N288.5-11, *Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills*
- N288.6-12, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills*
- N288.7-15, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills*

As a result of this gap analysis, an action plan was established in order to allow SRBT to improve processes and programs, and achieve compliance with these standards over a period of several years.

SRBT continues to ensure that our radiological impact to the environment is acceptably low, and strives to improve our processes further at every opportunity. In 2015, SRBT committed to allocate a significant percentage of annual profits toward tritium emission reduction initiatives during the licence term [27]. Work on this front has already begun, with several improvements being implemented or at various stages of implementation. In all cases, change control was applied to ensure the safety of workers, the public and the environment.

CNSC staff included an Environmental Assessment Information Report as part of the regulatory information during licence renewal in 2015. This report concluded that SRBT has and will continue to make adequate provision for the protection of the environment and the health and safety of persons.

b. Non-radiological Impacts

SRBT does not currently emit any appreciable quantities of conventional chemicals or contaminants to the environment as part of facility operations. This is expected to remain the case throughout the life cycle of the facility, including during eventual decommissioning.

Any emission of conventionally hazardous materials is regulated by the Ontario Ministry of the Environment. SRBT maintains registration with the Hazardous Waste Information Network (generator number ON5968708) for certain subject wastes.

14. Radioactive Waste Management

a. Control of Waste

As part of the licensing basis of the facility, a comprehensive Waste Management Program has been developed and implemented which covers all aspects of radioactive waste management at the facility. This program has been accepted by CNSC staff [28].

This program has been developed in line with the guidance of applicable CSA N292-series of standards, including:

- N292.0-14, *General principles for the management of radioactive waste and irradiated fuel.*
- N292.3-14, *Management of low- and intermediate-level radioactive waste.*
- N292.5-11, *Guideline for the exemption or clearance from regulatory control of materials that contain, or potentially contain, nuclear substances.*

Radioactive waste is controlled using processes aimed at ensuring waste is minimized, classified, segregated, characterized, stored, cleared where acceptable, and disposed of in a safe and compliant fashion.

b. Handling of Waste

All radioactive wastes are carefully segregated according to the classification system, at the source of generation.

Segregation is conducted initially by the worker who is the primary generator or processor of the waste. Training is provided to all staff by the area supervisors on how waste is classified, segregated and initially stored in their assigned work area.

Supervisors in those areas that manage radioactive / contaminated waste materials are all permanent members of the Waste Management Committee, and are thus knowledgeable and in a position of sufficient authority to provide this training to their staff.

Dedicated waste receptacles are designated for the purpose of collecting radioactive waste that is generated as part of daily work. Each type of receptacle is clearly marked, and workers ensure that the correct types of materials are placed in each type of container.

Characterization is performed on all classes of radioactive wastes generated at SRBT.

For wastes generated on a routine basis, characterization is performed using established, acceptably conservative methods in order to:

- define segregation and safe handling requirements,
- define the waste package type, packaging materials and packing method requirements,
- determine the optimal disposition option, and
- to verify the suitability of the intended disposition path

The requirements relating to the handling of radioactive wastes are described in procedure WMP-002, *Waste Handling and Minimization.*

c. Minimization of Waste

At SRBT, waste minimization is recognized as a fundamental approach in protecting people and the environment. An additional benefit is that waste minimization can often result in a reduction of costs.

All personnel are encouraged to participate in identifying new methods of eliminating or reducing waste and, to a practicable extent, employ waste minimization techniques in their daily operations. The Waste Management Committee is responsible to promote waste minimization goals to all staff working at SRBT.

Minimization techniques and requirements throughout the facility is described in procedure WMP-002, *Waste Handling and Minimization.*

d. Storage of Waste

Low-level waste materials are stored in Zone 3 within the Waste Room. This 7' x 6' room is made of concrete blocks with a poured concrete floor. It has two access points - a sealed door to the outside and a door to the work area in Zone 3. Routine access is gained from the Zone 3 area. The external access door is always locked and only authorized personnel may gain entry.

The Waste Storage Room is routinely assessed for non-fixed tritium contamination. Daily swipes of the Waste Storage Room are performed to monitor the area for possible surface contamination.

Any wastes that have been characterized as clearance-level waste may be stored temporarily in an appropriate area pending final disposal.

For further details regarding the storage of radioactive waste materials, refer to WMP-003, *Interim Preparation and Storage of Waste*.

e. Disposal of Waste

Low-level wastes are collected and stored until sufficient material is present to warrant performing a transfer to a licensed waste management facility using approved methods.

Clearance level waste materials are restricted by annual weight that may be disposed of, as well as a limit on activity per unit mass, as defined by the SRBT Conditional Clearance Levels (CCL).

For additional information pertaining to the waste management practices in place at SRBT, refer to the latest accepted revision of the Waste Management Program, as well as associated procedures and technical reports.

15. Decommissioning and End of Life Aspects

a. Decommissioning Plan

SRBT has a documented and approved preliminary decommissioning plan (PDP) which forms part of the overall licensing basis of the facility.

Within this plan, the end state objective is stated as the permanent retiring of the SRBT facility from service in a manner that protects the health, safety and security of workers, the public and the environment. Upon completion of decommissioning, the facility will be in a condition that will permit the premises to be released from any further regulatory control by the CNSC, allowing future commercial or industrial use or redevelopment.

A ‘prompt removal’ strategy will be adopted for the decommissioning of the facility. Decommissioning activities begin immediately upon facility shutdown and shall continue without interruption until complete. For planning purposes, it is anticipated that the facility will be decommissioned within six months from initiation of safe shutdown.

A phased schedule of planned activities is included in the PDP, itemizing the required activities and conservative cost estimates associated with the work. In order to adequately facilitate the decommissioning, planning envelopes have been developed with defined work packages being structured within each envelope.

The PDP was last revised in 2015, and was accepted as part of the licensing basis of the facility [29] with the issuance of NSPFOL-13.00/2022. The plan is reviewed and revised on a five-year frequency.

b. Financial Guarantee

In order to comply with the requirements of the Nuclear Safety and Control Act, as well as the operating licence, SRBT must maintain an accepted and adequate financial guarantee for the future decommissioning of the facility. At the conclusion of the last licence, the financial guarantee was 100% funded based upon the value established in the previous revision of the PDP.

The current financial guarantee is based upon the revised 2015 PDP, and amounts to $652,488.00. As of April 2017, the guarantee is ~97% funded, with installments being added in six-month intervals through to 2018 when the guarantee will be fully funded and secured.

SRBT maintains an escrow agreement combined with a security and access agreement which would provide access to the funds should SRBT be unable to meet its obligations with respect to decommissioning of the facility.

16. Public Information Program

SRBT implements and maintains a Public Information Program (PIP) that includes a Public Disclosure Protocol, as part of our management system. This program is developed in line with the requirements of CNSC Regulatory Document RD/GD-99.3, *Public Information and Disclosure,* and has been accepted by CNSC staff [30].

An important aspect of SRBT operations is the goal to be transparent, visible and open with our community, our regulators, and our staff. The PIP is designed to build awareness that SRBT is a nuclear substance processing facility, and to ensure a proactive approach is taken with members of the public living in the vicinity of the facility, local and adjacent businesses, local special interest groups and local elected officials.

SRBT employs several public information strategies and products aimed at achieving these objectives:

- A Public Information Committee has been implemented to ensure the execution of the PIP, and to monitor public opinion and media coverage.
- SRBT offers facility tours on a frequent basis to persons who wish to learn more about our operations.
- Presentations are made to local community groups as required, including City Council.
- As required, SRBT implements public meetings where information on overall operations, emissions measurements, monitoring results, mitigation measures, incidents and any other current activity may be provided.
- SRBT publishes a pamphlet and a brochure, both of which provide details and information on the facility, as well as associated levels of risk to persons.
- A comprehensive website is maintained at www.srbt.com where anyone with internet access can learn more about our facility, and access data pertaining to our operations, including information about Environmental Protection, and environmental monitoring results.

Consult the SRBT Public Information Program for additional information on the ways that our facility interfaces with the public and stakeholders.

17. Safety Analysis Review Process

SRBT maintains the SAR in a controlled fashion at a defined frequency, in order to ensure that the report contains recent and relevant information pertaining to the facility operations.

The procedure that governs this activity is ENG-022, *Safety Analysis Review Process,* and is in place to ensure compliance with the guidance pertaining to safety analysis in CSA standard N286-12, section 8.4.

This procedure requires that periodically, Senior Management ensures that a documented review of the SAR takes place, as the ongoing site evaluation process.

This review shall include, but is not limited to, evaluations of:

- changes to important site characteristics, such as hydrogeological, meteorological and seismic aspects.
- changes in the nature of other industrial facilities or businesses in the vicinity of the facility.
- internal process changes that may have an effect on safety.
- organizational changes.

Should deviations be identified between the information in the SAR and the characteristics of the site or the facility state, an assessment will be made to determine if a revision to the SAR is required, or action will be taken to realign the facility with the information in the report.

The review is documented and controlled, and records of the review are retained on file for the operating life of the facility.

Refer to ENG-022 for additional details on the Safety Analysis Review Process.

18. References

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[4] Seismic information from NRC website at http://www.earthquakescanada.nrcan.gc.ca/zones/eastcan-eng.php#WQSZ

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[6] *Derived Release Limit for the SRB Pembroke Facility - 2016 Update*, dated 22 January 2017.

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[10] IAEA Safety Report Series No. 44, *Derivation of Activity Concentration Values for Exclusion, Exemption and Clearance,* 2005.

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[25] Letter from J. Campbell (CNSC) to S. Levesque (SRBT), *SRB Technologies (Canada) INC. Licence Conditions Handbook (LCH) Rev. 1, to accompany NSPFOL-13.00/2022,* dated December 22, 2015; also, Letter from R. Buhr (CNSC) to S. Levesque (SRBT), *Transmittal of R002 of SRB Technologies (Canada) Inc. Licence Conditions Handbook,* dated January 6, 2017.

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[30] Letter from J. Campbell (CNSC) to S. Levesque (SRBT), *SRB Technologies (Canada) Inc. Public Information Program, Revision 9*, dated October 26, 2015.

19. Appendices

[A] 2017 Review and Update of Hypothetical Worst Case Scenarios for SRBT

[B] Data Tables for HotSpot Models for Scenarios A - D

[C] Rationale for Change to OL&C for Minimum Effective Stack Height (effective for Revision 4) – November 2017

[D] Review of Hypothetical Incident Scenarios, 2008 (including previous safety analyses and information).

APPENDIX A

2017 Review and Update of Hypothetical Worst Case Scenarios for SRBT

2017 Review and Update of Hypothetical Worst Case Scenarios for SRBT

Introduction

In 2008, based upon an analysis of the SRBT facility and the operations conducted, as well as a review and assessment of the previous set of safety analyses for the facility, seven bounding hypothetical worst case scenarios were developed and analyzed in order to determine the possible radiological consequences to members of the public, and to SRBT employees.

These seven scenarios and the associated maximum effective dose calculated were as follows:

Hypothetical Worst-Case Maximum Doses (2008)

	Scenario	**Maximum Dose (mSv)**	**Receptor**
A	Release of the entire contents of a tritium trap ('pyrophoric unit')	0.027	Member of the public
B	Release of the entire contents of a bulk container	0.222	Member of the public
C	Release from a tornado	0.147	Member of the public
D	Release from impact of a large rogue vehicle	0.142	Member of the public
E	Smoldering fire within the controlled area of the facility	12.41	Staff
F	Release from breakage during handling	5.28	Staff
G	Release from breakage during packing	4.04	Staff

Since 2008, several of the parameters and assumptions used to determine the likely maximum dose to any person have evolved due to advances in the scientific understanding of the mechanisms contributing to the resultant dose.

For example, the CSA standards that establish the acceptable dose coefficients and intake parameters for certain receptors have been revised. As well, the meteorological conditions near the facility are better understood with the installation and operation of a dedicated weather station since 2010.

As a result, the above seven hypothetical incidents require review and refinement based upon the latest available data and understanding of the conditions that would lead to exposure during worst-case emergency situations.

For the scenarios that involve limiting worker doses (scenarios E, F and G in the above table), the dose coefficient for HTO and HT for adults defined in N288.1-14 were applied to determine expected worst case effective dose.

The scenarios described which affect the public (scenarios A, B, C and D above) were analyzed using 'HotSpot', a modern plume dispersion modelling program designed to provide estimates of expected effective dose to persons located in a specific geographic zone under given meteorological conditions.

HotSpot Modelling Codes

HotSpot was created at the Lawrence Livermore National Laboratory by the National Atmospheric Release Advisory Center in the United States. The program uses Health Physics codes that were created to provide emergency response personnel with a set of software tools to conservatively evaluate incidents involving radioactive material, as well as to be used for safety analysis of facilities which handle nuclear material.

The user can simulate various scenarios using defined source term information. Pre-loaded mixtures of radionuclides may be used, or the user can specifically define the mixture profile, as well as other parameters such as committed effective dose coefficients (i.e. for adult, child, infant).

The user also defines several key parameters using the graphical interface, including effective release height, wind speed and direction, Pasquill stability class, height of the receptor, breathing rate of the receptor, and geographic terrain / surface roughness.

The outputs from these codes can be graphically translated using a mapping system that integrates with other common software such as Google © Earth, in order to provide a visual representation of the potential areas that could be at risk of significant exposure to radioactive materials dispersed into the air.

HotSpot codes involving the dispersal of radioactive material use the Gaussian model, and are continuously updated to incorporate the most current and approved methodologies as recommended by the ICRP.

Version 3.0.3 (August 15, 2015) was used to validate the magnitude of radiological risk that may be presented by any of the four hypothetical worst case scenarios identified in the analysis, and to expand the understanding of the potential geographic areas that may be affected by a tritium release during an emergency.

The following process was implemented in order to derive the maximum estimated effective dose to a member of the public, at a minimum distance of around 100 metres from the facility:

1. Create a ‘unit mixture’ in the HotSpot library with 25% HTO (1 Bq) and 75% HT (3 Bq), with appropriate dose coefficients for CED included for each of the three groups (infant, child, adult, as listed in N288.1-14).
2. Adjust scaling factor as required to generate release quantity of this mixture for each scenario. This is equal to the total release defined for the scenario, divided by 4 (as the ‘unit mixture’ contains 4 Bq of activity).
3. Run ‘General Plume’ model using each ‘unit mixture’ and appropriate parameters for each type of group:
    - Breathing rates (as per N288.1-14 - 2.66E-04 m^3/s for adults, 2.48E-04 m^3/s for child, and 8.68E-05 m^3/s for infant).
    - Receptor height (1.5 m for adult, 1.0 m for child and 0.5 m infant).
4. Run for each of the six Pasquill stability classes, using 2008 parameters for wind speed and release height. Surface roughness is set at standard as a conservative measure.
5. The wind is set at 135 degrees (out of the southeast, toward the critical group).
6. This will generate a total of 24 modelled scenarios. Tabulate the maximum public doses projected, and at what distance from the facility the maximum public dose is anticipated to occur.

The results of the HotSpot modelling aligns very closely with the previously calculated worst-case effective doses at a given distance.

Based on the methodology described above, the following information represents the maximum effective doses anticipated for the seven limiting hypothetical worst-case scenarios for SRBT in 2017.

Hypothetical Worst-Case Maximum Doses for Scenario A – Loss of PUTT (2017)

Pasquill Stability Class	Maximum Effective Dose (in mSv)			Distance from Source (in metres)
	Adult	Child	Infant	
A	0.0286	**0.0337**	0.0248	98 (adult) 99 (child/infant)
B	0.0237	0.0279	0.0206	160
C	0.0218	0.0257	0.0189	250
D	0.0174	0.0205	0.0151	390
E	0.0099	0.0116	0.0086	770
F	0.0054	0.0064	0.0047	1,700

Hypothetical Worst-Case Maximum Doses for Scenario B – Loss of Bulk Container (2017)

Pasquill Stability Class	Maximum Effective Dose (in mSv)			Distance from Source (in metres)
	Adult	Child	Infant	
A	0.258	**0.304**	0.224	98 (adult) 99 (child/infant)
B	0.213	0.252	0.185	160
C	0.197	0.232	0.171	250
D	0.157	0.185	0.136	390
E	0.089	0.105	0.077	770
F	0.049	0.058	0.042	1,700

Hypothetical Worst-Case Maximum Doses for Scenario C – Tornado (2017)

Pasquill Stability Class*	Maximum Effective Dose (in mSv)			Distance from Source (in metres)
	Adult	Child	Infant	
A	8.30	11.00	8.73	10**
A	1.20	1.50	1.10	30**
A	0.12	**0.14**	0.10	100
A	0.029	0.035	0.026	200
A	0.0048	0.0056	0.0041	500
A	0.0012	0.0014	0.0011	1,000

** Pasquill Stability Class A (highly unstable) is the only assessed condition assessed for this type of weather event.*
***The presence of an unsheltered member of the public within 100 metres of the facility during a tornado event would be extremely unlikely.*

Hypothetical Worst-Case Maximum Doses for Scenario D – Rogue Vehicle (2017)

Pasquill Stability Class	Maximum Effective Dose (in mSv)			Distance from Source (in metres)
	Adult	Child	Infant	
A	0.153	**0.180**	0.133	98 (adult) 99 (child/infant)
B	0.127	0.149	0.110	160
C	0.117	0.138	0.101	250
D	0.093	0.110	0.081	390
E	0.053	0.062	0.046	770
F	0.029	0.034	0.025	1,700

For the three analyzed scenarios where the exposed individual is a staff member (E, F, and G), the only difference between the defined parameters used in the calculations in 2008 and 2017 are the dose coefficients for tritium gas (HT) and tritium oxide (HTO).

In 2008, the coefficients used were based upon the ICRP 30 guidance for dose due to inhalation. In the case of HTO, the coefficient was artificially doubled in order to conservatively account for the absorption of HTO through the skin.

The CSA N288.1-14 standard accounts for absorption as part of the listed coefficient for HTO, thus the decision to artificially double the coefficient is no longer reasonable.

The analysis of the three internal scenarios yields the following updated calculations:

Scenario E: Smoldering Fire within the Controlled Area of the Facility

Based upon the fact that general operations with gaseous tritium light sources have not significantly changed since 2008, the source term of a container holding 100 light sources, each with an activity of 81.03 GBq (2.19 Ci.) continues to represent a conservative treatment of the worst-case scenario for a small smoldering fire.

The assumption of 25% conversion of the source term to tritium oxide in the time span of the event (300 seconds) is also considered to be sufficiently conservative. Adult breathing rates remain the same in the current guidance.

$$\textbf{Dose} = [(\chi)(B)(DCF)(t)(\%HTO)]_{FOR\ HTO} + [(\chi)(B)(DCF)(t)(\%HT)]_{FOR\ HT}$$

Where:

χ	= tritium concentration (Bq/m^3) = 1.55 x 10^{10} Bq/m^3
B	= breathing rate of receptor (meters3/second) = 2.66 x 10^{-4} m3/s (for an adult) (23.01 m^3/day)
DCF FOR HTO	= dose conversion factor for receptor for HTO (mSv/Bq) = 3.0 x 10^{-8} mSv/Bq (inhalation and absorption)
DCF FOR HT	= dose conversion factor for receptor for HT (mSv/Bq) = 2.0 x 10^{-12} mSv/Bq for HT (inhalation)
t	= exposure time (seconds) = 300 seconds
%HTO	= % of source term / concentration which is tritium oxide = 0.25
%HT	= % of source term / concentration which is tritium gas = 0.75

The maximum dose to a worker from this scenario is calculated to be **9.28 mSv**.

Scenario F: Release from Breakage During Handling

Based upon the fact that general operations with gaseous tritium light sources have not significantly changed since 2008, the source term of a dropped container of light sources releasing 17,233 GBq (465.75 Ci.) continues to represent a conservative treatment of the worst-case scenario for such an event.

The assumption of 25% conversion of the source term to tritium oxide in the time span of the event (120 seconds) is also considered to be sufficiently conservative. Adult breathing rates remain the same in the current guidance, as does the total volume in the room where the lights were broken.

$$\textbf{Dose} = [(\chi)(B)(DCF)(t)(\%HTO)]_{\text{FOR HTO}} + [(\chi)(B)(DCF)(t)(\%HT)]_{\text{FOR HT}}$$

Where:

χ	= tritium concentration (Bq/m^3) = 1.65×10^{10} Bq/m^3
B	= breathing rate of receptor (meters3/second) = 2.66×10^{-4} m3/s (for an adult) (23.01 m^3/day)
DCF FOR HTO	= dose conversion factor for receptor for HTO (mSv/Bq) = 3.0×10^{-8} mSv/Bq (inhalation and absorption)
DCF FOR HT	= dose conversion factor for receptor for HT (mSv/Bq) = 2.0×10^{-12} mSv/Bq for HT (inhalation)
t	= exposure time (seconds) = 120 seconds
%HTO	= % of source term / concentration which is tritium oxide = 0.25
%HT	= % of source term / concentration which is tritium gas = 0.75

The maximum dose to a worker from this scenario is calculated to be **3.95 mSv**.

Scenario G: Release from Breakage During Packing

Based upon the fact that general operations with gaseous tritium light sources have not significantly changed since 2008, the source term of a dropped shipping container of light sources releasing 10% of the activity in the container (total 74,000 GBq (2,000 Ci.); source term 7,400 GBq (200 Ci.)) continues to represent a conservative treatment of the worst-case scenario for such an event.

The assumption of 25% conversion of the source term to tritium oxide in the time span of the event (120 seconds) is also considered to be sufficiently conservative. Adult breathing rates remain the same in the current guidance, as does the total volume in the room where the lights were broken.

$$\textbf{Dose} = [(\chi)(B)(DCF)(t)(\%HTO)]_{FOR\ HTO} + [(\chi)(B)(DCF)(t)(\%HT)]_{FOR\ HT}$$

Where:

χ	= tritium concentration (Bq/m^3) = 1.26×10^{10} Bq/m^3
B	= breathing rate of receptor (meters3/second) = 2.66×10^{-4} m3/s (for an adult) (23.01 m^3/day)
DCF FOR HTO	= dose conversion factor for receptor for HTO (mSv/Bq) = 3.0×10^{-8} mSv/Bq (inhalation and absorption)
DCF FOR HT	= dose conversion factor for receptor for HT (mSv/Bq) = 2.0×10^{-12} mSv/Bq for HT (inhalation)
t	= exposure time (seconds) = 120 seconds
%HTO	= % of source term / concentration which is tritium oxide = 0.25
%HT	= % of source term / concentration which is tritium gas = 0.75

The maximum dose to a worker from this scenario is calculated to be **3.02 mSv**.

The following table provides an overall accounting of the maximum calculated effective doses for seven worst-case hypothetical scenarios for SRBT:

Hypothetical Worst-Case Maximum Doses (2017)

Scenario		Maximum Dose (mSv)	Receptor	Distance (m)
A	Release of the entire contents of a tritium trap ('pyrophoric unit')	0.0337	Member of the public	99
B	Release of the entire contents of a bulk container	0.304	Member of the public	99
C	Release from a tornado	0.140	Member of the public	100
D	Release from impact of a large rogue vehicle	0.180	Member of the public	99
E	Smoldering fire within the controlled area of the facility	9.28	Staff	
F	Release from breakage during handling	3.95	Staff	
G	Release from breakage during packing	3.02	Staff	

APPENDIX B

Data Tables for HotSpot Models for Scenarios A – D

The following twelve (12) pages consist of the programmed tritium source term for each of the four scenarios:

A. Loss of PUTT Inventory (25% HTO)
B. Loss of Bulk Container Inventory (25% HTO)
C. Tornado (25% HTO)
D. Rogue Vehicle Strike (25% HTO)

Each scenario is programmed with the N288.1-14 DCF values for the three types of receptor:

- Adult
- Child
- Infant

The source terms are defined as a ‘unit mixture’ of 1 Bq HTO + 3 Bq HT, giving a ratio of 25% HTO for each scenario. The scaling factor applied generates the postulated total activity released for the particular scenario (i.e. activity released divided by 4).

```
HotSpot User Mixture Database
User Mixture Name  : Adult HTO N288.1-14 Coeff.mix
HTO (1 Bq / 25%) HT (3 Bq / 75%) Scenario A
Mixture Scale Factor                              : 2.7750E+13
--------------------------------------------------------------------------
Nuclide [01] : H-3     V   12.35y
Halflife                                (Years): 1.2350E+01
Inhalation         50-yr CEDE           (Sv/Bq): 3.0000E-11
Submersion                      (Sv-m3)/(Bq-sec): 0.0000E+00
Ground Shine                    (Sv-m2)/(Bq-sec): 0.0000E+00
Total Activity Released                 (Bq)    : 1.0000E+00
Airborne Fraction                               : 1.0000E+00
Respirable Fraction                             : 1.0000E+00
Respirable Deposition Velocity (cm/sec)         : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)         : 0.0000E+00
--------------------------------------------------------------------------
Nuclide [02] : H-3     V   12.35y
Halflife                             (Years)    : 1.2350E+01
Inhalation         50-yr CEDE        (Sv/Bq)    : 2.0000E-15
Submersion                   (Sv-m3)/(Bq-sec)   : 0.0000E+00
Ground Shine                 (Sv-m2)/(Bq-sec)   : 0.0000E+00
Total Activity Released                 (Bq)    : 3.0000E+00
Airborne Fraction                               : 1.0000E+00
Respirable Fraction                             : 1.0000E+00
Respirable Deposition Velocity (cm/sec)         : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)         : 0.0000E+00
--------------------------------------------------------------------------
```

```
HotSpot User Mixture Database
User Mixture Name  : Adult HTO N288.1-14 Coeff.mix
HTO (1 Bq / 25%) HT (3 Bq / 75%) Scenario B
Mixture Scale Factor                           : 2.5000E+14
```

```
Nuclide [01] : H-3     V   12.35y
Halflife                           (Years): 1.2350E+01
Inhalation       50-yr CEDE        (Sv/Bq): 3.0000E-11
Submersion                 (Sv-m3)/(Bq-sec): 0.0000E+00
Ground Shine               (Sv-m2)/(Bq-sec): 0.0000E+00
Total Activity Released            (Bq)    : 1.0000E+00
Airborne Fraction                          : 1.0000E+00
Respirable Fraction                        : 1.0000E+00
Respirable Deposition Velocity (cm/sec)    : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)    : 0.0000E+00
```

```
Nuclide [02] : H-3     V   12.35y
Halflife                        (Years)    : 1.2350E+01
Inhalation       50-yr CEDE     (Sv/Bq)    : 2.0000E-15
Submersion              (Sv-m3)/(Bq-sec)   : 0.0000E+00
Ground Shine            (Sv-m2)/(Bq-sec)   : 0.0000E+00
Total Activity Released            (Bq)    : 3.0000E+00
Airborne Fraction                          : 1.0000E+00
Respirable Fraction                        : 1.0000E+00
Respirable Deposition Velocity (cm/sec)    : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)    : 0.0000E+00
```

```
HotSpot User Mixture Database
User Mixture Name  : Adult HTO N288.1-14 Coeff.mix
HTO (1 Bq / 25%) HT (3 Bq / 75%) Scenario C
Mixture Scale Factor                          : 9.0000E+14
-------------------------------------------------------------------------
Nuclide [01] : H-3     V   12.35y
Halflife                             (Years): 1.2350E+01
Inhalation        50-yr CEDE         (Sv/Bq): 3.0000E-11
Submersion                  (Sv-m3)/(Bq-sec): 0.0000E+00
Ground Shine                (Sv-m2)/(Bq-sec): 0.0000E+00
Total Activity Released              (Bq)   : 1.0000E+00
Airborne Fraction                           : 1.0000E+00
Respirable Fraction                         : 1.0000E+00
Respirable Deposition Velocity (cm/sec)     : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)     : 0.0000E+00
-------------------------------------------------------------------------
Nuclide [02] : H-3     V   12.35y
Halflife                          (Years)   : 1.2350E+01
Inhalation        50-yr CEDE      (Sv/Bq)   : 2.0000E-15
Submersion                (Sv-m3)/(Bq-sec)  : 0.0000E+00
Ground Shine              (Sv-m2)/(Bq-sec)  : 0.0000E+00
Total Activity Released              (Bq)   : 3.0000E+00
Airborne Fraction                           : 1.0000E+00
Respirable Fraction                         : 1.0000E+00
Respirable Deposition Velocity (cm/sec)     : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)     : 0.0000E+00
-------------------------------------------------------------------------
```

```
HotSpot User Mixture Database
User Mixture Name  : Adult HTO N288.1-14 Coeff.mix
HTO (1 Bq / 25%) HT (3 Bq / 75%) Scenario D
Mixture Scale Factor                            : 1.4823E+14
```

```
Nuclide [01] : H-3      V   12.35y
Halflife                             (Years): 1.2350E+01
Inhalation          50-yr CEDE         (Sv/Bq): 3.0000E-11
Submersion                    (Sv-m3)/(Bq-sec): 0.0000E+00
Ground Shine                  (Sv-m2)/(Bq-sec): 0.0000E+00
Total Activity Released              (Bq)    : 1.0000E+00
Airborne Fraction                             : 1.0000E+00
Respirable Fraction                           : 1.0000E+00
Respirable Deposition Velocity (cm/sec)       : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)       : 0.0000E+00
```

```
Nuclide [02] : H-3      V   12.35y
Halflife                          (Years)    : 1.2350E+01
Inhalation          50-yr CEDE     (Sv/Bq)    : 2.0000E-15
Submersion                 (Sv-m3)/(Bq-sec)   : 0.0000E+00
Ground Shine               (Sv-m2)/(Bq-sec)   : 0.0000E+00
Total Activity Released              (Bq)     : 3.0000E+00
Airborne Fraction                             : 1.0000E+00
Respirable Fraction                           : 1.0000E+00
Respirable Deposition Velocity (cm/sec)       : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)       : 0.0000E+00
```

```
HotSpot User Mixture Database
User Mixture Name  : Child HTO N288.1-14 Coeff.mix
HTO (1 Bq / 25%) HT (3 Bq / 75%) Scenario A
Mixture Scale Factor                          : 2.7750E+13
------------------------------------------------------------
Nuclide [01] : H-3     V   12.35y
Halflife                             (Years): 1.2350E+01
Inhalation        50-yr CEDE         (Sv/Bq): 3.8000E-11
Submersion                  (Sv-m3)/(Bq-sec): 0.0000E+00
Ground Shine                (Sv-m2)/(Bq-sec): 0.0000E+00
Total Activity Released              (Bq)   : 1.0000E+00
Airborne Fraction                           : 1.0000E+00
Respirable Fraction                         : 1.0000E+00
Respirable Deposition Velocity (cm/sec)     : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)     : 0.0000E+00
------------------------------------------------------------
Nuclide [02] : H-3     V   12.35y
Halflife                          (Years)   : 1.2350E+01
Inhalation        50-yr CEDE      (Sv/Bq)   : 2.5000E-15
Submersion               (Sv-m3)/(Bq-sec)   : 0.0000E+00
Ground Shine             (Sv-m2)/(Bq-sec)   : 0.0000E+00
Total Activity Released              (Bq)   : 3.0000E+00
Airborne Fraction                           : 1.0000E+00
Respirable Fraction                         : 1.0000E+00
Respirable Deposition Velocity (cm/sec)     : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)     : 0.0000E+00
------------------------------------------------------------
```

```
HotSpot User Mixture Database
User Mixture Name  : Child HTO N288.1-14 Coeff.mix
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Mixture Scale Factor                        : 2.5000E+14
------------------------------------------------------------
Nuclide [01] : H-3      V    12.35y
Halflife                          (Years): 1.2350E+01
Inhalation          50-yr CEDE    (Sv/Bq): 3.8000E-11
Submersion                 (Sv-m3)/(Bq-sec): 0.0000E+00
Ground Shine               (Sv-m2)/(Bq-sec): 0.0000E+00
Total Activity Released           (Bq)    : 1.0000E+00
Airborne Fraction                          : 1.0000E+00
Respirable Fraction                        : 1.0000E+00
Respirable Deposition Velocity (cm/sec)    : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)    : 0.0000E+00
------------------------------------------------------------
Nuclide [02] : H-3      V    12.35y
Halflife                       (Years)    : 1.2350E+01
Inhalation          50-yr CEDE (Sv/Bq)    : 2.5000E-15
Submersion              (Sv-m3)/(Bq-sec)  : 0.0000E+00
Ground Shine            (Sv-m2)/(Bq-sec)  : 0.0000E+00
Total Activity Released           (Bq)    : 3.0000E+00
Airborne Fraction                          : 1.0000E+00
Respirable Fraction                        : 1.0000E+00
Respirable Deposition Velocity (cm/sec)    : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)    : 0.0000E+00
------------------------------------------------------------
```

```
HotSpot User Mixture Database
User Mixture Name  : Child HTO N288.1-14 Coeff.mix
HTO (1 Bq / 25%) HT (3 Bq / 75%) Scenario C
Mixture Scale Factor                          : 9.0000E+14
----------------------------------------------------------------------
Nuclide [01] : H-3     V   12.35y
Halflife                             (Years): 1.2350E+01
Inhalation        50-yr CEDE         (Sv/Bq): 3.8000E-11
Submersion                  (Sv-m3)/(Bq-sec): 0.0000E+00
Ground Shine                (Sv-m2)/(Bq-sec): 0.0000E+00
Total Activity Released              (Bq)   : 1.0000E+00
Airborne Fraction                           : 1.0000E+00
Respirable Fraction                         : 1.0000E+00
Respirable Deposition Velocity (cm/sec)     : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)     : 0.0000E+00
----------------------------------------------------------------------
Nuclide [02] : H-3     V   12.35y
Halflife                          (Years)   : 1.2350E+01
Inhalation        50-yr CEDE      (Sv/Bq)   : 2.5000E-15
Submersion                (Sv-m3)/(Bq-sec)  : 0.0000E+00
Ground Shine              (Sv-m2)/(Bq-sec)  : 0.0000E+00
Total Activity Released              (Bq)   : 3.0000E+00
Airborne Fraction                           : 1.0000E+00
Respirable Fraction                         : 1.0000E+00
Respirable Deposition Velocity (cm/sec)     : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)     : 0.0000E+00
----------------------------------------------------------------------
```

```
HotSpot User Mixture Database
User Mixture Name  : Child HTO N288.1-14 Coeff.mix
HTO (1 Bq / 25%) HT (3 Bq / 75%) Scenario D
Mixture Scale Factor                              : 1.4823E+14
----------------------------------------------------------------------------
Nuclide [01] : H-3      V   12.35y
Halflife                              (Years): 1.2350E+01
Inhalation         50-yr CEDE         (Sv/Bq): 3.8000E-11
Submersion                   (Sv-m3)/(Bq-sec): 0.0000E+00
Ground Shine                 (Sv-m2)/(Bq-sec): 0.0000E+00
Total Activity Released               (Bq)   : 1.0000E+00
Airborne Fraction                            : 1.0000E+00
Respirable Fraction                          : 1.0000E+00
Respirable Deposition Velocity (cm/sec)      : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)      : 0.0000E+00
----------------------------------------------------------------------------
Nuclide [02] : H-3      V   12.35y
Halflife                           (Years)   : 1.2350E+01
Inhalation         50-yr CEDE      (Sv/Bq)   : 2.5000E-15
Submersion                (Sv-m3)/(Bq-sec)   : 0.0000E+00
Ground Shine              (Sv-m2)/(Bq-sec)   : 0.0000E+00
Total Activity Released               (Bq)   : 3.0000E+00
Airborne Fraction                            : 1.0000E+00
Respirable Fraction                          : 1.0000E+00
Respirable Deposition Velocity (cm/sec)      : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)      : 0.0000E+00
----------------------------------------------------------------------------
```

CEDEOnlyFile.mix

```
HotSpot User Mixture Database
User Mixture Name  : Infant HTO N288.1-14 Coeff.mix
HTO (1 Bq / 25%) HT (3 Bq / 75%) Scenario A
Mixture Scale Factor                          : 2.7750E+13
----------------------------------------------------------------------------
Nuclide [01] : H-3     V   12.35y
Halflife                             (Years): 1.2350E+01
Inhalation        50-yr CEDE         (Sv/Bq): 8.0000E-11
Submersion                  (Sv-m3)/(Bq-sec): 0.0000E+00
Ground Shine                (Sv-m2)/(Bq-sec): 0.0000E+00
Total Activity Released              (Bq)   : 1.0000E+00
Airborne Fraction                           : 1.0000E+00
Respirable Fraction                         : 1.0000E+00
Respirable Deposition Velocity (cm/sec)     : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)     : 0.0000E+00
----------------------------------------------------------------------------
Nuclide [02] : H-3     V   12.35y
Halflife                          (Years)   : 1.2350E+01
Inhalation        50-yr CEDE      (Sv/Bq)   : 5.3000E-15
Submersion               (Sv-m3)/(Bq-sec)   : 0.0000E+00
Ground Shine             (Sv-m2)/(Bq-sec)   : 0.0000E+00
Total Activity Released              (Bq)   : 3.0000E+00
Airborne Fraction                           : 1.0000E+00
Respirable Fraction                         : 1.0000E+00
Respirable Deposition Velocity (cm/sec)     : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)     : 0.0000E+00
----------------------------------------------------------------------------
```

```
HotSpot User Mixture Database
User Mixture Name  : Infant HTO N288.1-14 Coeff.mix
HTO (1 Bq / 25%) HT (3 Bq / 75%) Scenario B
Mixture Scale Factor                          : 2.5000E+14
```

```
Nuclide [01] : H-3      V   12.35y
Halflife                             (Years): 1.2350E+01
Inhalation         50-yr CEDE        (Sv/Bq): 8.0000E-11
Submersion                   (Sv-m3)/(Bq-sec): 0.0000E+00
Ground Shine                 (Sv-m2)/(Bq-sec): 0.0000E+00
Total Activity Released              (Bq)   : 1.0000E+00
Airborne Fraction                           : 1.0000E+00
Respirable Fraction                         : 1.0000E+00
Respirable Deposition Velocity (cm/sec)     : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)     : 0.0000E+00
```

```
Nuclide [02] : H-3      V   12.35y
Halflife                          (Years)   : 1.2350E+01
Inhalation         50-yr CEDE     (Sv/Bq)   : 5.3000E-15
Submersion                (Sv-m3)/(Bq-sec)  : 0.0000E+00
Ground Shine              (Sv-m2)/(Bq-sec)  : 0.0000E+00
Total Activity Released              (Bq)   : 3.0000E+00
Airborne Fraction                           : 1.0000E+00
Respirable Fraction                         : 1.0000E+00
Respirable Deposition Velocity (cm/sec)     : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)     : 0.0000E+00
```

HotSpot User Mixture Database
User Mixture Name : Infant HTO N288.1-14 Coeff.mix
HTO (1 Bq / 25%) HT (3 Bq / 75%) Scenario C
Mixture Scale Factor : 9.0000E+14

```
Nuclide [01] : H-3      V    12.35y
Halflife                              (Years): 1.2350E+01
Inhalation          50-yr CEDE        (Sv/Bq): 8.0000E-11
Submersion                   (Sv-m3)/(Bq-sec): 0.0000E+00
Ground Shine                 (Sv-m2)/(Bq-sec): 0.0000E+00
Total Activity Released               (Bq)   : 1.0000E+00
Airborne Fraction                            : 1.0000E+00
Respirable Fraction                          : 1.0000E+00
Respirable Deposition Velocity (cm/sec)      : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)      : 0.0000E+00
```

```
Nuclide [02] : H-3      V    12.35y
Halflife                           (Years)   : 1.2350E+01
Inhalation          50-yr CEDE     (Sv/Bq)   : 5.3000E-15
Submersion                (Sv-m3)/(Bq-sec)   : 0.0000E+00
Ground Shine              (Sv-m2)/(Bq-sec)   : 0.0000E+00
Total Activity Released               (Bq)   : 3.0000E+00
Airborne Fraction                            : 1.0000E+00
Respirable Fraction                          : 1.0000E+00
Respirable Deposition Velocity (cm/sec)      : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)      : 0.0000E+00
```

```
HotSpot User Mixture Database
User Mixture Name  : Infant HTO N288.1-14 Coeff.mix
HTO (1 Bq / 25%) HT (3 Bq / 75%) Scenario D
Mixture Scale Factor                          : 1.4823E+14
-------------------------------------------------------------------------
Nuclide [01] : H-3      V   12.35y
Halflife                              (Years): 1.2350E+01
Inhalation          50-yr CEDE        (Sv/Bq): 8.0000E-11
Submersion                    (Sv-m3)/(Bq-sec): 0.0000E+00
Ground Shine                  (Sv-m2)/(Bq-sec): 0.0000E+00
Total Activity Released               (Bq)   : 1.0000E+00
Airborne Fraction                            : 1.0000E+00
Respirable Fraction                          : 1.0000E+00
Respirable Deposition Velocity (cm/sec)      : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)      : 0.0000E+00
-------------------------------------------------------------------------
Nuclide [02] : H-3      V   12.35y
Halflife                           (Years)   : 1.2350E+01
Inhalation          50-yr CEDE     (Sv/Bq)   : 5.3000E-15
Submersion                 (Sv-m3)/(Bq-sec)  : 0.0000E+00
Ground Shine               (Sv-m2)/(Bq-sec)  : 0.0000E+00
Total Activity Released               (Bq)   : 3.0000E+00
Airborne Fraction                            : 1.0000E+00
Respirable Fraction                          : 1.0000E+00
Respirable Deposition Velocity (cm/sec)      : 0.0000E+00
Non-resp.  Deposition Velocity (cm/sec)      : 0.0000E+00
-------------------------------------------------------------------------
```

The following fifty-seven (57) pages consist of the tabular output of each modelled scenario, for each receptor, for each wind class type.

Adult Scenario A Pasquill A.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 11:27 AM

Source Term : Adult Mixtures\Scenario A Adult.mix (Mixture Scale Factor = 2.7750E+13)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.15 m/s
Stability Class : A
Receptor Height : 1.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.66E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.098 km
Maximum TEDE : 2.86E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 0.13 km
Exceeds Middle Dose Out To : 0.25 km
Exceeds Outer Dose Out To : 0.87 km

Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	3.1E-08	1.5E+07	<00:01
0.100	2.9E-05	1.4E+10	<00:01
0.200	1.5E-05	7.4E+09	00:01
0.300	7.6E-06	3.8E+09	00:02
0.400	4.5E-06	2.2E+09	00:03
0.500	2.9E-06	1.5E+09	00:03
0.600	2.1E-06	1.0E+09	00:04
0.700	1.5E-06	7.7E+08	00:05
0.800	1.2E-06	6.0E+08	00:06
0.900	9.5E-07	4.8E+08	00:06
1.000	7.7E-07	3.9E+08	00:07
2.000	2.0E-07	1.0E+08	00:15
4.000	5.5E-08	2.8E+07	00:31
6.000	2.6E-08	1.3E+07	00:46
8.000	1.6E-08	7.8E+06	01:02
10.000	1.1E-08	5.3E+06	01:17
20.000	3.2E-09	1.6E+06	02:35
40.000	1.0E-09	5.2E+05	05:10
60.000	5.5E-10	2.7E+05	07:45
80.000	3.5E-10	1.8E+05	10:20

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 11:30 AM

```
Source Term                 : Adult Mixtures\Scenario A Adult.mix (Mixture
Scale Factor = 2.7750E+13)
                              HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height    : 28 m
Wind Speed (h=10 m)         : 2.00 m/s
Wind Direction              : 135.0 degrees  Wind from the SE
Wind Speed (h=H-eff)        : 2.15 m/s
Stability Class             : B
Receptor Height             : 1.5 m
Inversion Layer Height      : None
Sample Time                 : 10.000 min
Breathing Rate              : 2.66E-04 m3/sec
Distance Coordinates        : All distances are on the Plume Centerline

Maximum Dose Distance       : 0.16 km
Maximum TEDE                : 2.37E-05 Sv
Inner  Contour Dose         : 2.50E-05 Sv
Middle Contour Dose         : 1.00E-05 Sv
Outer  Contour Dose         : 1.00E-06 Sv
Exceeds Inner  Dose Out To  : Not Exceeded
Exceeds Middle Dose Out To  : 0.38 km
Exceeds Outer  Dose Out To  : 1.3 km
```

Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	2.5E-15	1.2E+00	<00:01
0.100	1.2E-05	6.1E+09	<00:01
0.200	2.2E-05	1.1E+10	00:01
0.300	1.4E-05	7.2E+09	00:02
0.400	9.2E-06	4.6E+09	00:03
0.500	6.3E-06	3.2E+09	00:03
0.600	4.5E-06	2.3E+09	00:04
0.700	3.4E-06	1.7E+09	00:05
0.800	2.7E-06	1.3E+09	00:06
0.900	2.1E-06	1.1E+09	00:06
1.000	1.7E-06	8.7E+08	00:07
2.000	4.6E-07	2.3E+08	00:15
4.000	1.3E-07	6.3E+07	00:31
6.000	6.0E-08	3.0E+07	00:46
8.000	3.6E-08	1.8E+07	01:02
10.000	2.4E-08	1.2E+07	01:17
20.000	7.4E-09	3.7E+06	02:35
40.000	2.4E-09	1.2E+06	05:10
60.000	1.3E-09	6.3E+05	07:45
80.000	8.0E-10	4.0E+05	10:20

Adult Scenario A Pasquill C.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 11:31 AM

Source Term : Adult Mixtures\Scenario A Adult.mix (Mixture Scale Factor = 2.7750E+13)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.22 m/s
Stability Class : C
Receptor Height : 1.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.66E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.25 km
Maximum TEDE : 2.18E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : Not Exceeded
Exceeds Middle Dose Out To : 0.56 km
Exceeds Outer Dose Out To : 2.2 km

Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	5.9E-15	<00:01
0.100	9.4E-07	4.7E+08	<00:01
0.200	2.0E-05	9.8E+09	00:01
0.300	2.1E-05	1.0E+10	00:02
0.400	1.6E-05	8.0E+09	00:03
0.500	1.2E-05	6.0E+09	00:03
0.600	9.1E-06	4.5E+09	00:04
0.700	7.1E-06	3.5E+09	00:05
0.800	5.7E-06	2.8E+09	00:06
0.900	4.6E-06	2.3E+09	00:06
1.000	3.9E-06	1.9E+09	00:07
2.000	1.1E-06	5.7E+08	00:15
4.000	3.6E-07	1.8E+08	00:30
6.000	1.9E-07	9.4E+07	00:45
8.000	1.2E-07	6.1E+07	01:00
10.000	8.8E-08	4.4E+07	01:15
20.000	3.5E-08	1.8E+07	02:30
40.000	1.5E-08	7.6E+06	05:00
60.000	9.6E-09	4.8E+06	07:31
80.000	7.0E-09	3.5E+06	10:01

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 11:33 AM

Source Term : Adult Mixtures\Scenario A Adult.mix (Mixture Scale Factor = 2.7750E+13)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.33 m/s
Stability Class : D
Receptor Height : 1.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.66E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.39 km
Maximum TEDE : 1.74E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : Not Exceeded
Exceeds Middle Dose Out To : 0.83 km
Exceeds Outer Dose Out To : 4.5 km

Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	5.8E-09	2.9E+06	<00:01
0.200	5.9E-06	2.9E+09	00:01
0.300	1.5E-05	7.7E+09	00:02
0.400	1.7E-05	8.7E+09	00:02
0.500	1.6E-05	8.1E+09	00:03
0.600	1.4E-05	7.1E+09	00:04
0.700	1.2E-05	6.1E+09	00:05
0.800	1.0E-05	5.3E+09	00:05
0.900	9.1E-06	4.6E+09	00:06
1.000	8.0E-06	4.0E+09	00:07
2.000	3.1E-06	1.6E+09	00:14
4.000	1.2E-06	5.9E+08	00:28
6.000	6.8E-07	3.4E+08	00:42
8.000	4.7E-07	2.3E+08	00:57
10.000	3.5E-07	1.8E+08	01:11
20.000	1.5E-07	7.5E+07	02:22
40.000	6.8E-08	3.4E+07	04:45
60.000	4.4E-08	2.2E+07	07:08
80.000	3.2E-08	1.6E+07	09:31

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 11:34 AM

Source Term : Adult Mixtures\Scenario A Adult.mix (Mixture
Scale Factor = 2.7750E+13)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.86 m/s
Stability Class : E
Receptor Height : 1.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.66E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.77 km
Maximum TEDE : 9.88E-06 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : Not Exceeded
Exceeds Middle Dose Out To : Not Exceeded
Exceeds Outer Dose Out To : 7.2 km

Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	7.0E-07	<00:01
0.200	4.0E-09	2.0E+06	00:01
0.300	6.8E-07	3.4E+08	00:01
0.400	3.6E-06	1.8E+09	00:02
0.500	6.8E-06	3.4E+09	00:02
0.600	8.9E-06	4.4E+09	00:03
0.700	9.8E-06	4.9E+09	00:04
0.800	9.9E-06	4.9E+09	00:04
0.900	9.5E-06	4.8E+09	00:05
1.000	9.0E-06	4.5E+09	00:05
2.000	4.6E-06	2.3E+09	00:11
4.000	2.0E-06	9.8E+08	00:23
6.000	1.2E-06	6.1E+08	00:34
8.000	9.0E-07	4.5E+08	00:46
10.000	7.2E-07	3.6E+08	00:58
20.000	3.9E-07	2.0E+08	01:56
40.000	2.4E-07	1.2E+08	03:53
60.000	1.8E-07	9.2E+07	05:49
80.000	1.5E-07	7.7E+07	07:46

Adult Scenario A Pasquill F.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 11:34 AM

Source Term : Adult Mixtures\Scenario A Adult.mix (Mixture Scale Factor = 2.7750E+13)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 3.51 m/s
Stability Class : F
Receptor Height : 1.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.66E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 1.7 km
Maximum TEDE : 5.42E-06 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : Not Exceeded
Exceeds Middle Dose Out To : Not Exceeded
Exceeds Outer Dose Out To : 15 km

Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	0.0E+00	<00:01
0.200	0.0E+00	7.0E-06	<00:01
0.300	3.5E-12	1.8E+03	00:01
0.400	3.0E-09	1.5E+06	00:01
0.500	6.9E-08	3.4E+07	00:02
0.600	3.7E-07	1.8E+08	00:02
0.700	9.8E-07	4.9E+08	00:03
0.800	1.8E-06	9.0E+08	00:03
0.900	2.7E-06	1.3E+09	00:04
1.000	3.4E-06	1.7E+09	00:04
2.000	5.2E-06	2.6E+09	00:09
4.000	3.2E-06	1.6E+09	00:19
6.000	2.2E-06	1.1E+09	00:28
8.000	1.7E-06	8.5E+08	00:37
10.000	1.4E-06	7.0E+08	00:47
20.000	7.9E-07	4.0E+08	01:34
40.000	4.9E-07	2.4E+08	03:09
60.000	3.8E-07	1.9E+08	04:44
80.000	3.2E-07	1.6E+08	06:19

Child Scenario A Pasquill A.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 11:43 AM

```
Source Term                  : Child Mixtures\Scenario A Child.mix (Mixture
Scale Factor = 2.7750E+13)
                               HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height     : 28 m
Wind Speed (h=10 m)          : 2.00 m/s
Wind Direction               : 135.0 degrees  Wind from the SE
Wind Speed (h=H-eff)         : 2.15 m/s
Stability Class              : A
Receptor Height              : 1.0 m
Inversion Layer Height       : None
Sample Time                  : 10.000 min
Breathing Rate               : 2.48E-04 m3/sec
Distance Coordinates         : All distances are on the Plume Centerline

Maximum Dose Distance        : 0.099 km
Maximum TEDE                 : 3.37E-05 Sv
Inner  Contour Dose          : 2.50E-05 Sv
Middle Contour Dose          : 1.00E-05 Sv
Outer  Contour Dose          : 1.00E-06 Sv
Exceeds Inner  Dose Out To   : 0.15 km
Exceeds Middle Dose Out To   : 0.28 km
Exceeds Outer  Dose Out To   : 0.95 km
```

Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	2.8E-08	1.2E+07	<00:01
0.100	3.4E-05	1.4E+10	<00:01
0.200	1.7E-05	7.4E+09	00:01
0.300	8.9E-06	3.8E+09	00:02
0.400	5.3E-06	2.2E+09	00:03
0.500	3.5E-06	1.5E+09	00:03
0.600	2.5E-06	1.0E+09	00:04
0.700	1.8E-06	7.7E+08	00:05
0.800	1.4E-06	6.0E+08	00:06
0.900	1.1E-06	4.8E+08	00:06
1.000	9.1E-07	3.9E+08	00:07
2.000	2.4E-07	1.0E+08	00:15
4.000	6.5E-08	2.8E+07	00:31
6.000	3.1E-08	1.3E+07	00:46
8.000	1.8E-08	7.8E+06	01:02
10.000	1.2E-08	5.3E+06	01:17
20.000	3.8E-09	1.6E+06	02:35
40.000	1.2E-09	5.2E+05	05:10
60.000	6.5E-10	2.7E+05	07:45
80.000	4.1E-10	1.8E+05	10:20

Child Scenario A Pasquill B.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 11:45 AM

Source Term : Child Mixtures\Scenario A Child.mix (Mixture Scale Factor = 2.7750E+13)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.15 m/s
Stability Class : B
Receptor Height : 1.0 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.48E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.16 km
Maximum TEDE : 2.79E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 0.21 km
Exceeds Middle Dose Out To : 0.42 km
Exceeds Outer Dose Out To : 1.4 km

Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	1.1E-15	4.5E-01	<00:01
0.100	1.4E-05	6.0E+09	<00:01
0.200	2.6E-05	1.1E+10	00:01
0.300	1.7E-05	7.2E+09	00:02
0.400	1.1E-05	4.6E+09	00:03
0.500	7.4E-06	3.2E+09	00:03
0.600	5.4E-06	2.3E+09	00:04
0.700	4.0E-06	1.7E+09	00:05
0.800	3.1E-06	1.3E+09	00:06
0.900	2.5E-06	1.1E+09	00:06
1.000	2.1E-06	8.7E+08	00:07
2.000	5.5E-07	2.3E+08	00:15
4.000	1.5E-07	6.3E+07	00:31
6.000	7.1E-08	3.0E+07	00:46
8.000	4.2E-08	1.8E+07	01:02
10.000	2.9E-08	1.2E+07	01:17
20.000	8.7E-09	3.7E+06	02:35
40.000	2.8E-09	1.2E+06	05:10
60.000	1.5E-09	6.3E+05	07:45
80.000	9.5E-10	4.0E+05	10:20

Child Scenario A Pasquill C.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 11:46 AM

```
Source Term                   : Child Mixtures\Scenario A Child.mix (Mixture
Scale Factor = 2.7750E+13)
                                HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height      : 28 m
Wind Speed (h=10 m)           : 2.00 m/s
Wind Direction                : 135.0 degrees  Wind from the SE
Wind Speed (h=H-eff)          : 2.22 m/s
Stability Class               : C
Receptor Height               : 1.0 m
Inversion Layer Height        : None
Sample Time                   : 10.000 min
Breathing Rate                : 2.48E-04 m3/sec
Distance Coordinates          : All distances are on the Plume Centerline

Maximum Dose Distance         : 0.25 km
Maximum TEDE                  : 2.57E-05 Sv
Inner  Contour Dose           : 2.50E-05 Sv
Middle Contour Dose           : 1.00E-05 Sv
Outer  Contour Dose           : 1.00E-06 Sv
Exceeds Inner  Dose Out To    : 0.28 km
Exceeds Middle Dose Out To    : 0.62 km
Exceeds Outer  Dose Out To    : 2.4 km
```

Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	5.8E-16	<00:01
0.100	1.0E-06	4.2E+08	<00:01
0.200	2.3E-05	9.8E+09	00:01
0.300	2.4E-05	1.0E+10	00:02
0.400	1.9E-05	8.0E+09	00:03
0.500	1.4E-05	6.0E+09	00:03
0.600	1.1E-05	4.5E+09	00:04
0.700	8.4E-06	3.5E+09	00:05
0.800	6.7E-06	2.8E+09	00:06
0.900	5.5E-06	2.3E+09	00:06
1.000	4.6E-06	1.9E+09	00:07
2.000	1.4E-06	5.7E+08	00:15
4.000	4.2E-07	1.8E+08	00:30
6.000	2.2E-07	9.4E+07	00:45
8.000	1.4E-07	6.1E+07	01:00
10.000	1.0E-07	4.4E+07	01:15
20.000	4.1E-08	1.8E+07	02:30
40.000	1.8E-08	7.6E+06	05:00
60.000	1.1E-08	4.8E+06	07:31
80.000	8.3E-09	3.5E+06	10:01

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 11:47 AM

Source Term : Child Mixtures\Scenario A Child.mix (Mixture Scale Factor = 2.7750E+13)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.33 m/s
Stability Class : D
Receptor Height : 1.0 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.48E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.39 km
Maximum TEDE : 2.05E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : Not Exceeded
Exceeds Middle Dose Out To : 0.95 km
Exceeds Outer Dose Out To : 5.1 km

Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	4.9E-09	2.1E+06	<00:01
0.200	6.7E-06	2.9E+09	00:01
0.300	1.8E-05	7.6E+09	00:02
0.400	2.1E-05	8.7E+09	00:02
0.500	1.9E-05	8.1E+09	00:03
0.600	1.7E-05	7.1E+09	00:04
0.700	1.4E-05	6.1E+09	00:05
0.800	1.2E-05	5.3E+09	00:05
0.900	1.1E-05	4.6E+09	00:06
1.000	9.4E-06	4.0E+09	00:07
2.000	3.7E-06	1.6E+09	00:14
4.000	1.4E-06	5.9E+08	00:28
6.000	8.0E-07	3.4E+08	00:42
8.000	5.5E-07	2.3E+08	00:57
10.000	4.1E-07	1.8E+08	01:11
20.000	1.8E-07	7.5E+07	02:22
40.000	8.1E-08	3.4E+07	04:45
60.000	5.2E-08	2.2E+07	07:08
80.000	3.8E-08	1.6E+07	09:31

Child Scenario A Pasquill E.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 11:48 AM

```
Source Term                  : Child Mixtures\Scenario A Child.mix (Mixture
Scale Factor = 2.7750E+13)
                               HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height     : 28 m
Wind Speed (h=10 m)          : 2.00 m/s
Wind Direction               : 135.0 degrees  Wind from the SE
Wind Speed (h=H-eff)         : 2.86 m/s
Stability Class              : E
Receptor Height              : 1.0 m
Inversion Layer Height       : None
Sample Time                  : 10.000 min
Breathing Rate               : 2.48E-04 m3/sec
Distance Coordinates         : All distances are on the Plume Centerline

Maximum Dose Distance        : 0.77 km
Maximum TEDE                 : 1.16E-05 Sv
Inner  Contour Dose          : 2.50E-05 Sv
Middle Contour Dose          : 1.00E-05 Sv
Outer  Contour Dose          : 1.00E-06 Sv
Exceeds Inner  Dose Out To   : Not Exceeded
Exceeds Middle Dose Out To   : 1.1 km
Exceeds Outer  Dose Out To   : 8.5 km
```

Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	1.5E-07	<00:01
0.200	3.5E-09	1.5E+06	00:01
0.300	7.4E-07	3.1E+08	00:01
0.400	4.1E-06	1.7E+09	00:02
0.500	7.9E-06	3.4E+09	00:02
0.600	1.0E-05	4.4E+09	00:03
0.700	1.1E-05	4.9E+09	00:04
0.800	1.2E-05	4.9E+09	00:04
0.900	1.1E-05	4.8E+09	00:05
1.000	1.1E-05	4.5E+09	00:05
2.000	5.4E-06	2.3E+09	00:11
4.000	2.3E-06	9.8E+08	00:23
6.000	1.4E-06	6.1E+08	00:34
8.000	1.1E-06	4.5E+08	00:46
10.000	8.5E-07	3.6E+08	00:58
20.000	4.6E-07	2.0E+08	01:56
40.000	2.8E-07	1.2E+08	03:53
60.000	2.2E-07	9.2E+07	05:49
80.000	1.8E-07	7.7E+07	07:46

Child Scenario A Pasquill F.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 11:48 AM

Source Term : Child Mixtures\Scenario A Child.mix (Mixture Scale Factor = 2.7750E+13)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 3.51 m/s
Stability Class : F
Receptor Height : 1.0 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.48E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 1.7 km
Maximum TEDE : 6.38E-06 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : Not Exceeded
Exceeds Middle Dose Out To : Not Exceeded
Exceeds Outer Dose Out To : 18 km

Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	0.0E+00	<00:01
0.200	0.0E+00	1.6E-06	<00:01
0.300	2.2E-12	9.3E+02	00:01
0.400	2.6E-09	1.1E+06	00:01
0.500	6.9E-08	2.9E+07	00:02
0.600	3.9E-07	1.7E+08	00:02
0.700	1.1E-06	4.6E+08	00:03
0.800	2.0E-06	8.7E+08	00:03
0.900	3.1E-06	1.3E+09	00:04
1.000	4.0E-06	1.7E+09	00:04
2.000	6.2E-06	2.6E+09	00:09
4.000	3.8E-06	1.6E+09	00:19
6.000	2.6E-06	1.1E+09	00:28
8.000	2.0E-06	8.5E+08	00:37
10.000	1.6E-06	7.0E+08	00:47
20.000	9.3E-07	4.0E+08	01:34
40.000	5.7E-07	2.4E+08	03:09
60.000	4.4E-07	1.9E+08	04:44
80.000	3.7E-07	1.6E+08	06:19

Infant Scenario A Pasquill A.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 11:52 AM

Source Term : Infant Mixtures\Scenario A Infant.mix (Mixture Scale Factor = 2.7750E+13)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.15 m/s
Stability Class : A
Receptor Height : 0.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 8.68E-05 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.099 km
Maximum TEDE : 2.48E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : Not Exceeded
Exceeds Middle Dose Out To : 0.23 km
Exceeds Outer Dose Out To : 0.81 km

Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	1.7E-08	9.7E+06	<00:01
0.100	2.5E-05	1.4E+10	<00:01
0.200	1.3E-05	7.4E+09	00:01
0.300	6.6E-06	3.8E+09	00:02
0.400	3.9E-06	2.2E+09	00:03
0.500	2.6E-06	1.5E+09	00:03
0.600	1.8E-06	1.0E+09	00:04
0.700	1.3E-06	7.7E+08	00:05
0.800	1.0E-06	6.0E+08	00:06
0.900	8.3E-07	4.8E+08	00:06
1.000	6.7E-07	3.9E+08	00:07
2.000	1.8E-07	1.0E+08	00:15
4.000	4.8E-08	2.8E+07	00:31
6.000	2.3E-08	1.3E+07	00:46
8.000	1.4E-08	7.8E+06	01:02
10.000	9.2E-09	5.3E+06	01:17
20.000	2.8E-09	1.6E+06	02:35
40.000	9.1E-10	5.2E+05	05:10
60.000	4.8E-10	2.7E+05	07:45
80.000	3.0E-10	1.8E+05	10:20

Infant Scenario A Pasquill B.txt
HotSpot Version 3.0.3 General Plume
Apr 19, 2017 11:53 AM

Source Term : Infant Mixtures\Scenario A Infant.mix (Mixture Scale Factor = 2.7750E+13)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.15 m/s
Stability Class : B
Receptor Height : 0.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 8.68E-05 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.16 km
Maximum TEDE : 2.06E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : Not Exceeded
Exceeds Middle Dose Out To : 0.35 km
Exceeds Outer Dose Out To : 1.2 km

Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	3.0E-16	1.7E-01	<00:01
0.100	1.0E-05	5.9E+09	<00:01
0.200	1.9E-05	1.1E+10	00:01
0.300	1.2E-05	7.2E+09	00:02
0.400	8.0E-06	4.6E+09	00:03
0.500	5.5E-06	3.2E+09	00:03
0.600	3.9E-06	2.3E+09	00:04
0.700	3.0E-06	1.7E+09	00:05
0.800	2.3E-06	1.3E+09	00:06
0.900	1.9E-06	1.1E+09	00:06
1.000	1.5E-06	8.7E+08	00:07
2.000	4.0E-07	2.3E+08	00:15
4.000	1.1E-07	6.3E+07	00:31
6.000	5.2E-08	3.0E+07	00:46
8.000	3.1E-08	1.8E+07	01:02
10.000	2.1E-08	1.2E+07	01:17
20.000	6.4E-09	3.7E+06	02:35
40.000	2.1E-09	1.2E+06	05:10
60.000	1.1E-09	6.3E+05	07:45
80.000	7.0E-10	4.0E+05	10:20

Infant Scenario A Pasquill C.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 11:54 AM

Source Term : Infant Mixtures\Scenario A Infant.mix (Mixture Scale Factor = 2.7750E+13)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.22 m/s
Stability Class : C
Receptor Height : 0.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 8.68E-05 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.25 km
Maximum TEDE : 1.89E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : Not Exceeded
Exceeds Middle Dose Out To : 0.51 km
Exceeds Outer Dose Out To : 2.0 km

Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	4.1E-17	<00:01
0.100	6.9E-07	4.0E+08	<00:01
0.200	1.7E-05	9.7E+09	00:01
0.300	1.8E-05	1.0E+10	00:02
0.400	1.4E-05	8.0E+09	00:03
0.500	1.0E-05	6.0E+09	00:03
0.600	7.9E-06	4.5E+09	00:04
0.700	6.2E-06	3.5E+09	00:05
0.800	4.9E-06	2.8E+09	00:06
0.900	4.0E-06	2.3E+09	00:06
1.000	3.4E-06	1.9E+09	00:07
2.000	1.0E-06	5.8E+08	00:15
4.000	3.1E-07	1.8E+08	00:30
6.000	1.6E-07	9.4E+07	00:45
8.000	1.1E-07	6.1E+07	01:00
10.000	7.7E-08	4.4E+07	01:15
20.000	3.0E-08	1.8E+07	02:30
40.000	1.3E-08	7.6E+06	05:00
60.000	8.3E-09	4.8E+06	07:31
80.000	6.1E-09	3.5E+06	10:01

Infant Scenario A Pasquill D.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 11:55 AM

Source Term : Infant Mixtures\Scenario A Infant.mix (Mixture Scale Factor = 2.7750E+13)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.33 m/s
Stability Class : D
Receptor Height : 0.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 8.68E-05 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.39 km
Maximum TEDE : 1.51E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : Not Exceeded
Exceeds Middle Dose Out To : 0.74 km
Exceeds Outer Dose Out To : 4.0 km

Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	2.8E-09	1.6E+06	<00:01
0.200	4.9E-06	2.8E+09	00:01
0.300	1.3E-05	7.6E+09	00:02
0.400	1.5E-05	8.7E+09	00:02
0.500	1.4E-05	8.1E+09	00:03
0.600	1.2E-05	7.1E+09	00:04
0.700	1.1E-05	6.1E+09	00:05
0.800	9.1E-06	5.3E+09	00:05
0.900	7.9E-06	4.6E+09	00:06
1.000	7.0E-06	4.0E+09	00:07
2.000	2.7E-06	1.6E+09	00:14
4.000	1.0E-06	5.9E+08	00:28
6.000	5.9E-07	3.4E+08	00:42
8.000	4.1E-07	2.3E+08	00:57
10.000	3.0E-07	1.8E+08	01:11
20.000	1.3E-07	7.5E+07	02:22
40.000	6.0E-08	3.4E+07	04:45
60.000	3.8E-08	2.2E+07	07:08
80.000	2.8E-08	1.6E+07	09:31

Infant Scenario A Pasquill E.txt
HotSpot Version 3.0.3 General Plume
Apr 19, 2017 11:55 AM

Source Term : Infant Mixtures\Scenario A Infant.mix (Mixture Scale Factor = 2.7750E+13)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.86 m/s
Stability Class : E
Receptor Height : 0.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 8.68E-05 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.77 km
Maximum TEDE : 8.57E-06 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : Not Exceeded
Exceeds Middle Dose Out To : Not Exceeded
Exceeds Outer Dose Out To : 6.3 km

Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	3.1E-08	<00:01
0.200	2.0E-09	1.2E+06	00:01
0.300	5.2E-07	3.0E+08	00:01
0.400	3.0E-06	1.7E+09	00:02
0.500	5.8E-06	3.3E+09	00:02
0.600	7.6E-06	4.4E+09	00:03
0.700	8.4E-06	4.9E+09	00:04
0.800	8.6E-06	4.9E+09	00:04
0.900	8.3E-06	4.8E+09	00:05
1.000	7.9E-06	4.5E+09	00:05
2.000	4.0E-06	2.3E+09	00:11
4.000	1.7E-06	9.8E+08	00:23
6.000	1.1E-06	6.1E+08	00:34
8.000	7.9E-07	4.5E+08	00:46
10.000	6.3E-07	3.6E+08	00:58
20.000	3.4E-07	2.0E+08	01:56
40.000	2.1E-07	1.2E+08	03:53
60.000	1.6E-07	9.2E+07	05:49
80.000	1.3E-07	7.7E+07	07:46

Infant Scenario A Pasquill F.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 11:56 AM

Source Term : Infant Mixtures\Scenario A Infant.mix (Mixture Scale Factor = 2.7750E+13)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 3.51 m/s
Stability Class : F
Receptor Height : 0.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 8.68E-05 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 1.7 km
Maximum TEDE : 4.69E-06 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : Not Exceeded
Exceeds Middle Dose Out To : Not Exceeded
Exceeds Outer Dose Out To : 12 km

Note: Dose Results Include HTO Skin Absorption

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	0.0E+00	<00:01
0.200	0.0E+00	3.8E-07	<00:01
0.300	9.4E-13	5.4E+02	00:01
0.400	1.5E-09	8.9E+05	00:01
0.500	4.6E-08	2.6E+07	00:02
0.600	2.7E-07	1.6E+08	00:02
0.700	7.8E-07	4.5E+08	00:03
0.800	1.5E-06	8.5E+08	00:03
0.900	2.2E-06	1.3E+09	00:04
1.000	2.9E-06	1.7E+09	00:04
2.000	4.6E-06	2.6E+09	00:09
4.000	2.8E-06	1.6E+09	00:19
6.000	1.9E-06	1.1E+09	00:28
8.000	1.5E-06	8.5E+08	00:37
10.000	1.2E-06	7.0E+08	00:47
20.000	6.9E-07	4.0E+08	01:34
40.000	4.2E-07	2.4E+08	03:09
60.000	3.3E-07	1.9E+08	04:44
80.000	2.8E-07	1.6E+08	06:19

HotSpot Version 3.0.3 General Plume
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```
Source Term                 : Adult Mixtures\Scenario B Adult (Revised).mix
(Mixture Scale Factor = 2.5000E+14)
                              HTO (1 Bq / 25%) HT (3 Bq / 75%) Scenario B
Effective Release Height    : 28 m
Wind Speed (h=10 m)         : 2.00 m/s
Wind Direction              : 135.0 degrees  Wind from the SE
Wind Speed (h=H-eff)        : 2.15 m/s
Stability Class             : A
Receptor Height             : 1.5 m
Inversion Layer Height      : None
Sample Time                 : 10.000 min
Breathing Rate              : 2.66E-04 m3/sec
Distance Coordinates        : All distances are on the Plume Centerline

Maximum Dose Distance       : 0.098 km
Maximum TEDE                : 2.58E-04 Sv
Inner  Contour Dose         : 2.50E-05 Sv
Middle Contour Dose         : 1.00E-05 Sv
Outer  Contour Dose         : 1.00E-06 Sv
Exceeds Inner  Dose Out To  : 0.51 km
Exceeds Middle Dose Out To  : 0.83 km
Exceeds Outer  Dose Out To  : 2.7 km
```

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	2.8E-07	1.4E+08	<00:01
0.100	2.6E-04	1.3E+11	<00:01
0.200	1.3E-04	6.7E+10	00:01
0.300	6.8E-05	3.4E+10	00:02
0.400	4.0E-05	2.0E+10	00:03
0.500	2.6E-05	1.3E+10	00:03
0.600	1.9E-05	9.4E+09	00:04
0.700	1.4E-05	7.0E+09	00:05
0.800	1.1E-05	5.4E+09	00:06
0.900	8.6E-06	4.3E+09	00:06
1.000	7.0E-06	3.5E+09	00:07
2.000	1.8E-06	9.2E+08	00:15
4.000	5.0E-07	2.5E+08	00:31
6.000	2.4E-07	1.2E+08	00:46
8.000	1.4E-07	7.1E+07	01:02
10.000	9.5E-08	4.8E+07	01:17
20.000	2.9E-08	1.5E+07	02:35
40.000	9.4E-09	4.7E+06	05:10
60.000	4.9E-09	2.5E+06	07:45
80.000	3.1E-09	1.6E+06	10:20

HotSpot Version 3.0.3 General Plume
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Source Term : Adult Mixtures\Scenario B Adult (Revised).mix
(Mixture Scale Factor = 2.5000E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%) Scenario B
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.15 m/s
Stability Class : B
Receptor Height : 1.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.66E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.16 km
Maximum TEDE : 2.13E-04 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 0.78 km
Exceeds Middle Dose Out To : 1.3 km
Exceeds Outer Dose Out To : 4.3 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	2.2E-14	1.1E+01	<00:01
0.100	1.1E-04	5.5E+10	<00:01
0.200	2.0E-04	1.0E+11	00:01
0.300	1.3E-04	6.5E+10	00:02
0.400	8.3E-05	4.2E+10	00:03
0.500	5.7E-05	2.8E+10	00:03
0.600	4.1E-05	2.0E+10	00:04
0.700	3.1E-05	1.5E+10	00:05
0.800	2.4E-05	1.2E+10	00:06
0.900	1.9E-05	9.6E+09	00:06
1.000	1.6E-05	7.9E+09	00:07
2.000	4.2E-06	2.1E+09	00:15
4.000	1.1E-06	5.7E+08	00:31
6.000	5.4E-07	2.7E+08	00:46
8.000	3.2E-07	1.6E+08	01:02
10.000	2.2E-07	1.1E+08	01:17
20.000	6.7E-08	3.3E+07	02:35
40.000	2.2E-08	1.1E+07	05:10
60.000	1.1E-08	5.7E+06	07:45
80.000	7.2E-09	3.6E+06	10:20

Adult Scenario B Pasquill C REVISED.txt

HotSpot Version 3.0.3 General Plume
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```
Source Term                   : Adult Mixtures\Scenario B Adult (Revised).mix
(Mixture Scale Factor = 2.5000E+14)
                                HTO (1 Bq / 25%) HT (3 Bq / 75%) Scenario B
Effective Release Height      : 28 m
Wind Speed (h=10 m)           : 2.00 m/s
Wind Direction                : 135.0 degrees  Wind from the SE
Wind Speed (h=H-eff)          : 2.22 m/s
Stability Class               : C
Receptor Height               : 1.5 m
Inversion Layer Height        : None
Sample Time                   : 10.000 min
Breathing Rate                : 2.66E-04 m3/sec
Distance Coordinates          : All distances are on the Plume Centerline

Maximum Dose Distance         : 0.25 km
Maximum TEDE                  : 1.97E-04 Sv
Inner  Contour Dose           : 2.50E-05 Sv
Middle Contour Dose           : 1.00E-05 Sv
Outer  Contour Dose           : 1.00E-06 Sv
Exceeds Inner  Dose Out To    : 1.2 km
Exceeds Middle Dose Out To    : 2.0 km
Exceeds Outer  Dose Out To    : 8.5 km
```

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	5.3E-14	<00:01
0.100	8.4E-06	4.2E+09	<00:01
0.200	1.8E-04	8.8E+10	00:01
0.300	1.9E-04	9.3E+10	00:02
0.400	1.4E-04	7.2E+10	00:03
0.500	1.1E-04	5.4E+10	00:03
0.600	8.2E-05	4.1E+10	00:04
0.700	6.4E-05	3.2E+10	00:05
0.800	5.1E-05	2.6E+10	00:06
0.900	4.2E-05	2.1E+10	00:06
1.000	3.5E-05	1.7E+10	00:07
2.000	1.0E-05	5.2E+09	00:15
4.000	3.2E-06	1.6E+09	00:30
6.000	1.7E-06	8.5E+08	00:45
8.000	1.1E-06	5.5E+08	01:00
10.000	8.0E-07	4.0E+08	01:15
20.000	3.2E-07	1.6E+08	02:30
40.000	1.4E-07	6.8E+07	05:00
60.000	8.6E-08	4.3E+07	07:31
80.000	6.3E-08	3.2E+07	10:01

HotSpot Version 3.0.3 General Plume
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```
Source Term                   : Adult Mixtures\Scenario B Adult (Revised).mix
(Mixture Scale Factor = 2.5000E+14)
                                HTO (1 Bq / 25%) HT (3 Bq / 75%) Scenario B
Effective Release Height      : 28 m
Wind Speed (h=10 m)           : 2.00 m/s
Wind Direction                : 135.0 degrees  Wind from the SE
Wind Speed (h=H-eff)          : 2.33 m/s
Stability Class               : D
Receptor Height               : 1.5 m
Inversion Layer Height        : None
Sample Time                   : 10.000 min
Breathing Rate                : 2.66E-04 m3/sec
Distance Coordinates          : All distances are on the Plume Centerline

Maximum Dose Distance         : 0.39 km
Maximum TEDE                  : 1.57E-04 Sv
Inner  Contour Dose           : 2.50E-05 Sv
Middle Contour Dose           : 1.00E-05 Sv
Outer  Contour Dose           : 1.00E-06 Sv
Exceeds Inner  Dose Out To    : 2.2 km
Exceeds Middle Dose Out To    : 4.2 km
Exceeds Outer  Dose Out To    : 26 km
```

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	5.2E-08	2.6E+07	<00:01
0.200	5.3E-05	2.7E+10	00:01
0.300	1.4E-04	6.9E+10	00:02
0.400	1.6E-04	7.9E+10	00:02
0.500	1.5E-04	7.3E+10	00:03
0.600	1.3E-04	6.4E+10	00:04
0.700	1.1E-04	5.5E+10	00:05
0.800	9.4E-05	4.7E+10	00:05
0.900	8.2E-05	4.1E+10	00:06
1.000	7.2E-05	3.6E+10	00:07
2.000	2.8E-05	1.4E+10	00:14
4.000	1.1E-05	5.3E+09	00:28
6.000	6.1E-06	3.1E+09	00:42
8.000	4.2E-06	2.1E+09	00:57
10.000	3.2E-06	1.6E+09	01:11
20.000	1.4E-06	6.8E+08	02:22
40.000	6.2E-07	3.1E+08	04:45
60.000	4.0E-07	2.0E+08	07:08
80.000	2.9E-07	1.5E+08	09:31

Adult Scenario B Pasquill E REVISED.txt

HotSpot Version 3.0.3 General Plume
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Source Term : Adult Mixtures\Scenario B Adult (Revised).mix
(Mixture Scale Factor = 2.5000E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%) Scenario B
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.86 m/s
Stability Class : E
Receptor Height : 1.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.66E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.77 km
Maximum TEDE : 8.90E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 3.0 km
Exceeds Middle Dose Out To : 6.6 km
Exceeds Outer Dose Out To : 141 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	6.3E-06	<00:01
0.200	3.6E-08	1.8E+07	00:01
0.300	6.1E-06	3.1E+09	00:01
0.400	3.2E-05	1.6E+10	00:02
0.500	6.1E-05	3.1E+10	00:02
0.600	8.0E-05	4.0E+10	00:03
0.700	8.8E-05	4.4E+10	00:04
0.800	8.9E-05	4.5E+10	00:04
0.900	8.6E-05	4.3E+10	00:05
1.000	8.1E-05	4.1E+10	00:05
2.000	4.1E-05	2.1E+10	00:11
4.000	1.8E-05	8.8E+09	00:23
6.000	1.1E-05	5.5E+09	00:34
8.000	8.1E-06	4.1E+09	00:46
10.000	6.5E-06	3.3E+09	00:58
20.000	3.5E-06	1.8E+09	01:56
40.000	2.1E-06	1.1E+09	03:53
60.000	1.6E-06	8.3E+08	05:49
80.000	1.4E-06	6.9E+08	07:46

HotSpot Version 3.0.3 General Plume
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Source Term : Adult Mixtures\Scenario B Adult (Revised).mix
(Mixture Scale Factor = 2.5000E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%) Scenario B
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 3.51 m/s
Stability Class : F
Receptor Height : 1.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.66E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 1.7 km
Maximum TEDE : 4.88E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 4.7 km
Exceeds Middle Dose Out To : 13 km
Exceeds Outer Dose Out To : > 200 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	0.0E+00	<00:01
0.200	0.0E+00	6.3E-05	<00:01
0.300	3.2E-11	1.6E+04	00:01
0.400	2.7E-08	1.4E+07	00:01
0.500	6.2E-07	3.1E+08	00:02
0.600	3.3E-06	1.7E+09	00:02
0.700	8.8E-06	4.4E+09	00:03
0.800	1.6E-05	8.1E+09	00:03
0.900	2.4E-05	1.2E+10	00:04
1.000	3.1E-05	1.6E+10	00:04
2.000	4.7E-05	2.4E+10	00:09
4.000	2.9E-05	1.5E+10	00:19
6.000	2.0E-05	1.0E+10	00:28
8.000	1.5E-05	7.7E+09	00:37
10.000	1.3E-05	6.3E+09	00:47
20.000	7.1E-06	3.6E+09	01:34
40.000	4.4E-06	2.2E+09	03:09
60.000	3.4E-06	1.7E+09	04:44
80.000	2.9E-06	1.4E+09	06:19

HotSpot Version 3.0.3 General Plume
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```
Source Term                  : Child Mixtures\Scenario B Child (Revised).mix
(Mixture Scale Factor = 2.5000E+14)
                               HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height     : 28 m
Wind Speed (h=10 m)          : 2.00 m/s
Wind Direction               : 135.0 degrees  Wind from the SE
Wind Speed (h=H-eff)         : 2.15 m/s
Stability Class              : A
Receptor Height              : 1.0 m
Inversion Layer Height       : None
Sample Time                  : 10.000 min
Breathing Rate               : 2.48E-04 m3/sec
Distance Coordinates         : All distances are on the Plume Centerline

Maximum Dose Distance        : 0.099 km
Maximum TEDE                 : 3.04E-04 Sv
Inner  Contour Dose          : 2.50E-05 Sv
Middle Contour Dose          : 1.00E-05 Sv
Outer  Contour Dose          : 1.00E-06 Sv
Exceeds Inner  Dose Out To   : 0.56 km
Exceeds Middle Dose Out To   : 0.90 km
Exceeds Outer  Dose Out To   : 3.0 km
```

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	2.5E-07	1.1E+08	<00:01
0.100	3.0E-04	1.3E+11	<00:01
0.200	1.6E-04	6.7E+10	00:01
0.300	8.0E-05	3.4E+10	00:02
0.400	4.8E-05	2.0E+10	00:03
0.500	3.1E-05	1.3E+10	00:03
0.600	2.2E-05	9.4E+09	00:04
0.700	1.6E-05	7.0E+09	00:05
0.800	1.3E-05	5.4E+09	00:06
0.900	1.0E-05	4.3E+09	00:06
1.000	8.2E-06	3.5E+09	00:07
2.000	2.2E-06	9.2E+08	00:15
4.000	5.9E-07	2.5E+08	00:31
6.000	2.8E-07	1.2E+08	00:46
8.000	1.7E-07	7.1E+07	01:02
10.000	1.1E-07	4.8E+07	01:17
20.000	3.4E-08	1.5E+07	02:35
40.000	1.1E-08	4.7E+06	05:10
60.000	5.8E-09	2.5E+06	07:45
80.000	3.7E-09	1.6E+06	10:20

```
HotSpot  Version 3.0.3 General Plume
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Source Term                  : Child Mixtures\Scenario B Child (Revised).mix
(Mixture Scale Factor = 2.5000E+14)
                               HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height     : 28 m
Wind Speed (h=10 m)          : 2.00 m/s
Wind Direction               : 135.0 degrees  Wind from the SE
Wind Speed (h=H-eff)         : 2.15 m/s
Stability Class              : B
Receptor Height              : 1.0 m
Inversion Layer Height       : None
Sample Time                  : 10.000 min
Breathing Rate               : 2.48E-04 m3/sec
Distance Coordinates         : All distances are on the Plume Centerline

Maximum Dose Distance        : 0.16 km
Maximum TEDE                 : 2.52E-04 Sv
Inner  Contour Dose          : 2.50E-05 Sv
Middle Contour Dose          : 1.00E-05 Sv
Outer  Contour Dose          : 1.00E-06 Sv
Exceeds Inner  Dose Out To   : 0.85 km
Exceeds Middle Dose Out To   : 1.4 km
Exceeds Outer  Dose Out To   : 4.7 km
```

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	9.5E-15	4.0E+00	<00:01
0.100	1.3E-04	5.4E+10	<00:01
0.200	2.3E-04	1.0E+11	00:01
0.300	1.5E-04	6.5E+10	00:02
0.400	9.8E-05	4.2E+10	00:03
0.500	6.7E-05	2.8E+10	00:03
0.600	4.8E-05	2.0E+10	00:04
0.700	3.6E-05	1.5E+10	00:05
0.800	2.8E-05	1.2E+10	00:06
0.900	2.3E-05	9.6E+09	00:06
1.000	1.9E-05	7.9E+09	00:07
2.000	4.9E-06	2.1E+09	00:15
4.000	1.3E-06	5.7E+08	00:31
6.000	6.4E-07	2.7E+08	00:46
8.000	3.8E-07	1.6E+08	01:02
10.000	2.6E-07	1.1E+08	01:17
20.000	7.9E-08	3.3E+07	02:35
40.000	2.5E-08	1.1E+07	05:10
60.000	1.3E-08	5.7E+06	07:45
80.000	8.5E-09	3.6E+06	10:20

```
HotSpot  Version 3.0.3 General Plume
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Source Term                  : Child Mixtures\Scenario B Child (Revised).mix
(Mixture Scale Factor = 2.5000E+14)
                               HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height     : 28 m
Wind Speed (h=10 m)          : 2.00 m/s
Wind Direction               : 135.0 degrees  Wind from the SE
Wind Speed (h=H-eff)         : 2.22 m/s
Stability Class              : C
Receptor Height              : 1.0 m
Inversion Layer Height       : None
Sample Time                  : 10.000 min
Breathing Rate               : 2.48E-04 m3/sec
Distance Coordinates         : All distances are on the Plume Centerline

Maximum Dose Distance        : 0.25 km
Maximum TEDE                 : 2.32E-04 Sv
Inner  Contour Dose          : 2.50E-05 Sv
Middle Contour Dose          : 1.00E-05 Sv
Outer  Contour Dose          : 1.00E-06 Sv
Exceeds Inner  Dose Out To   : 1.3 km
Exceeds Middle Dose Out To   : 2.2 km
Exceeds Outer  Dose Out To   : 9.5 km
```

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	5.2E-15	<00:01
0.100	9.0E-06	3.8E+09	<00:01
0.200	2.1E-04	8.8E+10	00:01
0.300	2.2E-04	9.3E+10	00:02
0.400	1.7E-04	7.2E+10	00:03
0.500	1.3E-04	5.4E+10	00:03
0.600	9.6E-05	4.1E+10	00:04
0.700	7.5E-05	3.2E+10	00:05
0.800	6.0E-05	2.6E+10	00:06
0.900	4.9E-05	2.1E+10	00:06
1.000	4.1E-05	1.7E+10	00:07
2.000	1.2E-05	5.2E+09	00:15
4.000	3.8E-06	1.6E+09	00:30
6.000	2.0E-06	8.5E+08	00:45
8.000	1.3E-06	5.5E+08	01:00
10.000	9.4E-07	4.0E+08	01:15
20.000	3.7E-07	1.6E+08	02:30
40.000	1.6E-07	6.8E+07	05:00
60.000	1.0E-07	4.3E+07	07:31
80.000	7.4E-08	3.2E+07	10:01

HotSpot Version 3.0.3 General Plume
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Source Term : Child Mixtures\Scenario B Child (Revised).mix
(Mixture Scale Factor = 2.5000E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.33 m/s
Stability Class : D
Receptor Height : 1.0 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.48E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.39 km
Maximum TEDE : 1.85E-04 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 2.4 km
Exceeds Middle Dose Out To : 4.7 km
Exceeds Outer Dose Out To : 30 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	4.4E-08	1.9E+07	<00:01
0.200	6.1E-05	2.6E+10	00:01
0.300	1.6E-04	6.9E+10	00:02
0.400	1.9E-04	7.9E+10	00:02
0.500	1.7E-04	7.3E+10	00:03
0.600	1.5E-04	6.4E+10	00:04
0.700	1.3E-04	5.5E+10	00:05
0.800	1.1E-04	4.7E+10	00:05
0.900	9.7E-05	4.1E+10	00:06
1.000	8.5E-05	3.6E+10	00:07
2.000	3.3E-05	1.4E+10	00:14
4.000	1.3E-05	5.3E+09	00:28
6.000	7.2E-06	3.1E+09	00:42
8.000	5.0E-06	2.1E+09	00:57
10.000	3.7E-06	1.6E+09	01:11
20.000	1.6E-06	6.8E+08	02:22
40.000	7.3E-07	3.1E+08	04:45
60.000	4.7E-07	2.0E+08	07:08
80.000	3.4E-07	1.5E+08	09:31

HotSpot Version 3.0.3 General Plume
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Source Term : Child Mixtures\Scenario B Child (Revised).mix
(Mixture Scale Factor = 2.5000E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.86 m/s
Stability Class : E
Receptor Height : 1.0 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.48E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.77 km
Maximum TEDE : 1.05E-04 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 3.4 km
Exceeds Middle Dose Out To : 7.6 km
Exceeds Outer Dose Out To : 192 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	1.3E-06	<00:01
0.200	3.1E-08	1.3E+07	00:01
0.300	6.7E-06	2.8E+09	00:01
0.400	3.7E-05	1.6E+10	00:02
0.500	7.2E-05	3.0E+10	00:02
0.600	9.4E-05	4.0E+10	00:03
0.700	1.0E-04	4.4E+10	00:04
0.800	1.0E-04	4.4E+10	00:04
0.900	1.0E-04	4.3E+10	00:05
1.000	9.6E-05	4.1E+10	00:05
2.000	4.8E-05	2.1E+10	00:11
4.000	2.1E-05	8.8E+09	00:23
6.000	1.3E-05	5.5E+09	00:34
8.000	9.6E-06	4.1E+09	00:46
10.000	7.7E-06	3.3E+09	00:58
20.000	4.2E-06	1.8E+09	01:56
40.000	2.5E-06	1.1E+09	03:53
60.000	1.9E-06	8.3E+08	05:49
80.000	1.6E-06	6.9E+08	07:46

HotSpot Version 3.0.3 General Plume
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Source Term : Child Mixtures\Scenario B Child (Revised).mix
(Mixture Scale Factor = 2.5000E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 3.51 m/s
Stability Class : F
Receptor Height : 1.0 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.48E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 1.7 km
Maximum TEDE : 5.75E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 5.6 km
Exceeds Middle Dose Out To : 16 km
Exceeds Outer Dose Out To : > 200 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	0.0E+00	<00:01
0.200	0.0E+00	1.5E-05	<00:01
0.300	2.0E-11	8.3E+03	00:01
0.400	2.4E-08	1.0E+07	00:01
0.500	6.2E-07	2.6E+08	00:02
0.600	3.6E-06	1.5E+09	00:02
0.700	9.8E-06	4.2E+09	00:03
0.800	1.8E-05	7.8E+09	00:03
0.900	2.8E-05	1.2E+10	00:04
1.000	3.6E-05	1.5E+10	00:04
2.000	5.6E-05	2.4E+10	00:09
4.000	3.4E-05	1.5E+10	00:19
6.000	2.4E-05	1.0E+10	00:28
8.000	1.8E-05	7.7E+09	00:37
10.000	1.5E-05	6.3E+09	00:47
20.000	8.4E-06	3.6E+09	01:34
40.000	5.2E-06	2.2E+09	03:09
60.000	4.0E-06	1.7E+09	04:44
80.000	3.4E-06	1.4E+09	06:19

HotSpot Version 3.0.3 General Plume
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Source Term : Infant Mixtures\Scenario B Infant (Revised).mix
(Mixture Scale Factor = 2.5000E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.15 m/s
Stability Class : A
Receptor Height : 0.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 8.68E-05 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.099 km
Maximum TEDE : 2.24E-04 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 0.47 km
Exceeds Middle Dose Out To : 0.77 km
Exceeds Outer Dose Out To : 2.6 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	1.5E-07	8.8E+07	<00:01
0.100	2.2E-04	1.3E+11	<00:01
0.200	1.2E-04	6.7E+10	00:01
0.300	5.9E-05	3.4E+10	00:02
0.400	3.5E-05	2.0E+10	00:03
0.500	2.3E-05	1.3E+10	00:03
0.600	1.6E-05	9.4E+09	00:04
0.700	1.2E-05	7.0E+09	00:05
0.800	9.4E-06	5.4E+09	00:06
0.900	7.4E-06	4.3E+09	00:06
1.000	6.1E-06	3.5E+09	00:07
2.000	1.6E-06	9.2E+08	00:15
4.000	4.3E-07	2.5E+08	00:31
6.000	2.1E-07	1.2E+08	00:46
8.000	1.2E-07	7.1E+07	01:02
10.000	8.3E-08	4.8E+07	01:17
20.000	2.5E-08	1.5E+07	02:35
40.000	8.2E-09	4.7E+06	05:10
60.000	4.3E-09	2.5E+06	07:45
80.000	2.7E-09	1.6E+06	10:20

Infant Scenario B Pasquill B REVISED.txt

HotSpot Version 3.0.3 General Plume
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```
Source Term                   : Infant Mixtures\Scenario B Infant (Revised).mix
(Mixture Scale Factor = 2.5000E+14)
                                HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height      : 28 m
Wind Speed (h=10 m)           : 2.00 m/s
Wind Direction                : 135.0 degrees  Wind from the SE
Wind Speed (h=H-eff)          : 2.15 m/s
Stability Class               : B
Receptor Height               : 0.5 m
Inversion Layer Height        : None
Sample Time                   : 10.000 min
Breathing Rate                : 8.68E-05 m3/sec
Distance Coordinates          : All distances are on the Plume Centerline

Maximum Dose Distance         : 0.16 km
Maximum TEDE                  : 1.85E-04 Sv
Inner  Contour Dose           : 2.50E-05 Sv
Middle Contour Dose           : 1.00E-05 Sv
Outer  Contour Dose           : 1.00E-06 Sv
Exceeds Inner  Dose Out To    : 0.72 km
Exceeds Middle Dose Out To    : 1.2 km
Exceeds Outer  Dose Out To    : 4.0 km
```

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	2.7E-15	1.6E+00	<00:01
0.100	9.2E-05	5.3E+10	<00:01
0.200	1.7E-04	1.0E+11	00:01
0.300	1.1E-04	6.5E+10	00:02
0.400	7.2E-05	4.2E+10	00:03
0.500	4.9E-05	2.8E+10	00:03
0.600	3.6E-05	2.0E+10	00:04
0.700	2.7E-05	1.5E+10	00:05
0.800	2.1E-05	1.2E+10	00:06
0.900	1.7E-05	9.6E+09	00:06
1.000	1.4E-05	7.9E+09	00:07
2.000	3.6E-06	2.1E+09	00:15
4.000	9.9E-07	5.7E+08	00:31
6.000	4.7E-07	2.7E+08	00:46
8.000	2.8E-07	1.6E+08	01:02
10.000	1.9E-07	1.1E+08	01:17
20.000	5.8E-08	3.3E+07	02:35
40.000	1.9E-08	1.1E+07	05:10
60.000	9.8E-09	5.7E+06	07:45
80.000	6.3E-09	3.6E+06	10:20

Infant Scenario B Pasquill C REVISED.txt

HotSpot Version 3.0.3 General Plume
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```
Source Term                  : Infant Mixtures\Scenario B Infant (Revised).mix
(Mixture Scale Factor = 2.5000E+14)
                               HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height     : 28 m
Wind Speed (h=10 m)          : 2.00 m/s
Wind Direction               : 135.0 degrees  Wind from the SE
Wind Speed (h=H-eff)         : 2.22 m/s
Stability Class              : C
Receptor Height              : 0.5 m
Inversion Layer Height       : None
Sample Time                  : 10.000 min
Breathing Rate               : 8.68E-05 m3/sec
Distance Coordinates         : All distances are on the Plume Centerline

Maximum Dose Distance        : 0.25 km
Maximum TEDE                 : 1.71E-04 Sv
Inner  Contour Dose          : 2.50E-05 Sv
Middle Contour Dose          : 1.00E-05 Sv
Outer  Contour Dose          : 1.00E-06 Sv
Exceeds Inner  Dose Out To   : 1.1 km
Exceeds Middle Dose Out To   : 1.9 km
Exceeds Outer  Dose Out To   : 7.7 km
```

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	5.0E-16	<00:01
0.100	6.2E-06	3.6E+09	<00:01
0.200	1.5E-04	8.8E+10	00:01
0.300	1.6E-04	9.3E+10	00:02
0.400	1.2E-04	7.2E+10	00:03
0.500	9.3E-05	5.4E+10	00:03
0.600	7.1E-05	4.1E+10	00:04
0.700	5.6E-05	3.2E+10	00:05
0.800	4.4E-05	2.6E+10	00:06
0.900	3.6E-05	2.1E+10	00:06
1.000	3.0E-05	1.7E+10	00:07
2.000	9.0E-06	5.2E+09	00:15
4.000	2.8E-06	1.6E+09	00:30
6.000	1.5E-06	8.5E+08	00:45
8.000	9.6E-07	5.5E+08	01:00
10.000	6.9E-07	4.0E+08	01:15
20.000	2.7E-07	1.6E+08	02:30
40.000	1.2E-07	6.8E+07	05:00
60.000	7.5E-08	4.3E+07	07:31
80.000	5.5E-08	3.2E+07	10:01

Infant Scenario B Pasquill D REVISED.txt

HotSpot Version 3.0.3 General Plume
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Source Term : Infant Mixtures\Scenario B Infant (Revised).mix
(Mixture Scale Factor = 2.5000E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.33 m/s
Stability Class : D
Receptor Height : 0.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 8.68E-05 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.39 km
Maximum TEDE : 1.36E-04 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 2.0 km
Exceeds Middle Dose Out To : 3.8 km
Exceeds Outer Dose Out To : 23 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	2.5E-08	1.5E+07	<00:01
0.200	4.4E-05	2.5E+10	00:01
0.300	1.2E-04	6.9E+10	00:02
0.400	1.4E-04	7.8E+10	00:02
0.500	1.3E-04	7.3E+10	00:03
0.600	1.1E-04	6.4E+10	00:04
0.700	9.5E-05	5.5E+10	00:05
0.800	8.2E-05	4.7E+10	00:05
0.900	7.1E-05	4.1E+10	00:06
1.000	6.3E-05	3.6E+10	00:07
2.000	2.4E-05	1.4E+10	00:14
4.000	9.2E-06	5.3E+09	00:28
6.000	5.3E-06	3.1E+09	00:42
8.000	3.7E-06	2.1E+09	00:57
10.000	2.7E-06	1.6E+09	01:11
20.000	1.2E-06	6.8E+08	02:22
40.000	5.4E-07	3.1E+08	04:45
60.000	3.5E-07	2.0E+08	07:08
80.000	2.5E-07	1.5E+08	09:31

Infant Scenario B Pasquill E REVISED.txt
HotSpot Version 3.0.3 General Plume
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Source Term : Infant Mixtures\Scenario B Infant (Revised).mix
(Mixture Scale Factor = 2.5000E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.86 m/s
Stability Class : E
Receptor Height : 0.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 8.68E-05 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.77 km
Maximum TEDE : 7.72E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 2.7 km
Exceeds Middle Dose Out To : 5.8 km
Exceeds Outer Dose Out To : 110 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	2.8E-07	<00:01
0.200	1.8E-08	1.0E+07	00:01
0.300	4.6E-06	2.7E+09	00:01
0.400	2.7E-05	1.5E+10	00:02
0.500	5.2E-05	3.0E+10	00:02
0.600	6.9E-05	4.0E+10	00:03
0.700	7.6E-05	4.4E+10	00:04
0.800	7.7E-05	4.4E+10	00:04
0.900	7.5E-05	4.3E+10	00:05
1.000	7.1E-05	4.1E+10	00:05
2.000	3.6E-05	2.1E+10	00:11
4.000	1.5E-05	8.8E+09	00:23
6.000	9.6E-06	5.5E+09	00:34
8.000	7.1E-06	4.1E+09	00:46
10.000	5.7E-06	3.3E+09	00:58
20.000	3.1E-06	1.8E+09	01:56
40.000	1.9E-06	1.1E+09	03:53
60.000	1.4E-06	8.3E+08	05:49
80.000	1.2E-06	6.9E+08	07:46

Infant Scenario B Pasquill F REVISED.txt
HotSpot Version 3.0.3 General Plume
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Source Term : Infant Mixtures\Scenario B Infant (Revised).mix
(Mixture Scale Factor = 2.5000E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 3.51 m/s
Stability Class : F
Receptor Height : 0.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 8.68E-05 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 1.7 km
Maximum TEDE : 4.23E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 4.0 km
Exceeds Middle Dose Out To : 11 km
Exceeds Outer Dose Out To : > 200 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	0.0E+00	<00:01
0.200	0.0E+00	3.5E-06	<00:01
0.300	8.5E-12	4.9E+03	00:01
0.400	1.4E-08	8.0E+06	00:01
0.500	4.1E-07	2.4E+08	00:02
0.600	2.5E-06	1.4E+09	00:02
0.700	7.0E-06	4.0E+09	00:03
0.800	1.3E-05	7.6E+09	00:03
0.900	2.0E-05	1.2E+10	00:04
1.000	2.6E-05	1.5E+10	00:04
2.000	4.1E-05	2.4E+10	00:09
4.000	2.5E-05	1.5E+10	00:19
6.000	1.7E-05	1.0E+10	00:28
8.000	1.3E-05	7.7E+09	00:37
10.000	1.1E-05	6.3E+09	00:47
20.000	6.2E-06	3.6E+09	01:34
40.000	3.8E-06	2.2E+09	03:09
60.000	3.0E-06	1.7E+09	04:44
80.000	2.5E-06	1.4E+09	06:19

Adult Scenario C Pasquill A.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 01:25 PM

Source Term : Adult Mixtures\Scenario C Adult.mix (Mixture
Scale Factor = 9.0000E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 1.00 m
Wind Speed (h=10 m) : 50.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 44.67 m/s
Stability Class : A
Receptor Height : 1.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.66E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.010 km
Maximum TEDE : 8.30E-03 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 0.22 km
Exceeds Middle Dose Out To : 0.34 km
Exceeds Outer Dose Out To : 1.1 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	1.2E-03	6.2E+11	<00:01
0.100	1.2E-04	5.8E+10	<00:01
0.200	2.9E-05	1.5E+10	<00:01
0.300	1.3E-05	6.6E+09	<00:01
0.400	7.4E-06	3.7E+09	<00:01
0.500	4.8E-06	2.4E+09	<00:01
0.600	3.3E-06	1.7E+09	<00:01
0.700	2.5E-06	1.2E+09	<00:01
0.800	1.9E-06	9.5E+08	<00:01
0.900	1.5E-06	7.5E+08	<00:01
1.000	1.2E-06	6.1E+08	<00:01
2.000	3.2E-07	1.6E+08	<00:01
4.000	8.6E-08	4.3E+07	00:01
6.000	4.1E-08	2.0E+07	00:02
8.000	2.4E-08	1.2E+07	00:02
10.000	1.6E-08	8.2E+06	00:03
20.000	5.0E-09	2.5E+06	00:07
40.000	1.6E-09	8.1E+05	00:14
60.000	8.5E-10	4.3E+05	00:22
80.000	5.5E-10	2.7E+05	00:29

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 03:04 PM

Source Term : Child Mixtures\Scenario C Child.mix (Mixture
Scale Factor = 9.0000E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 1.00 m
Wind Speed (h=10 m) : 50.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 44.67 m/s
Stability Class : A
Receptor Height : 1.0 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.48E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.010 km
Maximum TEDE : 0.011 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 0.23 km
Exceeds Middle Dose Out To : 0.37 km
Exceeds Outer Dose Out To : 1.2 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	1.5E-03	6.3E+11	<00:01
0.100	1.4E-04	5.8E+10	<00:01
0.200	3.5E-05	1.5E+10	<00:01
0.300	1.5E-05	6.6E+09	<00:01
0.400	8.8E-06	3.7E+09	<00:01
0.500	5.6E-06	2.4E+09	<00:01
0.600	3.9E-06	1.7E+09	<00:01
0.700	2.9E-06	1.2E+09	<00:01
0.800	2.2E-06	9.5E+08	<00:01
0.900	1.8E-06	7.5E+08	<00:01
1.000	1.4E-06	6.1E+08	<00:01
2.000	3.8E-07	1.6E+08	<00:01
4.000	1.0E-07	4.3E+07	00:01
6.000	4.8E-08	2.0E+07	00:02
8.000	2.9E-08	1.2E+07	00:02
10.000	1.9E-08	8.2E+06	00:03
20.000	5.9E-09	2.5E+06	00:07
40.000	1.9E-09	8.1E+05	00:14
60.000	1.0E-09	4.3E+05	00:22
80.000	6.4E-10	2.7E+05	00:29

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 03:09 PM

Source Term : Infant Mixtures\Scenario C Infant.mix (Mixture Scale Factor = 9.0000E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 1.00 m
Wind Speed (h=10 m) : 50.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 44.67 m/s
Stability Class : A
Receptor Height : 0.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 8.68E-05 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.010 km
Maximum TEDE : 8.73E-03 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 0.20 km
Exceeds Middle Dose Out To : 0.32 km
Exceeds Outer Dose Out To : 1.0 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	1.1E-03	6.4E+11	<00:01
0.100	1.0E-04	5.8E+10	<00:01
0.200	2.6E-05	1.5E+10	<00:01
0.300	1.1E-05	6.6E+09	<00:01
0.400	6.5E-06	3.7E+09	<00:01
0.500	4.1E-06	2.4E+09	<00:01
0.600	2.9E-06	1.7E+09	<00:01
0.700	2.1E-06	1.2E+09	<00:01
0.800	1.6E-06	9.5E+08	<00:01
0.900	1.3E-06	7.5E+08	<00:01
1.000	1.1E-06	6.1E+08	<00:01
2.000	2.8E-07	1.6E+08	<00:01
4.000	7.5E-08	4.3E+07	00:01
6.000	3.6E-08	2.0E+07	00:02
8.000	2.1E-08	1.2E+07	00:02
10.000	1.4E-08	8.2E+06	00:03
20.000	4.4E-09	2.5E+06	00:07
40.000	1.4E-09	8.1E+05	00:14
60.000	7.4E-10	4.3E+05	00:22
80.000	4.7E-10	2.7E+05	00:29

Adult Scenario D Pasquill A.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 05:50 PM

Source Term : Adult Mixtures\Scenario D Adult.mix (Mixture Scale Factor = 1.4823E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.15 m/s
Stability Class : A
Receptor Height : 1.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.66E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.098 km
Maximum TEDE : 1.53E-04 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 0.39 km
Exceeds Middle Dose Out To : 0.63 km
Exceeds Outer Dose Out To : 2.1 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	1.6E-07	8.2E+07	<00:01
0.100	1.5E-04	7.7E+10	<00:01
0.200	7.9E-05	4.0E+10	00:01
0.300	4.0E-05	2.0E+10	00:02
0.400	2.4E-05	1.2E+10	00:03
0.500	1.6E-05	7.9E+09	00:03
0.600	1.1E-05	5.6E+09	00:04
0.700	8.2E-06	4.1E+09	00:05
0.800	6.4E-06	3.2E+09	00:06
0.900	5.1E-06	2.5E+09	00:06
1.000	4.1E-06	2.1E+09	00:07
2.000	1.1E-06	5.5E+08	00:15
4.000	2.9E-07	1.5E+08	00:31
6.000	1.4E-07	7.0E+07	00:46
8.000	8.4E-08	4.2E+07	01:02
10.000	5.6E-08	2.8E+07	01:17
20.000	1.7E-08	8.6E+06	02:35
40.000	5.6E-09	2.8E+06	05:10
60.000	2.9E-09	1.5E+06	07:45
80.000	1.9E-09	9.4E+05	10:20

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 05:52 PM

Source Term : Adult Mixtures\Scenario D Adult.mix (Mixture Scale Factor = 1.4823E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.15 m/s
Stability Class : B
Receptor Height : 1.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.66E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.16 km
Maximum TEDE : 1.27E-04 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 0.59 km
Exceeds Middle Dose Out To : 0.96 km
Exceeds Outer Dose Out To : 3.2 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	1.3E-14	6.6E+00	<00:01
0.100	6.5E-05	3.2E+10	<00:01
0.200	1.2E-04	5.9E+10	00:01
0.300	7.6E-05	3.8E+10	00:02
0.400	4.9E-05	2.5E+10	00:03
0.500	3.4E-05	1.7E+10	00:03
0.600	2.4E-05	1.2E+10	00:04
0.700	1.8E-05	9.1E+09	00:05
0.800	1.4E-05	7.1E+09	00:06
0.900	1.1E-05	5.7E+09	00:06
1.000	9.3E-06	4.7E+09	00:07
2.000	2.5E-06	1.2E+09	00:15
4.000	6.7E-07	3.4E+08	00:31
6.000	3.2E-07	1.6E+08	00:46
8.000	1.9E-07	9.6E+07	01:02
10.000	1.3E-07	6.5E+07	01:17
20.000	4.0E-08	2.0E+07	02:35
40.000	1.3E-08	6.4E+06	05:10
60.000	6.7E-09	3.4E+06	07:45
80.000	4.3E-09	2.1E+06	10:20

Adult Scenario D Pasquill C.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 05:53 PM

Source Term : Adult Mixtures\Scenario D Adult.mix (Mixture Scale Factor = 1.4823E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.22 m/s
Stability Class : C
Receptor Height : 1.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.66E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.25 km
Maximum TEDE : 1.17E-04 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 0.89 km
Exceeds Middle Dose Out To : 1.5 km
Exceeds Outer Dose Out To : 6.0 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	3.2E-14	<00:01
0.100	5.0E-06	2.5E+09	<00:01
0.200	1.0E-04	5.2E+10	00:01
0.300	1.1E-04	5.5E+10	00:02
0.400	8.5E-05	4.3E+10	00:03
0.500	6.4E-05	3.2E+10	00:03
0.600	4.8E-05	2.4E+10	00:04
0.700	3.8E-05	1.9E+10	00:05
0.800	3.0E-05	1.5E+10	00:06
0.900	2.5E-05	1.2E+10	00:06
1.000	2.1E-05	1.0E+10	00:07
2.000	6.1E-06	3.1E+09	00:15
4.000	1.9E-06	9.5E+08	00:30
6.000	1.0E-06	5.0E+08	00:45
8.000	6.5E-07	3.3E+08	01:00
10.000	4.7E-07	2.4E+08	01:15
20.000	1.9E-07	9.4E+07	02:30
40.000	8.1E-08	4.1E+07	05:00
60.000	5.1E-08	2.6E+07	07:31
80.000	3.7E-08	1.9E+07	10:01

Adult Scenario D Pasquill D.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 05:54 PM

Source Term : Adult Mixtures\Scenario D Adult.mix (Mixture Scale Factor = 1.4823E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.33 m/s
Stability Class : D
Receptor Height : 1.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.66E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.39 km
Maximum TEDE : 9.31E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 1.5 km
Exceeds Middle Dose Out To : 2.8 km
Exceeds Outer Dose Out To : 17 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	3.1E-08	1.5E+07	<00:01
0.200	3.1E-05	1.6E+10	00:01
0.300	8.2E-05	4.1E+10	00:02
0.400	9.3E-05	4.7E+10	00:02
0.500	8.6E-05	4.3E+10	00:03
0.600	7.5E-05	3.8E+10	00:04
0.700	6.5E-05	3.3E+10	00:05
0.800	5.6E-05	2.8E+10	00:05
0.900	4.9E-05	2.4E+10	00:06
1.000	4.3E-05	2.1E+10	00:07
2.000	1.7E-05	8.3E+09	00:14
4.000	6.3E-06	3.1E+09	00:28
6.000	3.6E-06	1.8E+09	00:42
8.000	2.5E-06	1.2E+09	00:57
10.000	1.9E-06	9.4E+08	01:11
20.000	8.0E-07	4.0E+08	02:22
40.000	3.7E-07	1.8E+08	04:45
60.000	2.4E-07	1.2E+08	07:08
80.000	1.7E-07	8.7E+07	09:31

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 05:54 PM

Source Term : Adult Mixtures\Scenario D Adult.mix (Mixture Scale Factor = 1.4823E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.86 m/s
Stability Class : E
Receptor Height : 1.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.66E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.77 km
Maximum TEDE : 5.28E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 2.0 km
Exceeds Middle Dose Out To : 4.1 km
Exceeds Outer Dose Out To : 57 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	3.7E-06	<00:01
0.200	2.2E-08	1.1E+07	00:01
0.300	3.6E-06	1.8E+09	00:01
0.400	1.9E-05	9.5E+09	00:02
0.500	3.6E-05	1.8E+10	00:02
0.600	4.7E-05	2.4E+10	00:03
0.700	5.2E-05	2.6E+10	00:04
0.800	5.3E-05	2.6E+10	00:04
0.900	5.1E-05	2.6E+10	00:05
1.000	4.8E-05	2.4E+10	00:05
2.000	2.4E-05	1.2E+10	00:11
4.000	1.0E-05	5.2E+09	00:23
6.000	6.6E-06	3.3E+09	00:34
8.000	4.8E-06	2.4E+09	00:46
10.000	3.9E-06	1.9E+09	00:58
20.000	2.1E-06	1.1E+09	01:56
40.000	1.3E-06	6.4E+08	03:53
60.000	9.8E-07	4.9E+08	05:49
80.000	8.2E-07	4.1E+08	07:46

Adult Scenario D Pasquill F.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 05:56 PM

Source Term : Adult Mixtures\Scenario D Adult.mix (Mixture Scale Factor = 1.4823E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 3.51 m/s
Stability Class : F
Receptor Height : 1.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.66E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 1.7 km
Maximum TEDE : 2.89E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 2.5 km
Exceeds Middle Dose Out To : 7.2 km
Exceeds Outer Dose Out To : > 200 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	0.0E+00	<00:01
0.200	0.0E+00	3.7E-05	<00:01
0.300	1.9E-11	9.4E+03	00:01
0.400	1.6E-08	8.1E+06	00:01
0.500	3.7E-07	1.8E+08	00:02
0.600	2.0E-06	9.8E+08	00:02
0.700	5.2E-06	2.6E+09	00:03
0.800	9.6E-06	4.8E+09	00:03
0.900	1.4E-05	7.1E+09	00:04
1.000	1.8E-05	9.2E+09	00:04
2.000	2.8E-05	1.4E+10	00:09
4.000	1.7E-05	8.7E+09	00:19
6.000	1.2E-05	5.9E+09	00:28
8.000	9.1E-06	4.6E+09	00:37
10.000	7.4E-06	3.7E+09	00:47
20.000	4.2E-06	2.1E+09	01:34
40.000	2.6E-06	1.3E+09	03:09
60.000	2.0E-06	1.0E+09	04:44
80.000	1.7E-06	8.5E+08	06:19

Child Scenario D Pasquill A.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 05:58 PM

```
Source Term                   : Child Mixtures\Scenario D Child.mix (Mixture
Scale Factor = 1.4823E+14)
                                HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height      : 28 m
Wind Speed (h=10 m)           : 2.00 m/s
Wind Direction                : 135.0 degrees  Wind from the SE
Wind Speed (h=H-eff)          : 2.15 m/s
Stability Class               : A
Receptor Height               : 1.0 m
Inversion Layer Height        : None
Sample Time                   : 10.000 min
Breathing Rate                : 2.48E-04 m3/sec
Distance Coordinates          : All distances are on the Plume Centerline

Maximum Dose Distance         : 0.099 km
Maximum TEDE                  : 1.80E-04 Sv
Inner  Contour Dose           : 2.50E-05 Sv
Middle Contour Dose           : 1.00E-05 Sv
Outer  Contour Dose           : 1.00E-06 Sv
Exceeds Inner  Dose Out To    : 0.43 km
Exceeds Middle Dose Out To    : 0.69 km
Exceeds Outer  Dose Out To    : 2.3 km
```

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	1.5E-07	6.3E+07	<00:01
0.100	1.8E-04	7.6E+10	<00:01
0.200	9.3E-05	4.0E+10	00:01
0.300	4.8E-05	2.0E+10	00:02
0.400	2.8E-05	1.2E+10	00:03
0.500	1.9E-05	7.9E+09	00:03
0.600	1.3E-05	5.6E+09	00:04
0.700	9.7E-06	4.1E+09	00:05
0.800	7.5E-06	3.2E+09	00:06
0.900	6.0E-06	2.5E+09	00:06
1.000	4.9E-06	2.1E+09	00:07
2.000	1.3E-06	5.5E+08	00:15
4.000	3.5E-07	1.5E+08	00:31
6.000	1.7E-07	7.0E+07	00:46
8.000	9.9E-08	4.2E+07	01:02
10.000	6.7E-08	2.8E+07	01:17
20.000	2.0E-08	8.6E+06	02:35
40.000	6.6E-09	2.8E+06	05:10
60.000	3.5E-09	1.5E+06	07:45
80.000	2.2E-09	9.4E+05	10:20

Child Scenario D Pasquill B.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 05:59 PM

Source Term : Child Mixtures\Scenario D Child.mix (Mixture Scale Factor = 1.4823E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.15 m/s
Stability Class : B
Receptor Height : 1.0 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.48E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.16 km
Maximum TEDE : 1.49E-04 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 0.64 km
Exceeds Middle Dose Out To : 1.0 km
Exceeds Outer Dose Out To : 3.5 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	5.6E-15	2.4E+00	<00:01
0.100	7.5E-05	3.2E+10	<00:01
0.200	1.4E-04	5.9E+10	00:01
0.300	9.0E-05	3.8E+10	00:02
0.400	5.8E-05	2.5E+10	00:03
0.500	4.0E-05	1.7E+10	00:03
0.600	2.9E-05	1.2E+10	00:04
0.700	2.2E-05	9.1E+09	00:05
0.800	1.7E-05	7.1E+09	00:06
0.900	1.3E-05	5.7E+09	00:06
1.000	1.1E-05	4.7E+09	00:07
2.000	2.9E-06	1.2E+09	00:15
4.000	8.0E-07	3.4E+08	00:31
6.000	3.8E-07	1.6E+08	00:46
8.000	2.3E-07	9.6E+07	01:02
10.000	1.5E-07	6.5E+07	01:17
20.000	4.7E-08	2.0E+07	02:35
40.000	1.5E-08	6.4E+06	05:10
60.000	7.9E-09	3.4E+06	07:45
80.000	5.1E-09	2.1E+06	10:20

Child Scenario D Pasquill C.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 06:00 PM

Source Term : Child Mixtures\Scenario D Child.mix (Mixture
Scale Factor = 1.4823E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.22 m/s
Stability Class : C
Receptor Height : 1.0 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.48E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.25 km
Maximum TEDE : 1.38E-04 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 0.98 km
Exceeds Middle Dose Out To : 1.6 km
Exceeds Outer Dose Out To : 6.7 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	3.1E-15	<00:01
0.100	5.3E-06	2.3E+09	<00:01
0.200	1.2E-04	5.2E+10	00:01
0.300	1.3E-04	5.5E+10	00:02
0.400	1.0E-04	4.3E+10	00:03
0.500	7.5E-05	3.2E+10	00:03
0.600	5.7E-05	2.4E+10	00:04
0.700	4.5E-05	1.9E+10	00:05
0.800	3.6E-05	1.5E+10	00:06
0.900	2.9E-05	1.2E+10	00:06
1.000	2.4E-05	1.0E+10	00:07
2.000	7.2E-06	3.1E+09	00:15
4.000	2.2E-06	9.5E+08	00:30
6.000	1.2E-06	5.0E+08	00:45
8.000	7.7E-07	3.3E+08	01:00
10.000	5.6E-07	2.4E+08	01:15
20.000	2.2E-07	9.4E+07	02:30
40.000	9.6E-08	4.1E+07	05:00
60.000	6.0E-08	2.6E+07	07:31
80.000	4.4E-08	1.9E+07	10:01

Child Scenario D Pasquill D.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 06:01 PM

```
Source Term                  : Child Mixtures\Scenario D Child.mix (Mixture
Scale Factor = 1.4823E+14)
                               HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height     : 28 m
Wind Speed (h=10 m)          : 2.00 m/s
Wind Direction               : 135.0 degrees  Wind from the SE
Wind Speed (h=H-eff)         : 2.33 m/s
Stability Class              : D
Receptor Height              : 1.0 m
Inversion Layer Height       : None
Sample Time                  : 10.000 min
Breathing Rate               : 2.48E-04 m3/sec
Distance Coordinates         : All distances are on the Plume Centerline

Maximum Dose Distance        : 0.39 km
Maximum TEDE                 : 1.10E-04 Sv
Inner  Contour Dose          : 2.50E-05 Sv
Middle Contour Dose          : 1.00E-05 Sv
Outer  Contour Dose          : 1.00E-06 Sv
Exceeds Inner  Dose Out To   : 1.7 km
Exceeds Middle Dose Out To   : 3.2 km
Exceeds Outer  Dose Out To   : 19 km
```

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	2.6E-08	1.1E+07	<00:01
0.200	3.6E-05	1.5E+10	00:01
0.300	9.6E-05	4.1E+10	00:02
0.400	1.1E-04	4.7E+10	00:02
0.500	1.0E-04	4.3E+10	00:03
0.600	8.9E-05	3.8E+10	00:04
0.700	7.7E-05	3.3E+10	00:05
0.800	6.6E-05	2.8E+10	00:05
0.900	5.8E-05	2.4E+10	00:06
1.000	5.0E-05	2.1E+10	00:07
2.000	2.0E-05	8.3E+09	00:14
4.000	7.4E-06	3.1E+09	00:28
6.000	4.3E-06	1.8E+09	00:42
8.000	2.9E-06	1.2E+09	00:57
10.000	2.2E-06	9.4E+08	01:11
20.000	9.5E-07	4.0E+08	02:22
40.000	4.3E-07	1.8E+08	04:45
60.000	2.8E-07	1.2E+08	07:08
80.000	2.0E-07	8.7E+07	09:31

Child Scenario D Pasquill E.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 06:03 PM

Source Term : Child Mixtures\Scenario D Child.mix (Mixture Scale Factor = 1.4823E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.86 m/s
Stability Class : E
Receptor Height : 1.0 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.48E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.77 km
Maximum TEDE : 6.22E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 2.2 km
Exceeds Middle Dose Out To : 4.8 km
Exceeds Outer Dose Out To : 76 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	7.8E-07	<00:01
0.200	1.8E-08	7.8E+06	00:01
0.300	3.9E-06	1.7E+09	00:01
0.400	2.2E-05	9.3E+09	00:02
0.500	4.2E-05	1.8E+10	00:02
0.600	5.6E-05	2.4E+10	00:03
0.700	6.1E-05	2.6E+10	00:04
0.800	6.2E-05	2.6E+10	00:04
0.900	6.0E-05	2.6E+10	00:05
1.000	5.7E-05	2.4E+10	00:05
2.000	2.9E-05	1.2E+10	00:11
4.000	1.2E-05	5.2E+09	00:23
6.000	7.7E-06	3.3E+09	00:34
8.000	5.7E-06	2.4E+09	00:46
10.000	4.6E-06	1.9E+09	00:58
20.000	2.5E-06	1.1E+09	01:56
40.000	1.5E-06	6.4E+08	03:53
60.000	1.2E-06	4.9E+08	05:49
80.000	9.7E-07	4.1E+08	07:46

Child Scenario D Pasquill F.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 06:04 PM

Source Term : Child Mixtures\Scenario D Child.mix (Mixture Scale Factor = 1.4823E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 3.51 m/s
Stability Class : F
Receptor Height : 1.0 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.48E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 1.7 km
Maximum TEDE : 3.41E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 3.1 km
Exceeds Middle Dose Out To : 8.6 km
Exceeds Outer Dose Out To : > 200 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	0.0E+00	<00:01
0.200	0.0E+00	8.7E-06	<00:01
0.300	1.2E-11	4.9E+03	00:01
0.400	1.4E-08	5.9E+06	00:01
0.500	3.7E-07	1.6E+08	00:02
0.600	2.1E-06	8.9E+08	00:02
0.700	5.8E-06	2.5E+09	00:03
0.800	1.1E-05	4.6E+09	00:03
0.900	1.6E-05	6.9E+09	00:04
1.000	2.1E-05	9.1E+09	00:04
2.000	3.3E-05	1.4E+10	00:09
4.000	2.0E-05	8.7E+09	00:19
6.000	1.4E-05	5.9E+09	00:28
8.000	1.1E-05	4.6E+09	00:37
10.000	8.8E-06	3.7E+09	00:47
20.000	5.0E-06	2.1E+09	01:34
40.000	3.1E-06	1.3E+09	03:09
60.000	2.4E-06	1.0E+09	04:44
80.000	2.0E-06	8.5E+08	06:19

Infant Scenario D Pasquill A.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 06:07 PM

Source Term : Infant Mixtures\Scenario D Infant.mix (Mixture
Scale Factor = 1.4823E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.15 m/s
Stability Class : A
Receptor Height : 0.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 8.68E-05 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.099 km
Maximum TEDE : 1.33E-04 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 0.36 km
Exceeds Middle Dose Out To : 0.59 km
Exceeds Outer Dose Out To : 1.9 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	9.0E-08	5.2E+07	<00:01
0.100	1.3E-04	7.6E+10	<00:01
0.200	6.9E-05	4.0E+10	00:01
0.300	3.5E-05	2.0E+10	00:02
0.400	2.1E-05	1.2E+10	00:03
0.500	1.4E-05	7.9E+09	00:03
0.600	9.7E-06	5.6E+09	00:04
0.700	7.2E-06	4.1E+09	00:05
0.800	5.5E-06	3.2E+09	00:06
0.900	4.4E-06	2.5E+09	00:06
1.000	3.6E-06	2.1E+09	00:07
2.000	9.5E-07	5.5E+08	00:15
4.000	2.6E-07	1.5E+08	00:31
6.000	1.2E-07	7.0E+07	00:46
8.000	7.3E-08	4.2E+07	01:02
10.000	4.9E-08	2.8E+07	01:17
20.000	1.5E-08	8.6E+06	02:35
40.000	4.8E-09	2.8E+06	05:10
60.000	2.5E-09	1.5E+06	07:45
80.000	1.6E-09	9.4E+05	10:20

Infant Scenario D Pasquill B.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 06:08 PM

```
Source Term                   : Infant Mixtures\Scenario D Infant.mix (Mixture
Scale Factor = 1.4823E+14)
                                HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height      : 28 m
Wind Speed (h=10 m)           : 2.00 m/s
Wind Direction                : 135.0 degrees  Wind from the SE
Wind Speed (h=H-eff)          : 2.15 m/s
Stability Class               : B
Receptor Height               : 0.5 m
Inversion Layer Height        : None
Sample Time                   : 10.000 min
Breathing Rate                : 8.68E-05 m3/sec
Distance Coordinates          : All distances are on the Plume Centerline

Maximum Dose Distance         : 0.16 km
Maximum TEDE                  : 1.10E-04 Sv
Inner  Contour Dose           : 2.50E-05 Sv
Middle Contour Dose           : 1.00E-05 Sv
Outer  Contour Dose           : 1.00E-06 Sv
Exceeds Inner  Dose Out To    : 0.55 km
Exceeds Middle Dose Out To    : 0.89 km
Exceeds Outer  Dose Out To    : 3.0 km
```

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	1.6E-15	9.3E-01	<00:01
0.100	5.5E-05	3.2E+10	<00:01
0.200	1.0E-04	5.9E+10	00:01
0.300	6.6E-05	3.8E+10	00:02
0.400	4.3E-05	2.5E+10	00:03
0.500	2.9E-05	1.7E+10	00:03
0.600	2.1E-05	1.2E+10	00:04
0.700	1.6E-05	9.1E+09	00:05
0.800	1.2E-05	7.1E+09	00:06
0.900	9.9E-06	5.7E+09	00:06
1.000	8.1E-06	4.7E+09	00:07
2.000	2.2E-06	1.2E+09	00:15
4.000	5.9E-07	3.4E+08	00:31
6.000	2.8E-07	1.6E+08	00:46
8.000	1.7E-07	9.6E+07	01:02
10.000	1.1E-07	6.5E+07	01:17
20.000	3.4E-08	2.0E+07	02:35
40.000	1.1E-08	6.4E+06	05:10
60.000	5.8E-09	3.4E+06	07:45
80.000	3.7E-09	2.1E+06	10:20

Infant Scenario D Pasquill C.txt

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 06:09 PM

Source Term : Infant Mixtures\Scenario D Infant.mix (Mixture Scale Factor = 1.4823E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.22 m/s
Stability Class : C
Receptor Height : 0.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 8.68E-05 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.25 km
Maximum TEDE : 1.01E-04 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 0.82 km
Exceeds Middle Dose Out To : 1.4 km
Exceeds Outer Dose Out To : 5.5 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	3.0E-16	<00:01
0.100	3.7E-06	2.1E+09	<00:01
0.200	9.0E-05	5.2E+10	00:01
0.300	9.6E-05	5.5E+10	00:02
0.400	7.4E-05	4.3E+10	00:03
0.500	5.5E-05	3.2E+10	00:03
0.600	4.2E-05	2.4E+10	00:04
0.700	3.3E-05	1.9E+10	00:05
0.800	2.6E-05	1.5E+10	00:06
0.900	2.2E-05	1.2E+10	00:06
1.000	1.8E-05	1.0E+10	00:07
2.000	5.3E-06	3.1E+09	00:15
4.000	1.7E-06	9.5E+08	00:30
6.000	8.7E-07	5.0E+08	00:45
8.000	5.7E-07	3.3E+08	01:00
10.000	4.1E-07	2.4E+08	01:15
20.000	1.6E-07	9.4E+07	02:30
40.000	7.0E-08	4.1E+07	05:00
60.000	4.5E-08	2.6E+07	07:31
80.000	3.2E-08	1.9E+07	10:01

Infant Scenario D Pasquill D.txt
HotSpot Version 3.0.3 General Plume
Apr 19, 2017 06:09 PM

Source Term : Infant Mixtures\Scenario D Infant.mix (Mixture
Scale Factor = 1.4823E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.33 m/s
Stability Class : D
Receptor Height : 0.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 8.68E-05 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.39 km
Maximum TEDE : 8.08E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 1.3 km
Exceeds Middle Dose Out To : 2.6 km
Exceeds Outer Dose Out To : 15 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	1.5E-08	8.7E+06	<00:01
0.200	2.6E-05	1.5E+10	00:01
0.300	7.1E-05	4.1E+10	00:02
0.400	8.1E-05	4.6E+10	00:02
0.500	7.5E-05	4.3E+10	00:03
0.600	6.6E-05	3.8E+10	00:04
0.700	5.6E-05	3.3E+10	00:05
0.800	4.9E-05	2.8E+10	00:05
0.900	4.2E-05	2.4E+10	00:06
1.000	3.7E-05	2.1E+10	00:07
2.000	1.4E-05	8.3E+09	00:14
4.000	5.5E-06	3.1E+09	00:28
6.000	3.2E-06	1.8E+09	00:42
8.000	2.2E-06	1.2E+09	00:57
10.000	1.6E-06	9.4E+08	01:11
20.000	7.0E-07	4.0E+08	02:22
40.000	3.2E-07	1.8E+08	04:45
60.000	2.0E-07	1.2E+08	07:08
80.000	1.5E-07	8.7E+07	09:31

HotSpot Version 3.0.3 General Plume
Apr 19, 2017 06:10 PM

Source Term : Infant Mixtures\Scenario D Infant.mix (Mixture
Scale Factor = 1.4823E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 2.86 m/s
Stability Class : E
Receptor Height : 0.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 8.68E-05 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.77 km
Maximum TEDE : 4.58E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 1.7 km
Exceeds Middle Dose Out To : 3.7 km
Exceeds Outer Dose Out To : 46 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	1.6E-07	<00:01
0.200	1.1E-08	6.2E+06	00:01
0.300	2.8E-06	1.6E+09	00:01
0.400	1.6E-05	9.1E+09	00:02
0.500	3.1E-05	1.8E+10	00:02
0.600	4.1E-05	2.4E+10	00:03
0.700	4.5E-05	2.6E+10	00:04
0.800	4.6E-05	2.6E+10	00:04
0.900	4.4E-05	2.6E+10	00:05
1.000	4.2E-05	2.4E+10	00:05
2.000	2.1E-05	1.2E+10	00:11
4.000	9.1E-06	5.2E+09	00:23
6.000	5.7E-06	3.3E+09	00:34
8.000	4.2E-06	2.4E+09	00:46
10.000	3.4E-06	1.9E+09	00:58
20.000	1.8E-06	1.1E+09	01:56
40.000	1.1E-06	6.4E+08	03:53
60.000	8.5E-07	4.9E+08	05:49
80.000	7.2E-07	4.1E+08	07:46

Infant Scenario D Pasquill F.txt
HotSpot Version 3.0.3 General Plume
Apr 19, 2017 06:11 PM

Source Term : Infant Mixtures\Scenario D Infant.mix (Mixture Scale Factor = 1.4823E+14)
HTO (1 Bq / 25%) HT (3 Bq / 75%)
Effective Release Height : 28 m
Wind Speed (h=10 m) : 2.00 m/s
Wind Direction : 135.0 degrees Wind from the SE
Wind Speed (h=H-eff) : 3.51 m/s
Stability Class : F
Receptor Height : 0.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 8.68E-05 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 1.7 km
Maximum TEDE : 2.51E-05 Sv
Inner Contour Dose : 2.50E-05 Sv
Middle Contour Dose : 1.00E-05 Sv
Outer Contour Dose : 1.00E-06 Sv
Exceeds Inner Dose Out To : 1.8 km
Exceeds Middle Dose Out To : 6.2 km
Exceeds Outer Dose Out To : 159 km

Include Plume Passage Inhalation and Submersion
Include Resuspension (Resuspension Factor : Maxwell-Anspaugh)
Exposure Window:(Start: 0.00 days; Duration: 4.00 days) [100% stay time].

DISTANCE km	T E D E (Sv)	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION (Bq-sec)/m3	ARRIVAL TIME (hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	0.0E+00	<00:01
0.200	0.0E+00	2.1E-06	<00:01
0.300	5.0E-12	2.9E+03	00:01
0.400	8.2E-09	4.7E+06	00:01
0.500	2.4E-07	1.4E+08	00:02
0.600	1.5E-06	8.4E+08	00:02
0.700	4.1E-06	2.4E+09	00:03
0.800	7.9E-06	4.5E+09	00:03
0.900	1.2E-05	6.8E+09	00:04
1.000	1.6E-05	9.0E+09	00:04
2.000	2.4E-05	1.4E+10	00:09
4.000	1.5E-05	8.7E+09	00:19
6.000	1.0E-05	6.0E+09	00:28
8.000	7.9E-06	4.6E+09	00:37
10.000	6.5E-06	3.7E+09	00:47
20.000	3.7E-06	2.1E+09	01:34
40.000	2.3E-06	1.3E+09	03:09
60.000	1.8E-06	1.0E+09	04:44
80.000	1.5E-06	8.5E+08	06:19

APPENDIX C

Rationale for Change to OL&C for Minimum Effective Stack Height

(Effective for Revision 4) – November 2017

RATIONALE FOR CHANGE TO OL&C FOR MINIMUM EFFECTIVE STACK HEIGHT

Effective stack height (ESH) is a derived characteristic that integrates the physical nature of the actual stack itself (including the height of the stack relative to the ground, and the velocity of the gases being ejected) with environmental factors such as temperature and wind speed.

This value is taken to be a more accurate input into calculations of pollutant concentration from a point source in Gaussian dispersion models.

The simplified equation historically used by SRBT in calculating the effective stack height is as follows:

$$Effective\ Stack\ Height\ (m) = Physical\ Stack\ Height\ (m) + \left(\frac{Exhaust\ Gas\ Velocity\ (m/s)}{Wind\ Speed\ (m/s)}\right)^{1.4}$$

ESH Requirement

In the SRBT Safety Analysis Report (SAR) Revision 3, under the Operating Limits and Conditions in Section 10, it is stated under clause (f) that:

> *"Tritium processing operations shall not occur unless the minimum effective stack height of 27.8 metres is being achieved on applicable stack unit."*

This limit was included in the latest version of the SAR, as it has been enforced since 2005 as part of our compliance with a previous licence condition. This condition is not currently explicitly noted in either our licence nor our LCH, but continues to be applied as a requirement internally.

ESH History

The value of 27.8 metres was originally calculated by Canatom in the 1996 Derived Emission Limit (DEL) document (as being the average between the two stacks), and was based upon best available data at that time. It was not established as an operating limit for the facility at that point, but was only used in the calculation of the DEL.

In 2005, CNSC inserted the maintenance of an effective stack height of 27.8 metres directly into our operating licence as a licence condition.

Subsequently in 2006 the DEL was replaced by a new derived release limits (DRL) document. The 2006 DRL calculation was different than the 1996 DEL calculation in several ways.

First, the physical stack height used in 1996 (7.5 metres) neglected that the stacks were raised off of ground level by several metres, as they were mounted on top of the air handling units (AHU). Taking this into account added about 3-4 physical metres to each stack as part of the 2006 DRL calculation.

The rated air moving capacity of the AHUs was used in 1996 to calculate the exhaust gas velocity. In 2006, actual directly measured values of flow rates were integrated into the calculation of effective stack height in the DRL.

In 1996 a wind speed of 2.6 m/s was used based upon data from Environment Canada for Petawawa for the years 1979-1988, for wind blowing from the ESE wind sector, towards the WNW sector where the critical group is situated. The 2006 DRL used data from 2000-2004, applying a wind speed of 2.2 m/s.

Finally, buoyancy effects due to temperature differences were ignored in 1996, while the 2006 calculation accounted for it within the DRL calculation.

ESH Compliance

SRBT has continued to evaluate the average effective stack height as part of weekly gaseous effluent measurements, in order to demonstrate that the minimum effective stack height is being achieved.

SRBT does not calculate instantaneous effective stack height; rather, a calculation is performed on a weekly basis based on an assumed average wind speed, as well as direct daily measurements of the differential pressure of the gas flowing out of each stack.

The assumed average wind speed incorporated into our calculations is 2.2 m/s, which aligns with the 2006 DRL calculation assumptions.

2016 DRL and the ESH

During the 2016 revision of the Derived Release Limits (DRL) document, the use of site-specific data was preferred where available.

The SRBT weather station collects data continuously regarding wind speed and direction; this information was used in determining the new DRLs.

The 2016 DRL noted that based on the latest triple-joint frequency wind data gathered through the weather station, the mean wind speed of relevance (to the NW) is 2.44 m/s.

In 2006, data from Environment Canada's Petawawa Weather Station was used to calculate the DRLs. An average wind speed of relevance was 2.2 m/s.

The use of the 2.44 m/s wind speed in calculating the DRL in 2016 was justified as it represents site-specific data, and was derived using only active operating hours (0700 – 1900h).

In applying the new mean wind speed to the calculation of the ESH, all other inputs being equal, the higher average wind speed will result in a decrease in the calculated average effective stack height.

If SRBT was to apply this <u>mean</u> value of 2.44 m/s into the equations used to calculate the weekly ESHs as part of our gaseous effluent monitoring program, the current physical configuration of the stack equipment would ultimately result in calculated weekly ESHs that <u>on occasion</u> may not reach the 27.8 m minimum.

Minimum ESH – Is this the best way to define an OL&C for stack performance?

Instead of defining a minimum effective stack height as an operating limit and condition within the SAR, a more logical approach would be to define a limit on the differential pressure measurement within the stack ducting, taken each day prior to operation.

The reasoning for this is as follows:

1. The 2016 DRL took into account revised exit velocities from the stacks, which are based over the last decade of differential pressure measurements and independent assessments by third parties.
2. The intent of the 2005 licence condition prescribing the minimum ESH for operation was to ensure the active ventilation systems were maintained and monitored in such a way that the characteristics of the equipment were in line with the assumptions made in the 1996 DEL.
3. For more than a decade, SRBT has monitored the differential pressure in each stack prior to beginning tritium processing operations at the start of the day. This is not a check of ESH – it is a check of equipment performance. The values obtained are averaged and a weekly ESH is calculated with the rest of the effluent and assumed environmental characteristics.
4. SRBT has a comprehensive Maintenance Program that ensures that the active ventilation systems are functioning to specification, through routine preventive maintenance and independent third party assessment of performance characteristics.
5. ESH is directly tied in with wind speed, which is beyond SRBT's control. By prescribing a requirement for ESH, it could be proposed that SRBT should cease operation when a certain wind speed threshold is reached, as the ESH would not be attained.

By instead applying minimum differential pressure readings as the OL&C (which is ultimately a proxy for a limit on minimum exit velocity of the gases being ejected), SRBT will ensure that:

- the stack / AHU equipment continues to meet a minimum standard of operation,
- that the impacts of SRBT operations on public and the environment are acceptable and as low as reasonably achievable, and
- that the models used in calculating the 2016 DRL continue to be an adequately reasonable representation of environmental conditions.

Therefore, SRBT has changed the SAR, Section 10 (f), to read:

f. Minimum Differential Pressure Measurements for Tritium Processing

Tritium processing operations shall not occur unless the following differential pressures are achieved, as measured by the gauges on each of the active ventilation system stacks:

- *Rig Stack: 0.27 inches of water column*
- *Bulk Stack: 0.38 inches of water column*

These measurements correspond to an average effective stack height of 27.8 metres, assuming a wind speed of 2.2 m/s.

APPENDIX D

Review of Hypothetical Incident Scenarios, 2008

(including previous safety analyses and information)

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SRB TECHNOLOGIES (CANADA) INC.

REVIEW OF HYPOTHETICAL INCIDENT SCENARIOS

Date: February 22, 2008

Prepared by: Stephane Levesque

Reviewed by: Ross Fitzpatrick

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Saunders-Roe (Canada) Inc. Licensing for a Gaseous Tritium Light Source Manufacturing Facility, BMD 90-192, November 21, 1990.	B
SAFETY ANALYSIS REPORT, Potential Radiological Impact From Hypothetical Release of Tritium At the SRB Technologies Canada Facility Located at 320 Boundary Road, Pembroke, Ontario, January 15, 1996.	C
SAFETY ANALYSIS REPORT, Potential Radiological Impact From Hypothetical Release of Tritium From a Smoldering Fire Incident At the SRB Technologies (Canada) Facility Located at 320 Boundary Road, Pembroke, Ontario, October 16, 2000.	D
SAFETY ANALYSIS REPORT, Potential Radiological Impact From Hypothetical Release of Tritium From a Smoldering Fire Incident that Causes Structural Failure of the Mezzanine At the SRB Technologies Canada Facility Located at 320 Boundary Road, Pembroke, Ontario, November 6, 2000.	E
CANADIAN NUCLEAR SAFETY COMMISSION, Review of accident scenarios for SRB Technologies Environmental Assessment , November 23, 2000.	F
Excel representation of Table 2.5 in D.B. Turner's workbook representing the values for σ_y and σ_z as a function of downwind distance from source to receptor ranging between 100 meters and 100 kilometers.	G
All calculation results for release of the entire contents of a pyrophoric unit.	H
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INTRODUCTION

SRB TECHNOLOGIES (CANADA) INC. has been Licenced by the Canadian Nuclear Safety Commission (CNSC) formerly known as the Atomic Energy Control Board (AECB) since December 1990 to process tritium for the purpose of manufacturing gaseous filled tritium light sources and associated products.

The type of production activities performed by SRB have remained relatively unchanged since 1997. However, in an effort to further protect the workers, the public and the environment from possible exposure, to reduce or eliminate the possibility of incidents or the exposures from an incident, safety programs and procedures have substantially improved over the years and a number of equipment and system upgrades have been implemented.

BACKGROUND

As part of the initial licensing of the facility in 1990 and re-licensing in 1996 and in 2000, a number of hypothetical accident scenarios resulting in the release of tritium were defined and analyzed in order to determine the resulting dose to a member of the public.

The Organizational Study performed by SRB recognized that a specific review schedule should be implemented to ensure the accuracy of the Safety Analysis Report.

During an Executive Committee meeting documented on September 13, 2007 Senior Management have now instituted a requirement that ensures that the Safety Analysis Report is continuously reviewed to ensure that no incident with greater consequence has been identified and analyzed.

Senior Management committed to ensure that formal reviews of the document would be conducted and documented yearly by the end of January of each year.

PURPOSE

The purpose of this document is to review the existing incident scenarios for the facility and to determine if these are still applicable considering the improvements made to the safety programs and procedures and the equipment and system upgrades that have been implemented over the years.

The review will also ensure that the hypothetical incidents identified and analyzed reflect worse case conditions, are credible and can survive scrutiny.

This document will also address Senior Management's commitment to document the review of the incident scenarios found in the Safety Analysis Report.

METHODOLOGY

Although SRB's licence currently does not allow tritium processing, operating conditions and activities associated with a processing licence will be reviewed as part of this document. It is important to note that current licence activities would also be performed under a licence that would allow processing to resume. This review therefore encompasses the activities and conditions of the current licence and those of a licence that would allow tritium processing to resume. The review will be systematic and use some of the information in the document titled "Systematic and Quantitative Analysis of Tritium Sources and Their Potential Contribution to Groundwater Contamination" dated March 29, 2007 which will be referred as the "Sources Report" in this document.

This review document will provide:

- Review of hypothetical incidents previously defined. This would include:
    - Discussions of parameters and results associated with hypothetical incidents and discussions of methodology, parameters and results used in assessing the dose from each hypothetical incident.
    - Discussions on the possibility of an incident to occur considering the improvements made to the safety programs and procedures and the equipment and system upgrades that have been implemented over the years of operation.
    - Discussions on the possibility of an incident to occur based on operational experience and other historical data.
    - Of the incidents previously defined, determination of their credibility of and review of the parameters that were used to calculated the maximum dose to a receptor.
- Determination of additional hypothetical incidents. This would include:
    - Discussions on systematic method used to identify additional hypothetical incident.
    - Discussions on possibility of incident to occur considering current safety envelope, operational experience and other historical data.
    - Define the parameters that will be used to calculate the maximum dose to a receptor.

- Review of analytical method previously used to assess maximum dose to a receptor.

- Calculation of the maximum dose to a receptor from each hypothetical incident.

- Consideration of any possible environmental impacts.

- Provide recommendations and implementation plan to further limit the possibility of an incident to occur or to reduce the dose to the public from the incident.

REVIEW OF HYPOTHETICAL INCIDENTS PREVIOUSLY DEFINED

INITIAL LICENSING OF THE FACILITY IN 1990

As part of the initial licensing of the facility in 1990, SRB contracted the services of Atomic Energy of Canada Limited (AECL) to perform an assessment of the dose to a member of the public from a hypothetical worst case scenario.

RELEASE OF THE ENTIRE CONTENTS OF A PYROPHORIC UNIT

Based on operational experience reported by SRB, the worst case scenario first adopted by AECL was for a release of 56 TBq (1,514 Ci) from a pyrophoric unit.

For the prediction the most conservative, 100% conversion to tritium oxide was assumed.

The dose calculations were performed assuming that the receptor was sited directly beneath the central axis of the plume at distances of 2.5, 15 and 70 km.

It was also assumed that the release of the stated amount of tritium took place over a period of 10 seconds.

The second draft of the standard from the Canadian Standard Association, N288.2, on the guidelines for calculating radiation doses to the public from a release of airborne radioactive material under hypothetical accident conditions, dispersion effects based on Pasquill F atmospheric conditions and the stack characteristics of the time were used in calculating the resulting dose to a member of the public. Specific data used and results can be found in document NSN-SRB-071 dated November 1990 which is included in **Appendix A** of this review document.

The maximum dose to a member of the public from this hypothetical worse case scenario was calculated to be 42 μSv (microsieverts).

RELEASE OF THE ENTIRE CONTENTS OF A BULK CONTAINER

At the recommendation of the Atomic Energy Control Board (AECB), the regulatory body at the time, the dose to a member of the public from another hypothetical worst case scenario was performed using the same assessment method, parameters and stack characteristics used in the document NSN-SRB-071.

This worst case scenario was for a release of 1,110 TBq (30,000 Ci) from a bulk or transportation container.

Results can be found in document BMD 90-192 dated November 21, 1990 which is included in **Appendix B** of this review document.

The maximum dose to a member of the public from this hypothetical worse case scenario was calculated to be 840 μSv (microsieverts).

RE-LICENSING OF THE FACILITY IN 1996

As part of the re-licensing of the facility in 1996 SRB contracted the services of Alpha-Dyne, LLC to define additional hypothetical worse case scenarios and to perform an assessment of the dose to a member of the public associated with the occurrence of these hypothetical worst case scenarios.

As a result Alpha-Dyne identified and assessed the dose to a member of the public associated with the impact from a large vehicle, and from the occurrence of a tornado and from a fire.

TORNADO ACCIDENT

One of the hypothetical scenarios analyzed by Alpha-Dyne was the release of tritium resulting from the facility being subjected to a tornado with sustained winds with a velocity in excess of 55.5 m/s (meters per second) causing a violent collapse of the building.

To be conservative, the hypothetical scenario assumed that approximately 50% (150,000 Ci or 5,550 TBq) of the maximum possible inventory on site (based on the possession limit of the licence at the time) would be contained in sealed glass capsules and released at ground level as a result of the collapse of the building.

For the prediction it was assumed that 1.5% of the tritium would be converted to tritium oxide.

Tritium concentrations at distances between 100 meters to 3,000 meters from the release were calculated to determine the highest possible exposure to a receptor.

The dose calculations were performed assuming that an individual would be standing 100 meters downwind from the release (at the point of highest concentration) for the entire duration of the passage of the contaminated plume.

It was also assumed that the release of the stated amount of tritium took place over a period of 10 seconds.

The analytical method developed by D.B. Turner found in the “Workbook of Atmospheric Dispersion Estimates” from the U.S. Department of Health, dispersion effects based on Pasquill A atmospheric conditions and the stack characteristics of the time were used in calculating the resulting dose to a member of the public.

Specific data used and results can be found in the document from Alpha-Dyne dated January 15, 1996 which is included in **Appendix C** of this review document.

The maximum dose to a member of the public from this hypothetical worse case scenario was calculated to be 7 μSv (microsieverts).

IMPACT OF A LARGE ROGUE VEHICLE

Another hypothetical scenario analyzed by Alpha-Dyne was the release of tritium resulting from the impact of a large motor vehicle (heavier than 10,000 kg) with the facility with the vehicle coming to rest after penetrating the outside wall of the building.

It was assumed that the vehicle would come to rest just after penetrating the outside wall of the building and that the ventilation system continued to exhaust any release of tritium from the damaged area of the building. The tritium was therefore assumed to be released at the physical height of the building exhaust stack at the time (approximately 12 meters).

The impact is assumed to take place against the wall of the storage room, which is located in zone 3. The storage room houses tritium filled tubes that have been removed from the components of expired devices. The storage room is further described on page 10 of the “Sources Report”.

To be conservative, the hypothetical scenario assumed that approximately 60,000 Ci (2,220 TBq) would be stored in this room in sealed glass capsules and entirely released as a result of the collapse of the wall of the storage room.

For the prediction it was assumed that 1.5% of the tritium would be converted to tritium oxide.

Tritium concentrations at distances between 10 meters to 20,000 meters from the release were calculated to determine the highest possible exposure to a receptor.

The dose calculations were performed assuming that an individual would be standing 70 meters downwind from the release (at the point of highest concentration) for the entire duration of the passage of the contaminated plume.

It was also assumed that the release of the stated amount of tritium took place over a period of 10 seconds.

The analytical method developed by D.B. Turner found in the “Workbook of Atmospheric Dispersion Estimates” from the U.S. Department of Health, dispersion effects based on Pasquill C atmospheric conditions and the stack characteristics of the time were used in calculating the resulting dose to a member of the public.

Specific data used and results can be found in document from Alpha-Dyne dated January 15, 1996 included in **Appendix C** of this review document.

The maximum dose to a member of the public from this hypothetical worse case scenario was calculated to be 171 μSv (microsieverts).

TOTAL DESTRUCTION OF THE BUILDING BY FIRE

Another hypothetical scenario analyzed by Alpha-Dyne was the release of tritium resulting from the total conflagration of the facility by fire.

It was assumed that the fire would consume the entire structure, releasing the entire possible inventory of tritium on site (300, 000 Ci or 11,100 TBq), just slightly higher than the possession limit of the licence at the time of 297,297 (11,000 TBq).

At the time, the document assumed that it was necessary to raise the temperature of the fire to at least 650 degrees Celsius before enough softening of the glass was achieved to release any tritium from the sealed glass capsules, it was assumed that the release would take place over a period of 1 hour.

It was further assumed that since the release could only occur at such high temperatures that all the tritium would be converted to tritium oxide on release.

The analytical method developed by D.B. Turner found in the workbook of atmospheric dispersion estimates from the U.S. Department of Health, dispersion effects based on Pasquill's atmospheric conditions were used in calculating the resulting dose to a member of the public.

The calculations were performed assuming two different atmospheric conditions. The first assuming the fire would take place during slightly unstable atmospheric conditions typical of daylight as characterized under Pasquill C. The second assuming the fire would take place during moderately stable atmospheric conditions typical of a cold winter night as characterized under Pasquill F.

Tritium concentrations at distances between 10 meters to 20,000 meters from the release were calculated to determine the highest possible exposure to a receptor from a fire that would occur during daylight with a corresponding thermal plume release height of 100 meters.

Tritium concentrations at distances between 100 meters to 70,000 meters from the release were calculated to determine the highest possible exposure to a receptor from a fire that would occur at night with a corresponding thermal plume release height of 50 meters.

The maximum dose was calculated to be received by an individual that would be standing 4 km downwind from the release (at the point of highest concentration) for the entire duration of the passage of the contaminated plume during a fire that would occur during atmospheric conditions typical of a cold winter night.

Specific data used and results can be found in document from Alpha-Dyne dated January 15, 1996 included in **Appendix C** of this review document.

The maximum dose to a member of the public from this hypothetical worse case scenario was calculated to be 71 µSv (microsieverts).

RE-LICENSING OF THE FACILITY IN 2000

As part of the re-licensing of the facility in 2000 SRB contracted the services of Alpha-Dyne, LLC to analyze hypothetical worse case scenarios associated with the occurrence of a fire at the facility which does not result in the total destruction of the building (previously assessed) and to perform an assessment of the dose to a first responder associated with the occurrence of these hypothetical worst case scenarios.

As a result Alpha-Dyne identified and assessed the dose to a first responder associated with two different circumstances associated with the occurrence of a fire at the facility.

SMOLDERING FIRE WITHIN THE CONTROLLED AREA OF THE FACILITY

One of the hypothetical scenarios analyzed by Alpha-Dyne, was as a result of a slow burning, smoldering fire that breaks out somewhere within the facility.

This scenario assumed firemen, in their efforts to extinguish the fire, would use sufficient force to break from water or other physical force, a significant number of sealed glass capsules containing tritium, causing a tritium release.

A review of the practices was made and it was determined that the assembly area of the facility (zone 2) was the most probable location for a smoldering fire scenario in which tritium tubes are most vulnerable.

Based on SRB's operational experience it was determined that a bucket containing a quantity of 100 sealed tubes each containing 2.19 Curies (81 GBq) was conservative in estimating the quantity of tritium in a localized part of the facility. Although unlikely, the scenario therefore assumed that water from a fire hose would fracture the entire contents of the bucket releasing 219 Curies (8 TBq).

For the prediction it was assumed that 1.5% of the tritium would be converted to tritium oxide.

It was also assumed that fire personnel stay time was 15 minutes.

The scenario made the most conservative assumption that the tritium concentration in the assembly room would stay constant for the entire stay time and be equal to the initial concentration assuming the ventilation has failed and no other ventilation exists.

For further conservatism the scenario assumed that firefighters were not equipped with a self contained breathing apparatus (SCBA). An SCBA would eliminate practically all tritium absorption by the lungs.

The method used to calculate the dose used internal dose conversion factors from ICRP 30. Specific data used and results can be found in document from Alpha-Dyne dated October 16, 2000 included in **Appendix D** of this review document.

The maximum dose to a member of the public from this hypothetical worse case scenario was calculated to be 3.2 mSv (millisieverts).

SMOLDERING FIRE THAT CAUSES STRUCTURAL FAILURE OF MEZZANINE

CNSC Staff in 2000, were not convinced that the scenario previously analyzed by SRB and defined as “SMOLDERING FIRE WITHIN THE CONTROLLED AREA OF THE FACILITY” represented the worse case situation as a result of a fire and requested that further analysis be performed to define other possible hypothetical incident scenario as a result of a fire which was subsequently provided by SRB.

As a result Alpha-Dyne defined and analyzed another hypothetical scenario as a result of a fire that would burn rapidly, sufficient to attack the structure supporting the mezzanine located above the shipping area.

This scenario assumed that the fire resulted in the structural collapse of the mezzanine onto the shipping area.

The collapse was presumed to occur when the shipping area contained the largest quantity of material ever likely to be shipped at one time (20,000 Ci or 740 TBq).

The material in the shipping area is typically packed in shipping packages that are designed and tested to resist heavy impacts, the scenario therefore assumed that 10% of the tubes contained within these packages would be broken (2,000 Ci or 74 TBq) and released into the building.

This scenario assumed firemen will arrive and enter the facility just as the release occurs, resulting in the maximum possible exposure.

For the prediction it was assumed that 1.5% of the tritium would be converted to tritium oxide.

It was also assumed that fire personnel stay time was 15 minutes.

The scenario made the most conservative assumption that the tritium concentration in the shipping area would stay constant for the entire stay time and be equal to the initial concentration assuming the ventilation has failed and no other ventilation exists.

For further conservatism the scenario assumed that firefighters were not equipped with a SCBA. A SCBA would eliminate practically all tritium absorption by the lungs.

The method used to calculate the dose used internal dose conversion factors from ICRP 30. Specific data used and results can be found in document from Alpha-Dyne dated November 6, 2000 included in **Appendix E** of this review document.

The maximum dose to a member of the public from this hypothetical worse case scenario was calculated to be 8.2 mSv (millisieverts).

CNSC REVIEW IN 2000

During re-licensing of the facility in 2000, in the context of the environmental assessment for SRB, CNSC Staff performed a review of some of the documented assessments of hypothetical accident scenarios and malfunctions for SRB. The review recalculated some of the consequences from the scenarios to account for modifications that had been made since the assessments were submitted and to reflect accepted values of the time for dose conversion factors for tritium (HT) and tritium oxide (HTO).

RELEASE OF THE ENTIRE CONTENTS OF A PYROPHORIC UNIT

This scenario was not reviewed by the CNSC in 2000.

RELEASE OF THE ENTIRE CONTENTS OF A BULK CONTAINER

This worst case scenario was originally calculated for a release of 1,110 TBq (30,000 Ci) from a bulk or transportation container. The scenario was re-assessed by CNSC Staff assuming 1,850 TBq (50,000 Ci) would be released from the container which represents the maximum allowable limit for the container.

The new scenario assumes the most unstable atmospheric conditions as characterized under Pasquill A where the scenario was originally calculated assuming moderately stable atmospheric conditions as characterized under Pasquill F.

Previous calculations suggest that the closest point where the highest dose received was at 2.5 km from the facility where the CNSC assumed that the highest dose was received at 100 meters from the facility.

Specific data used and results can be found in document from CNSC Staff dated November 23, 2000 included in **Appendix F** of this review document.

The maximum dose to a member of the public from this hypothetical worse case scenario was calculated to be approximately 4 mSv (millisieverts).

TORNADO ACCIDENT

In their 2000 review, CNSC Staff judged the scenario to be generally acceptable with some questions in regards to the assumptions used. Nevertheless, it was concluded that this hypothetical scenario was bounded by the hypothetical scenario which assumed the release of the entire contents of a bulk container.

Since the release was assumed to occur at ground level from the violent collapse of the facility, stack height is not a factor reflected in the calculation and therefore changes to stack height over the years do not affect the effective dose from the hypothetical scenario.

The dose to a member of the public from this hypothetical worse case scenario was recalculated for the sole reason of reflecting accepted values of the time for dose conversion factors for tritium (HT) and tritium oxide (HTO).

Specific data used and results can be found in document from CNSC Staff dated November 23, 2000 included in **Appendix F** of this review document.

The maximum dose to a member of the public from this hypothetical worse case scenario was calculated to be 16 μSv (microsieverts).

IMPACT OF A LARGE ROGUE VEHICLE

In their 2000 review, CNSC Staff concluded that this hypothetical scenario was bounded by the hypothetical scenario which assumed the release of the entire contents of a bulk container.

The CNSC Staff review calculated the dose assuming that an individual would be standing 100 meters downwind from the release (at the point of highest concentration) for the entire duration of the passage of the contaminated plume where the original scenario assumed a distance of 70 meters.

The calculations reflected accepted values of the time for dose conversion factors for tritium (HT) and tritium oxide (HTO).

Specific data used and results can be found in the document from CNSC Staff dated November 23, 2000 included in **Appendix F** of this review document.

The maximum dose to a member of the public from this hypothetical worse case scenario was calculated to be 65 μSv (microsieverts).

TOTAL DESTRUCTION OF THE BUILDING BY FIRE (HOT FIRE AS DEFINED BY CNSC STAFF)

In their 2000 review, CNSC Staff noted that this hypothetical scenario was assessed at the time of original submission and found to be acceptable.

The dose to a member of the public from this hypothetical worse case scenario was recalculated for the sole reason of reflecting accepted values of the time for dose conversion factors for tritium (HT) and tritium oxide (HTO).

Specific data used and results can be found in document from CNSC Staff dated November 23, 2000 included in **Appendix F** of this review document.

The maximum dose to a member of the public from this hypothetical worse case scenario was calculated to be 1,655 μSv (microsieverts).

SMOLDERING FIRE WITHIN THE CONTROLLED AREA OF THE FACILITY (SMALL FIRE AS DEFINED BY CNSC STAFF)

In their 2000 review, CNSC Staff were not convinced that this proposed scenario was bounding and requested that further analysis be performed to define other possible hypothetical incident scenario as a result of a fire which was subsequently provided by SRB.

Nevertheless, CNSC Staff recalculated the dose to a fire responder from this hypothetical worse case scenario to reflect accepted values of the time for dose conversion factors for tritium (HT) and tritium oxide (HTO).

Specific data used and results can be found in document from CNSC Staff dated November 23, 2000 included in **Appendix F** of this review document.

The maximum dose to a member of the public from this hypothetical worse case scenario was calculated to be 7.5 mSv (millisieverts).

SMOLDERING FIRE THAT CAUSES STRUCTURAL FAILURE OF MEZZANINE (MEDIUM FIRE AS DEFINED BY CNSC STAFF)

In their 2000 review, CNSC Staff suggested that by using other assumptions this scenario could result in larger dose estimates. As a result, it was recommended that further fire safety analysis of the facility be carried out and actions be taken to ensure the facility is compliant with the fire code. In the interim, and as agreed by the licensee, procedural measures were implemented to limit the total quantities of tritium that could be stored under the mezzanine.

The dose to a fire responder from this hypothetical worse case scenario was recalculated for the sole reason of reflecting accepted values of the time for dose conversion factors for tritium (HT) and tritium oxide (HTO).

Specific data used and results can be found in the document from CNSC Staff dated November 23, 2000 included in **Appendix F** of this review document.

The maximum dose to a member of the public from this hypothetical worse case scenario was calculated to be 19 mSv (millisieverts).

TABULATION OF RESULTS FROM PREVIOUS REVIEWS

The maximum doses to a member of the public and first responders from the hypothetical worse case scenario previously defined analyzed in the year 2000 and earlier are tabulated below:

TABLE 1: MAXIMUM DOSE TO A RECEPTOR BASED ON ASSESSMENTS PERFORMED UP TO 2000

SCENARIO	MAXIMUM DOSE (mSv)	RECEPTOR
RELEASE OF THE ENTIRE CONTENTS OF A PYROPHORIC UNIT	0.042	MEMBER OF THE PUBLIC
RELEASE OF THE ENTIRE CONTENTS OF A BULK CONTAINER	4	MEMBER OF THE PUBLIC
TOTAL DESTRUCTION OF THE BUILDING BY FIRE	1.655	MEMBER OF THE PUBLIC
RELEASE FROM IMPACT OF A LARGE ROGUE VEHICLE	0.065	MEMBER OF THE PUBLIC
RELEASE FROM A TORNADO	0.016	MEMBER OF THE PUBLIC
SMOLDERING FIRE CAUSING STRUCTURAL FAILURE OF MEZZANINE	19	FIRST RESPONDER
SMOLDERING FIRE WITHIN THE CONTROLLED AREA OF THE FACILITY	7.5	FIRST RESPONDER

BENEFITS FROM IMPROVEMENTS

Improvements made to the safety programs and procedures coupled with equipment and system upgrades implemented over the years have reduced or eliminated the probability of the hypothetical incidents previously defined and analyzed to occur or reduced the maximum exposure to a receptor should an incident occur.

INSTITIUTED NEW FIRE PROTECTION ACTIVITIES

In their 2000 review, CNSC Staff recommended that further fire safety analysis of the facility be carried out and actions be taken to ensure the facility is compliant with the fire code. Since 2000 SRB has implemented a number of changes that reduce or eliminate the probability of the hypothetical incidents previously defined and analyzed to occur or reduce the maximum exposure to a receptor should an incident occur.

DEVELOPED A FIRE PROTECTION PROGRAM

Following the CNSC Staff's recommendation a "Fire Safety Plan" was developed in November 2000 in accordance with the Ontario Fire Code and submitted to the Pembroke Fire Department.

A "Life Safety Study" report was completed by NADINE INTERNATIONAL INC. in January 2003 in order to analyze compliance of SRB against applicable requirements of the National Building and Fire Codes and applicable NFPA Standards.

The Fire Safety Plan was expanded into SRB's first Fire Protection Program in October 2005. The Fire Protection Program was revised in April 2006 to ensure the company's compliance with the National Fire and Building Codes and the National Fire Protection Association, NFPA-801. The new Fire Protection Program was also complemented by a new Site Plan, a Fire Hazards Analysis, a Fire Systems Inspection Audit, a Pre-Incident Plan and a Fire Safety Plan.

INSTITUTED REGULAR INSPECTIONS FROM THE PEMBROKE FIRE DEPARTMENT

Numerous inspections were performed by the Pembroke Fire Department to ensure compliance against applicable fire codes and standards. Initially inspections were performed against Ontario Building and Fire Codes but in 2006 inspections were also performed against the National Fire and Building Codes and the National Fire Protection Association, NFPA-801.

Inspections were performed in November 2000, November 2002, March 2005, May 2006 and in May 2007. Any finding was promptly addressed.

In August 2006 the Pembroke Fire Department agreed to implement a systematic inspection program of the SRB facility and to perform yearly inspections of SRB, in May of each year.

INSTITUTED THIRD PART INSPECTIONS

SRB contracted Nadine International Inc. to perform a "Fire Hazards Analysis" of the facility with respect to the requirements of the National Fire and Building Codes, and of the National Fire Protection Association, NFPA-801.

As a result "Fire Hazards Analyses" were performed in 2005, 2006 and 2007 following dedicated on-site inspections. All recommendations of each "Fire Hazards Analysis" were promptly addressed.

IMPLEMENTED FIRE RESPONDER TRAINING

In April 2006 SRB funded the majority of a training program for NFPA and EMS course titles for the Officers of the Pembroke Fire Department. Course titles include: Respiratory Protection, Personal Protective equipment, Advanced Hazardous Waste Operations, Emergency Response Awareness, Spill Prevention and Control, Combustible and Flammable Liquids, Compressed Gas Safety and Radiation Safety.

On site training and familiarization was provided to members of the Pembroke Fire Department in November 2000, December 2002, June 2005 and in September 2006

For further conservatism past scenarios assumed that firefighters were not equipped with a SCBA. A SCBA would eliminate practically all tritium absorption by the lungs.

The training provided by SRB reinforces the importance of wearing of full protective clothing including a SCBA to reduce any exposure. The pre-fire safety plan prepared by the Pembroke Fire Department also mandates the use of SCBA's.

Therefore as a result of the use of SCBA's by fire responders, the exposure to a fire responder from an hypothetical incident scenario should be re-calculated accordingly.

IMPLEMENTED NEW STAFF TRAINING

Early staff fire extinguisher training was initiated and first conducted by the Pembroke Fire Department in August 2006 and in September 2007.

INSTITUTED FIRE ALARM DRILLS

SRB in conjunction with the Pembroke Fire Department performed fire alarm drills in August 2006 and in September 2007. Any finding was promptly addressed.

FAST RESPONSE TIME

The average response time of the Pembroke Fire Department for two false alarms in 2007 averaged 2 minutes and 35 seconds, the longest being 2 minutes and 37 seconds. The Average response time for the entire City of Pembroke in 2007 was 4 minutes and 2 seconds.

It is reasonable to assume that it would take a few minutes for a smoke detector to detect a fire and a few minutes for the alarm monitoring company to notify the Pembroke Department.

This little time reduces the possibility of a small fire to spread to any size of consequence and therefore reduces the possibility of the hypothetical scenario that would result in the total destruction of the building by fire.

INSTALLATION OF A SPRINKLER SYSTEM

In order to improve the life safety conditions at our facility, an automatic sprinkler system was installed in the SRB facility in 2006. A fire alarm control panel was also installed to monitor the sprinkler fire alarms.

The sprinkler system design was reviewed and approved by both the Pembroke Fire Department in July 2006 and by Nadine International Inc. in September 2006 against applicable requirements prior to installation. All recommendations were implemented.

Site inspections were performed by the Pembroke Fire Department and by Nadine International Inc. in October 2006 to verify sprinkler system installation against applicable requirements. All recommendations were implemented.

The fire alarm control panel was also verified in August 2006 against applicable ULC requirements by a member of the Canadian Fire Alarm Association.

The presence of a sprinkler system greatly reduces the possibility of a small fire to spread to any size of consequence and therefore the possibility of the hypothetical scenario that would result in the total destruction of the building by fire is no longer possible.

REDUCTION OF COMBUSTIBLE LOADINGS

Good housekeeping practices are maintained which reduces the possibility of clutter which could accelerate the spread of fire.

Since 2000 efforts have been made to reduce combustible loading in the facility, especially in the areas of the facility where tritium is handled.

The 2007 Fire Hazards Analysis reports that zones 2 and 3, the areas where tritium is stored on containers and in light sources have “minimal fire load” and represent a “low fire hazard”.

INSTITUTION OF FIRE PROTECTION EQUIPMENT INSPECTIONS

Since 2000 equipment inspections have been implemented to ensure continued operation and effectiveness of fire protection equipment. A “Fire Systems Inspection Audit” report was completed by Nadine International Inc. in January 2003 in order to provide recommendations on the maintenance inspections of the fire protection equipment being performed at SRB.

As a result, monthly inspections of the emergency lighting and fire extinguishers, to the requirements of the National Fire Code have been performed since March 2003. In addition monthly inspections of the sprinkler system and of the fire alarm control panel, to the requirements of the National Fire Code are being performed since January 2007.

CHANGES IN PRACTICES AND MODIFICATION OF THE MEZZANINE

When the review of hypothetical incident scenarios was performed in 2000, all shipping activities of product took place directly under the mezzanine thereby generating the possibility of a tritium release from the collapse of the mezzanine. In order to mitigate the dose to a receptor, in 2000 SRB implemented procedural measures to limit the total quantities of tritium that could be stored under the mezzanine.

In September 2002 all shipping activities were moved to a new area of the facility well away from the mezzanine. Therefore the possibility of a release of tritium from the hypothetical scenario of a smoldering fire that causes structural failure of mezzanine (medium fire as defined by CNSC staff) <u>is no longer possible</u>.

In addition, the 2007 Fire Hazards Analysis states that it is expected that a fire occurring in the mezzanine would be controlled by the automatic sprinkler system. In the event of a fire in this area, it is expected that one or two sprinkler heads would activate and control the fire. As the sprinkler flow is monitored by the Fire Alarm System, the Pembroke Fire Department would be notified of the fire during the early stages. Due to the layout of the mezzanine, it is expected that the damage caused as a result of a controlled fire would include fire and heat damage to the material in the vicinity of the fire. In 2007 modifications were made to ensure that the Mezzanine is fire separated from the remainder of the floor area. As a result, in the case of a fire, it is expected that integrity of the structure will be intact, and fire fighters will be able to access the Mezzanine area to attack and extinguish the fire.

ADDITION OF NEW EMISSION MONITORING EQUIPMENT

Since 2000 the majority of equipment used in emissions monitoring has been upgraded to more modern standards in order to provide better assurance of accuracy and to provide prompt warning of any release.

Releases are individually monitored by a tritium monitor connected to a real-time chart recorder and measured by the bubbler system. The real-time chart recorder provides real-time data of any release which in an incident situation could provide staff the time necessary to take measures to mitigate the impact from an incident.

ENSURE PERFORMANCE OF VENTILATION

Visual and audible alarms have also been installed that would be triggered in the event of ventilation malfunction. Ventilation equipment operation and effectiveness is important in mitigating the dose to a receptor depending on the incident scenario in question.

ADDITION OF MAINTENANCE PROGRAM

In March 2006, SRB developed its first Maintenance Program which incorporates monthly preventive maintenance that ensures continued operation and effectiveness of ventilation equipment.

CHANGES IN OPERATIONAL PROCEDURES

A number of procedures were implemented since 2005 which eliminate or reduce the probability of an incident or reduce the maximum possible release from a specific hypothetical scenario. Some of these procedures were implemented to meet operating restrictions of the licence at the time but will be maintained should tritium processing resume.

SUPERVISED BULK SPLITTING RIG USE

The bulk container is only used when loaded on the splitting rig. New procedures require that the bulk splitting rig shall only be operated if the operator is in the presence of a qualified supervisor adding another level of protection.

This reduces the possibility of an accidental release from a bulk container.

REDUCED MAXIMUM QUANTITY LOADED ON A BULK CONTAINER

The bulk container can be loaded up to 1,850 TBq (50,000 Ci) which represents the maximum allowable limit for the container. To reduce the impact from a release of the contents of the entire container new procedures require that bulk containers are only purchased and loaded up to 925 TBq (25,000 Ci).

Therefore as a result of this reduction, the exposure to a receptor from an hypothetical incident scenario resulting in the release of the entire contents of the bulk container should be re-calculated accordingly.

OPERATIONAL EXPERIENCE AND HISTORICAL DATA

Operational experience is one of the most important factors in determining the probability of some of the incidents to occur. Similar incidents in nature, that were of lesser consequence can be used to define new barriers of protection or mitigating measures to reduce the impact from an incident. Historical data and the findings outlined in the "Sources Report" were used in assessing the probability of certain incidents.

RELEASE OF THE ENTIRE CONTENTS OF A PYROPHORIC UNIT

This worst case scenario was for a significant release of tritium from a pyrophoric unit.

A pyrophoric unit is primarily used on a filling rig which is a piece of processing equipment that is used to dispense tritium from the pyrophoric unit to fill light sources.

The number of cycles performed on the filling rig varies depending on production demand. Records evaluated indicate that for 2005, 2006 and 2007 an average of 286.88 cycles have been performed per month. It is therefore reasonable to assume that 286.88 cycles have been have been performed per month since start of operations in December 1990 resulting in over 55,000 cycles.

According to all records available and staff interview results, during routine operations only a single occurrence of significant release from this source has occurred since the company's inception in December 1990. The release was reported to CNSC staff in a report dated October 1, 2002. A review of records showed that a release of 89 TBq (2,405 Curies) resulted from the incident. During the investigation it was recognized that there were several actions that could have been taken to eliminate the possibility of the recurrence of events of similar nature, these have since been incorporated in our operating procedures.

With all the changes and improvements made to the operation, in the future an operational release from the pyrophoric unit (source) is prevented by seven layers of protection. Multiple valves, pump, training of the operator and procedural steps would all have to fail for a significant release from a pyrophoric unit to occur as depicted in Figure 1 below:

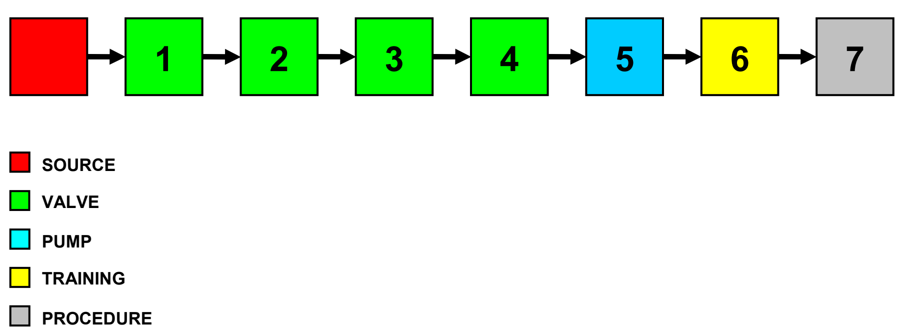

FIGURE 1: LAYERS OF PROTECTION FROM RELEASING CONTENTS OF PYROPHORIC UNIT

RELEASE OF THE ENTIRE CONTENTS OF A BULK CONTAINER

This worst case scenario was for releasing the entire content of a full bulk container.

A bulk container is primarily used on the bulk splitter which is a piece of processing equipment that allows the dispensing of tritium gas from one uranium bed to another. Bulk splitting is primarily performed to dispense the contents of a bulk container or AMERSHAM AY0666 container into a number of smaller pyrophoric units which are used on the filling rigs.

The number of cycle varies depending on production demand. Records indicate that for 2005, 2006 and 2007 an average of 389.76 cycles have been performed per year.

It is therefore reasonable to assume that 389.76 cycles have been have been performed per year since start of operations in December 1990 resulting in over 6,200 cycles.

According to all records available and staff interview results only a single occurrence of release from this source has occurred since the company's inception in December 1990. The release was reported to CNSC staff in a report dated June 21, 2005. It was concluded the incident resulted in a release of 107 TBq (2,887 Curies). During the investigation it was recognized that there were several actions that could have been taken to eliminate the possibility of the recurrence of events of similar nature, these have since been incorporated in our operating procedures.

With all the changes and improvements made to the operation, in the future an operational release from the bulk container (source) is prevented by eight layers of protection. Multiple valves, pump, training of the operator and of the supervisor and procedural steps would all have to fail for a significant release from a bulk container to occur as depicted in Figure 2 below:

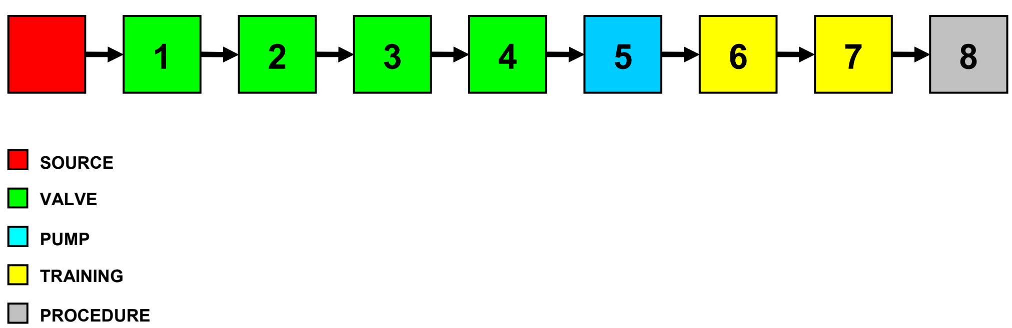

FIGURE 2: LAYERS OF PROTECTION FROM RELEASING CONTENTS OF BULK CONTAINER

TORNADO ACCIDENT

One of the hypothetical scenarios analyzed was the release of tritium resulting from the facility being subjected to a tornado of F2 scale with sustained winds with a velocity in excess of 55.5 m/s (200 Km/hr) causing a violent collapse of the building.

A review of Environment Canada's web site and other weather related web sites and publications did not reveal the occurrence of a major tornado since 1879 in either Pembroke or in its neighboring towns Cobden, Eganville, Renfrew and Petawawa.

According to the Atlas of Canada, in Canada, more than 70 tornadoes a year strike the populated regions. Fortunately, most are too weak to cause damage. In Canada, every province is subject to the risk of tornadoes (Figure 3). Overall, a third of the tornadoes occur in Ontario, and most of these are in the extreme southern part of the province.

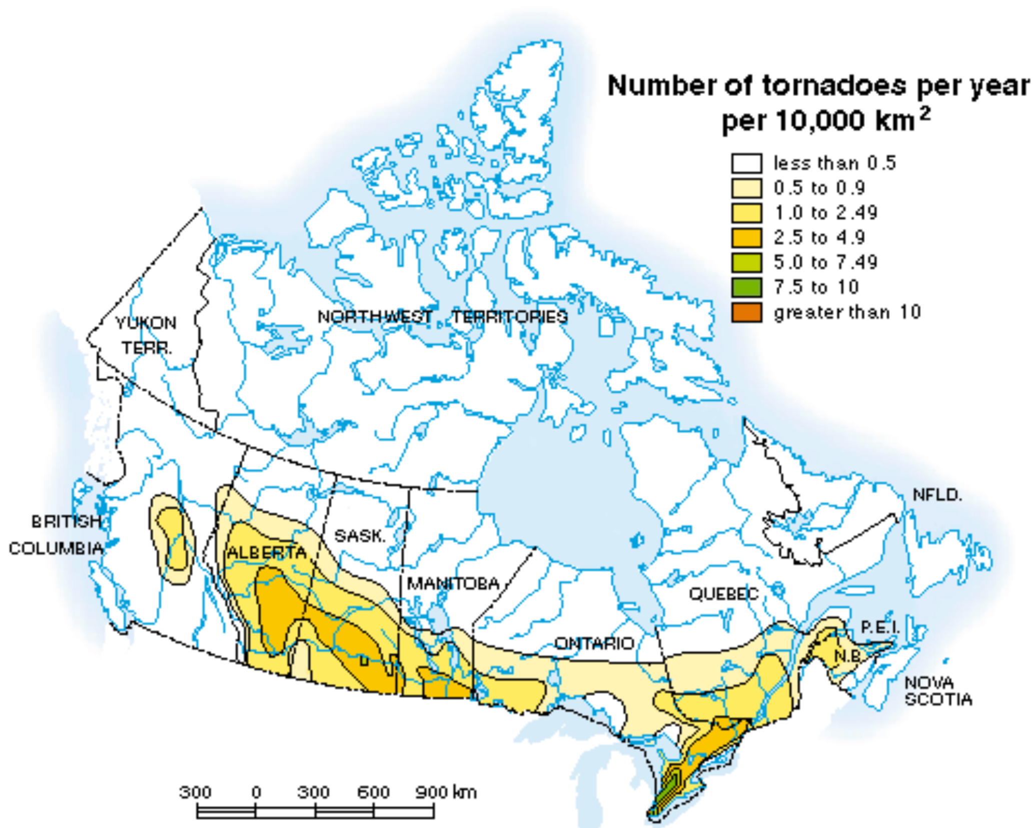

FIGURE 3: MAP OF THE ANNUAL NUMBER OF TORNADOES IN CANADA

IMPACT OF A LARGE ROGUE VEHICLE

Another hypothetical scenario analyzed was the release of tritium resulting from the impact of a large motor vehicle (heavier than 10,000 kg) with the facility with the vehicle coming to rest after penetrating the outside wall of the building.

Other than minor damage caused during snow plowing of the premises, at no time has a vehicle come in collision with any part of the building that has caused major structural damage. Such damage could only be caused deliberately. A vehicle that would loose control in the parking lot or on Boundary Road would have to turn at an angle of 90 degrees to come in collision with the building, the turn would itself scrub most of the speed from the vehicle reducing the force of the impact.

FIRE RELATED SCENARIOS

Since start of operation in December 1990, in 17 years of operation, not a single fire has occurred at the facility that required the intervention from the Pembroke Fire Department.

According to all records available and staff interview results only on one occasion has a small fire started at the facility that required the use of a fire extinguisher. This small fire occurred in the early 1990’s, in zone 1, in the glass shop where no tritium or products containing tritium is handled. The fire did not cause any damage. The fire occurred due to the storage of cardboard near the glass rolling machine. This practice was permanently discontinued immediately after the incident.

CREDIBILITY OF HYPOTHETICAL INCIDENTS

The credibility of hypothetical incidents and associated parameters must be revisited. Of the incidents previously defined and analyzed only a few are still credible considering all the improvements and changes made since 2000.

RELEASE OF THE ENTIRE CONTENTS OF A PYROPHORIC UNIT

Only one incident has occurred resulting in a significant release from a pyrophoric unit in over 55,000 cycles resulting in the release of 89 TBq (2,405 Curies). Since this incident additional measures have been implemented which eliminates the circumstances of this particular incident from re-occurring, resulting in a remote possibility that a significant release from a pyrophoric unit would occur. Seven layers of protection prevent an operational release but a remote possibility still exists that a failure of the container occur while a filling operation takes place.

The scenario was initially calculated using a release of only 56 TBq (1,514 Ci) from a pyrophoric unit. Since the unit can contain up to 111 TBq (3,000 Curies) and a previous incident resulted in the release of 89 TBq (2,405 Curies), it would be reasonable to assume that all its contents could be released although it is more likely that the container would be partially full. The scenario will therefore be recalculated to be more conservative and assume a release of the entire contents of the container of 111 TBq (3,000 Curies).

Previous assessments assumed that 100% of the contents would be converted to tritium oxide (HTO) and released. This is conservative but not at all credible. Review of emissions between 1996 and 2006 (while tritium processing took place) show that tritium oxide releases account for 12% of total releases on average, with the highest being 25%. In addition, emissions from the last 21 weeks of operation (since most effective mitigation measures were implemented) show that SRB's HTO releases constitute approximately 15% of total emissions. It would therefore be realistic and conservative to use a 25% conversion rate. 25% also exceeds the oxide content found in aged lights sources in the study by R.J. Traub and G.A. Jensen (reference number 16).

CNSC Staff assessment performed in 2000 assumed that the most unstable atmospheric conditions as characterized under Pasquill A would provide the most conservative approach for assessment of the maximum dose to a receptor. SRB will however assess the maximum dose to a receptor for all stability classes to determine the most conservative conditions.

Previous calculations for this scenario suggest that the closest point where the highest dose received was at 2.5 km from the facility. It would be best to calculate the maximum possible dose at various distances from the facility ranging from 100 meters to a distance where the dose is expected to decline.

RELEASE OF THE ENTIRE CONTENTS OF A BULK CONTAINER

Only one incident has occurred resulting in a significant release from a pyrophoric unit in over 6,200 cycles resulting in the release of 107 TBq (2,887 Curies). Since this incident additional measures have been implemented which eliminates the circumstances of this particular incident from re-occurring, resulting in a remote possibility that a significant release from a pyrophoric unit would occur. Eight layers of protection prevent an operational release but a remote possibility still exists that a failure of the container may occur while a bulk splitting operation takes place.

The scenario was initially calculated using a release of 1,110 TBq (30,000 Ci) from a bulk container, in 2000 CNSC Staff assumed that since the unit can contain up to 1,850 TBq (50,000 Curies) that it would be reasonable to assume that all its contents could be released. SRB has not purchased or received a container with more than 925 TBq (25,000 Curies) since July 2005. In addition, new procedures require that bulk containers are only purchased and loaded up to 925 TBq (25,000 Ci). Therefore as a result of this reduction, the exposure to a receptor from an hypothetical incident scenario resulting in the release of the entire contents of the bulk container should be re-calculated accordingly.

Previous assessments assumed that 100% of the contents would be converted to tritium oxide (HTO) and released. This is conservative but not at all credible. Review of emissions between 1996 and 2006 (while tritium processing took place) show that tritium oxide releases account for 12% of total releases on average, with the highest being 25%. In addition, emissions from the last 21 weeks of operation (since most effective mitigation measures were implemented) show that SRB's HTO releases constitute approximately 15% of total emissions. It would therefore be realistic and conservative to use a 25% conversion rate.

CNSC Staff assessment performed in 2000 assumed that the most unstable atmospheric conditions as characterized under Pasquill A would provide the most conservative approach for assessment of the maximum dose to a receptor. SRB will however assess the maximum dose to a receptor for all stability classes to determine the most conservative conditions.

Previous calculations for this scenario suggest that the closest point where the highest dose received was at 2.5 km from the facility where the CNSC assumed that the highest dose was received at 100 meters from the facility. It would be best to calculate the maximum possible dose at various distances from the facility ranging from 100 meters to a distance where the dose is expected to decline.

TORNADO ACCIDENT

Although no major tornadoes have occurred in either Pembroke or in its neighboring towns Cobden, Eganville, Renfrew and Petawawa, a remote possibility exists of the occurrence of a major tornado of F2 scale with sustained winds with a velocity in excess of 55.5 m/s (200 Km/hr) causing a violent collapse of the building.

At the time the hypothetical scenario assumed that approximately 50% (150,000 Ci or 5,550 TBq) of the maximum possible inventory on site (based on the possession limit of the licence at the time) would be contained in sealed glass capsules and released at ground level as a result of the collapse of the building.

The possession limit in SRB's licence was amended at SRB's request in an amendment granted on a decision release on May 11, 2007. The possession limit was reduced by 45% from 11,000 TBq (297,297 Curies) to 6,000 TBq (162,162 Curies).

Records indicate that for 2005, 2006 and January 2007 while SRB processed tritium, an average of 3,753 TBq (101,426 Curies) was contained in sealed glass capsules, with the maximum being 5,041TBq (136,249 Curies) which represented 46% of the inventory limit at that time. The possession limit is now lower, and practices proportionally minimize the inventory contained in sealed glass capsules. It therefore likely that the inventory of glass tubes will represent approximately 50% of the total possible inventory on site and it would be conservative to assume that a the maximum worse case hypothetical scenario could be based on the maximum of 60% of the new possession limit which is equal to 3,600 TBq (97,297 Curies).

Previous assessments assumed that 1.5% of the contents would be converted to tritium oxide (HTO) and released. This is not conservative. Review of emissions between 1996 and 2006 (while tritium processing took place) show that tritium oxide releases account for 12% of total releases on average, with the highest being 25%. In addition, emissions from the last 21 weeks of operation (since most effective mitigation measures were implemented) show that SRB's HTO releases constitute approximately 15% of total emissions. It would therefore be realistic and conservative to use a 25% conversion rate.

It remains conservative to assume that being subjected to a tornado would yield the most unstable atmospheric conditions as characterized under Pasquill A as assumed in the assessments to date.

Previous calculations for this scenario suggest that the closest point where the highest dose received was at 100 m from the facility. It would be best to calculate the maximum possible dose at various distances from the facility ranging from 100 meters to a distance where the dose is expected to decline.

IMPACT OF A LARGE ROGUE VEHICLE

Although it is extremely unlikely that a vehicle would deliberately come in collision with any part of the building that would cause major structural damage a remote possibility still exists of it occurring.

The original scenario was calculated assuming the impact takes place against the wall of the storage room, which is located in zone 3. The hypothetical scenario originally assumed that approximately 60,000 Ci (2,220 TBq) would be stored in this room in sealed glass capsules and entirely released as a result of the collapse of the wall of the storage room.

Records indicate that for 2005, 2006 and January 2007 while SRB processed tritium, an average of 17,928 Curies (663 TBq) was stored in this room in sealed glass capsules, with the maximum being 32,049 Curies (1,186 TBq). Presently very little is stored in this room. The current possession limit is 45% lower than the former possession limit, this will minimize the inventory contained in sealed glass capsules on site. It therefore very conservative to assume that a the maximum worse case hypothetical scenario could be based on the maximum of 32,049 Curies (1,186 TBq). The original scenario also assumed that 100% of the tubes would be broken which is not at all credible.

The storage room houses tritium filled tubes that have been removed from the components of expired devices. The storage room is further described on page 10 of the “Sources Report”. Tritium filled tubes are stored in plastic bags which in turn are placed in sturdy plastic bins. Usually some adhesive that was used to bond the tubes inside the assembly components is left on the tubes which provides further protection and shock absorption. Bins are stored on industrial metal shelving. The original scenario assumes that 100% of the tubes would be broken which is not at all credible. Given that the tubes are stored in robust bins that would prevent a lot of the tubes from breaking. It would be more realistic and still conservative to assume that 50% of the tubes 16,025 Curies (593 TBq) would be broken from a collapse of the wall or penetration of the vehicle into the room. Therefore as a result of this reduction, the exposure to a receptor from an hypothetical incident scenario resulting in the release of 16,025 Curies (593 TBq) from this room should be re-calculated accordingly.

Previous assessments assumed that 1.5% of the contents would be converted to tritium oxide (HTO) and released. This is not conservative. Review of emissions between 1996 and 2006 (while tritium processing took place) show that tritium oxide releases account for 12% of total releases on average, with the highest being 25%. In addition, emissions from the last 21 weeks of operation (since most effective mitigation measures were implemented) show that SRB’s HTO releases constitute approximately 15% of total emissions. It would therefore be realistic and conservative to use a 25% conversion rate.

CNSC Staff assessment performed in 2000 assumed that the most unstable atmospheric conditions as characterized under Pasquill A would provide the most conservative approach for assessment of the maximum dose to a receptor. SRB will however assess the maximum dose to a receptor for all stability classes to determine the most conservative conditions.

The CNSC Staff review calculated the dose assuming that an individual would be standing 100 meters downwind from the release (at the point of highest concentration) for the entire duration of the passage of the contaminated plume. It would be best to calculate the maximum possible dose at various distances from the facility ranging from 100 meters to a distance where the dose is expected to decline.

TOTAL DESTRUCTION OF THE BUILDING BY FIRE

As a result of the numerous fire protection activities instituted by SRB and the installation of an automatic sprinkler system, we strongly believe that it is no longer possible for this scenario to occur.

The 2007 Fire Hazards Analysis states the most likely fire scenario for SRB would involve a fire occurring on the mezzanine level. The Fire Hazards Analysis further states that it is expected that a fire occurring in the mezzanine would be controlled by the automatic sprinkler system by one or two sprinkler heads. As both smoke detectors and sprinkler flow are monitored by the Fire Alarm System, the Pembroke Fire Department would be notified of the fire during the early stages. The response time of less than 3 minutes and the familiarity that the firefighters have with the facility through their training would ensure that a small fire would be quickly extinguish. The possibility of a small fire to spread to any size of consequence that would result in the total destruction of the building by fire we believe is no longer possible and will no longer be assessed.

SMOLDERING FIRE THAT CAUSES STRUCTURAL FAILURE OF MEZZANINE

This scenario assumed that the fire resulted in the structural collapse of the mezzanine onto the shipping area while the shipping area contained the largest quantity of material ever likely to be shipped at one time (20,000 Ci or 740 TBq).

In September 2002 all shipping activities have been moved to a new area of the facility well away from the mezzanine. Therefore the possibility of a release of tritium from the hypothetical scenario of a smoldering fire that causes structural failure of mezzanine (medium fire as defined by CNSC staff) is no longer possible.

SMOLDERING FIRE WITHIN THE CONTROLLED AREA OF THE FACILITY

This scenario assumed firemen, in their efforts to extinguish a fire, would use sufficient water force to break a significant number of sealed glass capsules containing tritium, causing a tritium release.

Although numerous fire protection activities have been instituted by SRB with the installation of an automatic sprinkler system a remote possibility still exists that a small smoldering fire could occur that would require firemen to use a fire hose that would result in the breakage of sealed glass capsules containing tritium in a localized part of the facility.

The scenario assumed that firefighters were not equipped with an SCBA. An SCBA eliminates practically all tritium absorption by the lungs. As a result of both the training received and the procedures that were put in place since 2000, firemen are required to wear an SCBA when entering the facility thereby eliminating the possibility of significant exposure to a fireman from a smoldering fire within the controlled area of the facility.

A possibility however still exists that during work hours a small smoldering fire breaks out in the facility which would be extinguished with the use of a fire extinguisher by one of the staff members without intervention from the fire department. The force exerted by the spray from a fire extinguisher is much smaller than the force exerted by a water from a hose. This would result in much less breakage of light sources, if any.

In the original scenario it was determined that an entire bucket containing a quantity of 100 sealed tubes each containing 2.19 Curies (81 GBq) would be released. For conservatism we will continue to assume that a quantity of 100 sealed tubes each containing 2.19 Curies (81 GBq) would be released.

The scenario will therefore be recalculated assuming exposure is to a staff member.

Previous assessments assumed that 1.5% of the contents would be converted to tritium oxide (HTO) and released. This is not conservative. Review of emissions between 1996 and 2006 (while tritium processing took place) show that tritium oxide releases account for 12% of total releases on average, with the highest being 25%. In addition, emissions from the last 21 weeks of operation (since most effective mitigation measures were implemented) show that SRB's HTO releases constitute approximately 15% of total emissions. It would therefore be realistic and conservative to use a 25% conversion rate.

In the original scenario the room in which the incident was assumed to take place was zone 2 or the assembly room which was assumed to have a volume of only 198 m^3. The volume of this room was verified calculated and found to equal 522 m^3, with a floor area of 180 m^2 and a ceiling height of approximately 2.9 meters.

The scenario made the most conservative assumption that the tritium concentration in the assembly room would stay constant for the entire stay time and be equal to the initial concentration assuming the ventilation has failed and no other ventilation exists.

It was also assumed that fire personnel stay time was 15 minutes. In reality with a sprinkler system only a very small fire could break out which would be extinguished by the contents of a single 5 or 10 lbs fire extinguisher found throughout the facility. Such extinguishers would take considerably less than a minute to empty, even if two extinguishers are used it is expected that a fire would be extinguished in much less than 5 minutes. It would therefore be credible and conservative that a stay time of 5 minutes maximum be used.

The scenario made the most conservative assumption that the tritium concentration in the assembly room would stay constant for the entire stay time and be equal to the initial concentration assuming the ventilation has failed and no other ventilation exists.

DETERMINATION OF ADDITIONAL HYPOTHETICAL INCIDENTS

A review has also been undertaken in order to determine any additional hypothetical incidents that might not have been previously identified.

A systematic approach was undertaken based on the work performed to complete the document titled "Sources Report" dated March 29, 2007.

The systematic approach consisted of a number of different activities:

- An analysis of tritium movement through entire facility and each individual process.

- A review of historical records held that may provide insight on a historical event or work practice that could result in an additional hypothetical incident.

- Interviews with staff who may have insight who maybe able to identify additional hypothetical incidents based on their knowledge and work experience.

TRITIUM MOVEMENT THROUGH FACILITY

An analysis of tritium movement through the entire facility and each individual process was performed in order to get a detailed understanding of where tritium is used and stored in the facility which will in turn help determine potential and known sources for additional hypothetical incidents. A schematic of the facility was reviewed to show areas where tritium is processed, where tritium light sources and devices containing tritium light sources are handled and where tritium contaminated waste is handled and generated.

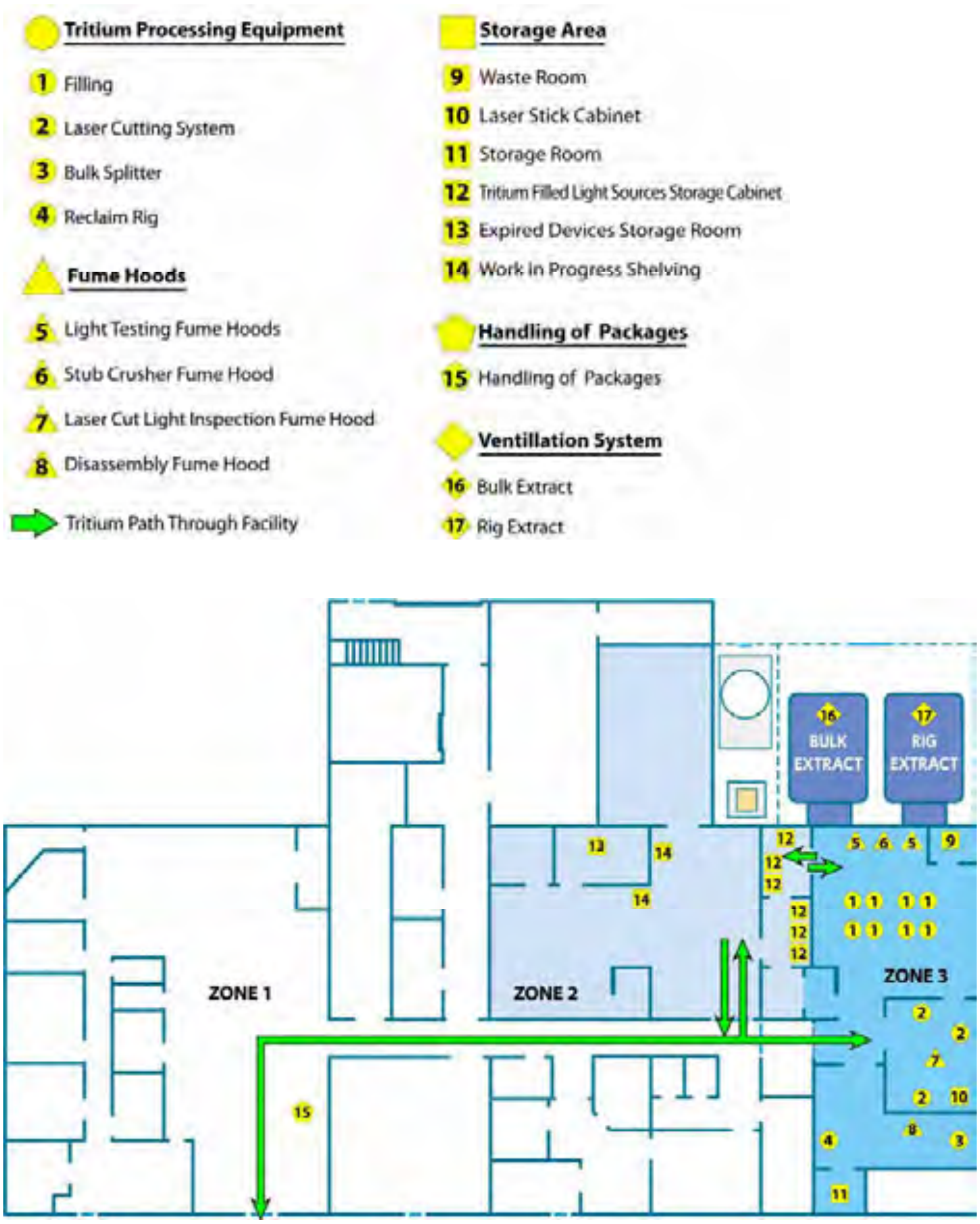

FIGURE 4: DIAGRAM OF TRITIUM AND PRODUCT MOVEMENT THROUGH FACILITY

The flow chart used in the “Sources Report” was also used here in order to systematically identify main activities performed at the facility that could result in a release of tritium. Each activity was individually analyzed to determine if any additional hypothetical incident could result from the activity.

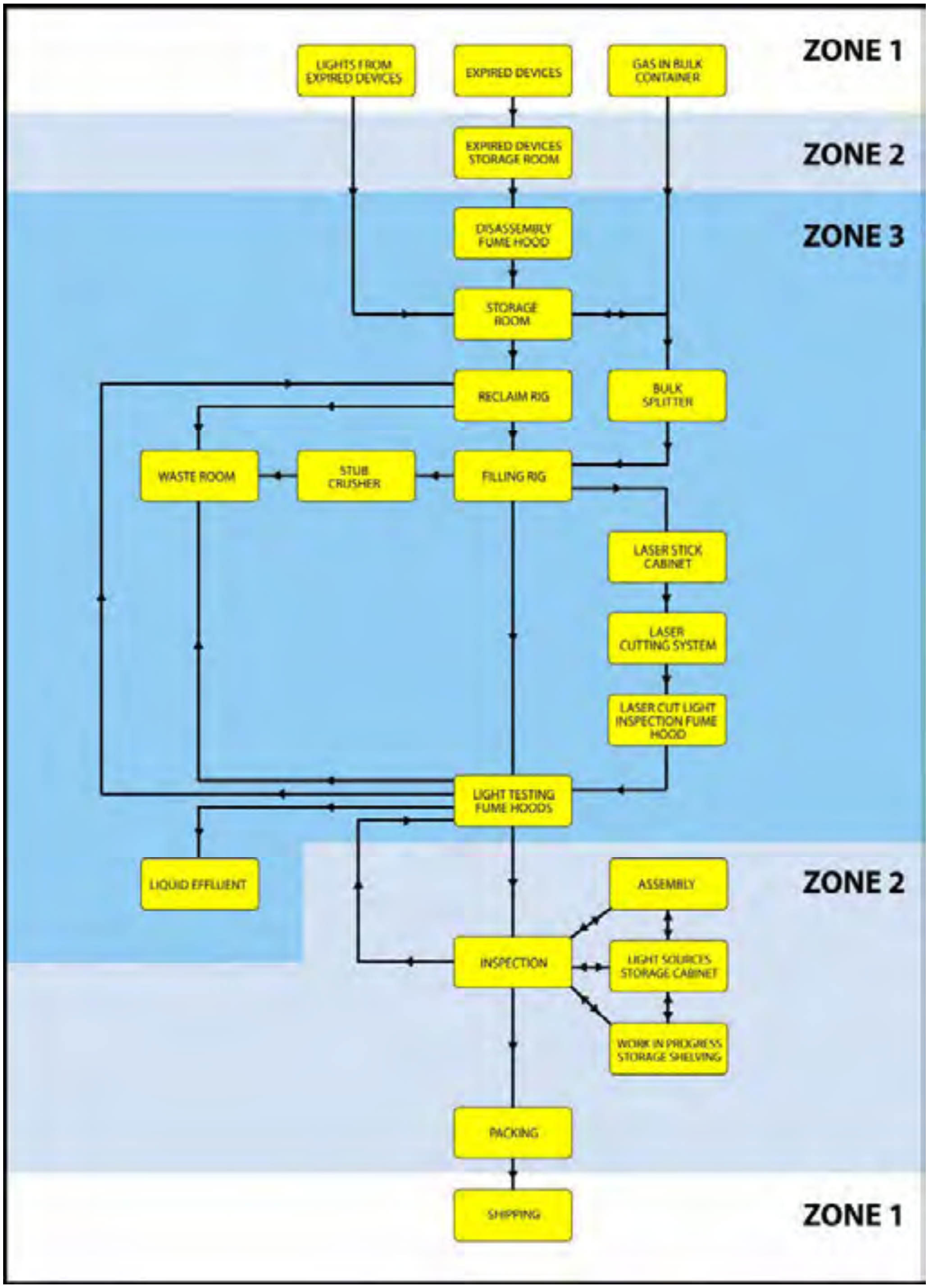

FIGURE 5: FLOW CHART OF TRITIUM AND PRODUCT MOVEMENT THROUGH FACILITY

RECEIPT OF A BULK CONTAINER

The release of the entire contents of a bulk container has already been defined and analyzed as an hypothetical scenario. This release however was presumed to occur in zone 3 where ventilation is the most effective.

A potential source of potential release of tritium could occur if the contents or part of the contents of a container is released in zone 1 as it is being received, or as it is moved to the storage room in zone 3 until the container is removed from the overpack and installed on one of ports of the bulk splitter.

These bulk containers are contained in a Type ‘B’ Package or overpack that has been tested and is capable of enduring the rigours of transport. These containers are received at SRB by individuals certified in accordance with Section 6 of the Transportation of Dangerous Good. These individuals ensure that the package is checked to ensure that there is no evidence of damage or tamper. Once received the container is immediately transferred to zone 3.

A member of the Health Physics Department also verifies that the container is checked to ensure that there is no evidence of damage or tamper. A member of the Health Physics Department then further ensures that the contents of the package are also not damaged or have escaped using a portable tritium in air monitor. The container would then be placed in secure storage area in the storage room or the bulk container would be removed from the overpack and installed on one of the ports of the bulk splitter. Since the container is designed in such a manner as the gas within the container is only released by opening its valve and heating the container to 450 degrees Celsius any potential release from this source would only result from surface contamination from the container and not result in a significant dose to a receptor.

Before the shipment is made by the supplier, under the transport regulations, the packaging is checked to ensure that removable surface contamination on the packaging is less than 4 Bq/cm^2. This would also ensure that tritium is not leaking from the package and only very low levels of tritium contamination would result.

In addition according to all records available and staff interview results no occurrence of release from this source has occurred since the company’s inception in December 1990. For these reasons the probability for receipt of a container to result in an hypothetical scenario <u>is not credible</u>.

RECEIPT OF DEVICES AND LIGHT SOURCES

Devices or light sources received for onward distribution or received for disposal are received regularly as Excepted packages (UN2910 or UN2911) and Type ‘A’ packages (UN2915). Packaging meets the requirements of the IAEA Regulations for the Safe Transport of Radioactive Material and IATA Dangerous Goods Regulations. These packages can contain as much as 1,000 Curies per package. Quantities per package over the years have varied from 0 to 1,000 Curies. These packages are shipped using the services of an approved courier services.

A potential source of potential release of tritium could occur if the contents or part of the contents of a package is released in zone 1 as it is being received, or as it is moved to zone 3 and where the light sources are removed from the packaging and placed in plastic bags which in turn are placed in plastic bins in the storage room. .

The Excepted packages and Type 'A' packages in which these light sources are packed have been tested and are capable of enduring the rigors of transport.

These packages are received at SRB by individuals certified in accordance with Section 6 of the Transportation of Dangerous Good. These individuals ensure that the packages are checked to ensure that there is no evidence of damage or tamper. Once received the packages are immediately transferred to zone 3.

A member of the Health Physics Department would also verify that the packages are checked to ensure that there is no evidence of damage or tamper. A member of the Health Physics Department then further ensures that the contents of the packages are also not damaged or have escaped using a portable tritium in air monitor.

The light sources are removed from the packaging and placed in plastic bags under the disassembly fume hood in zone 3. During staff interviews it was revealed that in some instances the unpacking activities took place in zone 2 rather than zone 3.

Before the shipment was made by the shipper, under the transport regulations, the packaging is checked to ensure that removable surface contamination on the packaging is less than 4 Bq/cm^2. This would also ensure that tritium is not leaking from the package and only very low levels of tritium contamination would result.

It has been noted during staff interviews that on a few occasions that packages of lights showed signs of tritium leaks after being checked with a tritium-in-air monitor resulting from one broken or leaking tube. For this reason it is credible that a shipment of light sources may result in exposure to staff members. However tubes received average 1.08 Curies in activity at time of manufacture. In addition the tritium light sources are protected by the Excepted packages and Type 'A' packages and housing in the case of devices, a release would likely only result in the breakage of one tube. The tritium from one tube, even if entirely released as tritium oxide would result in a very low dose to an employee and will therefore not be considered as an additional hypothetical incident.

BULK SPLITTER OPERATION

The bulk splitter is a piece of processing equipment in zone 3 that allows the dispensing of tritium gas from one uranium bed to another. Bulk splitting is primarily performed to dispense the contents of a bulk container or AMERSHAM AY0666 container into a number of smaller pyrophoric units which are used on the filling rigs. The largest release which could occur as a result of the operation of the bulk splitter is the release of the entire contents of either a bulk container or a pyrophoric unit which has already been defined as a hypothetical scenario.

FILLING RIG OPERATION

The filling rig is a piece of processing equipment that is used to dispense tritium from a uranium bed to fill as many as 100 light sources. The largest release which could occur as a result of the operation of a filling rig is the release of the entire contents of a pyrophoric unit which has already been defined as an hypothetical scenario.

RECLAIM RIG OPERATION

The reclaim rig is a piece of processing equipment that recycles tritium gas from light sources removed from expired devices located in the storage room and lights transferred from the light testing fume hoods that were rejected at various stages of the manufacturing process. The largest release which could occur as a result of the operation of the reclaim is the release of the entire contents of either a bulk container or a pyrophoric unit which has already been defined as an hypothetical scenario. In future operation of the facility it is planned to no longer operate the reclaim rig, thereby eliminating any hypothetical accident scenario from this operation.

STUB CRUSHER OPERATION

The stubs generated when a cycle on a filling rig is performed are loaded in a simple crushing device in order to reduce the volume of the waste generated. Stubs are normally crushed a few times a day resulting in the release of low levels of tritium with each operation. The dose to a receptor would be very low and will therefore not be considered as an additional hypothetical incident.

LASER CUTTING OPERATION

The laser cutting system is a piece of processing equipment that is used as a secondary sealing process.

When a cycle on a laser cutting system is performed a single tritium filled tube is inserted in a sealed cutting chamber. The tritium filled tube is then exposed to a low energy CO_2 laser to further seal the tritium filled tube into smaller sealed capsules. This secondary sealing process produces a very straight seal and is only performed at the request of the customer or if such a seal characteristic is necessary for fitting the tritium filled source in an intended device. After the lights are cut into smaller sections they are directed to a collection vessel at the bottom of the cutting chamber. After a number of tubes are processed, the operator opens the sliding doors of the ventilated cabinet which also houses the cutting chamber and empties the contents of the collection vessel in a plastic container. The container is then sealed with a lid and moved to the laser cut light inspection fume hood. Ventilation to the cutting chamber is provided by the bulk extract.

While processing, a small number of tubes may be broken by the mechanism or not sealed properly. Tubes can only be broken one at a time, since tubes average 1.08 Curies in activity, the tritium from one tube, even if entirely release as tritium oxide would result in a very low dose to an employee and will therefore not be considered as an additional hypothetical incident.

LIGHT TESTING

All tubes are subjected to a high temperature sealing test to the requirements of internationally recognized industry standards. The test performed ensures the integrity of the sealing process. Any failure of this process will result in a release of tritium from the light source. Such failures are infrequent in the order of one or two lights per week.

All lights are then checked for leakage with a tritium in air monitor. To ensure that the most minute leaks are detected the lights are then submerged in water in a plastic container and subjected to liquid scintillation testing to the requirements of internationally recognized industry standards. The water would capture any of the tritium released from the light sources. This liquid would be assessed for tritium concentration and disposed to the sewer system which will also be considered as a source in further discussions.

Ventilation to these fume hoods are provided by the rig extract. Tubes manufactured average 1.08 Curies in activity. Typically only two tubes are broken per week, if we assume that these tubes are broken at the same time, even if entirely released as tritium oxide would result in a very low dose to an employee and <u>will therefore not be considered as an additional hypothetical incident</u>.

SEWER LINE LEAK

As a result of the manufacturing process, tritium contaminated liquids are generated which are disposed to the sewer system. Tritium in liquid form is comprised of wash water used to wash work areas and plastic containers, water used in the liquid scintillation procedure, well purge water, well water, as well as water from any other procedure or sampling method.

Between 2003 and 2007 annual liquid releases have not exceeded 50 GBq, ranging between 8 and 50 GBq, with weekly releases averaging less than 1 GBq. Pipes near SRB are some of the newer ones in Pembroke, 25 to 30 year old pipes with gaskets made of PVC or asbestos cement. Any leaks would be expected to be small. Sewage lines from SRB are also gravity fed and not under pressure therefore leaks are likely to allow infiltration rather than outward flow. Samples at sewage plant are performed on a daily basis to allow us to determine that releases have resulted in concentrations within the range of those expected (less than 150 Bq/L). Results are continuously assessed against expected concentrations to assess the presence of possible leaks.

Based on discussions with the City of Pembroke Utilities Department Staff, a large leak in the pipes near SRB is extremely unlikely. In the unlikely event of a large leak, City of Pembroke Utilities Department Staff would become aware of such a leak very quickly and the repairs would be performed immediately. In that time, SRB would have released much less than its weekly average of 1 GBq which would result in a very low dose to worker trying to repair the leak and will therefore <u>not be considered as an additional hypothetical incident</u>.

RELEASE FROM BREAKAGE DURING HANDLING

All tritium filled light sources are transferred from zone 3 to zone 2 to the inspection area for final inspection or to the assembly area for assembly into devices or painting.

Staff receive extensive training to ensure that light sources are handled to ensure that breakages are minimized. A remote possibility does exist however that lights could be dropped causing a number of lights to break resulting in a release of tritium. Due to the high negative pressure in zone 3, the air from this area flows to zone 3 and is being monitored by the tritium monitors connected to the chart recorder for real time monitoring and measured by the bubbler system.

Typically breakage occurs once or twice a week consisting of tubes that average 1.08 Curies in activity. The tritium from one tube, even if entirely released as tritium oxide would result in a very low dose to an employee. According to all records available and staff interview results no occurrence of release from this scenario has occurred since the company's inception in December 1990, it is however credible that a bin containing a number of lights is dropped while being carried from one area to another causing a number of tubes to break.

Review of bin contents performed in January 2008 showed that the maximum that a bin contained was 621 tubes totaling 465.75 Ci (17 TBq). It is therefore credible that a bin containing 621 tubes totaling 465.75 Ci (17 TBq) would be dropped causing the breakage of 50% of the tubes within the bin at most. This scenario will therefore be calculated assuming exposure is to a staff member.

The assessment will assume that 25% of the contents would be converted to tritium oxide (HTO) and released.

The scenario will be assumed to take place in zone 2 or the assembly room with a volume of 522 m^3.

The scenario will make the most conservative assumption that the tritium concentration in the assembly room would stay constant for the entire stay time and be equal to the initial concentration assuming the ventilation has failed and no other ventilation exists.

Breakages would immediately be observed by staff shortly thereafter resulting in the sounding of either a room or portable tritium in air monitor. Personnel would evacuate the work area very quickly, personnel stay time would therefore be much less than 2 minutes.

RELEASE FROM BREAKAGE DURING PACKING

After completing the final inspection stage, lights and devices are packaged in bubble bags or other protective containment before leaving zone 2 before being moved to the packing and shipping area in order to be placed in outer packaging in preparation for transport. Staff receive extensive training to ensure that lights sources are handled to ensure that breakages are minimized. A remote possibility does exist however that lights could be dropped causing a number of lights to break resulting in a release of tritium.

The devices are exit signs, emergency lighting devices or military tactical devices which have also been subjected to various performance tests that would make the devices capable of enduring the rigours of handling and use. All items removed from zone 2, including these packages and exit signs are assessed for removable contamination levels.

The acceptable contamination levels for items to be removed from Zones 2 and 3 are 4 Bq/cm^2 based on a 100 cm^2 swipe area.

According to all records available and staff interview results no occurrence of release from this scenario has occurred since the company's inception in December 1990, it is however credible that a bin containing product is dropped while being carried to the shipping area causing a number of tubes to break.

Due to the high negative pressure in zone 3, the air from this area flows to zone 3 and is being monitored by the tritium monitors connected to the chart recorder for real time monitoring and measured by the bubbler system.

Since the product is already packaged in bubble bags or other protective containment before leaving the assembly area it is unlikely that a large number of tubes would be broken. To be conservative however, It will therefore be assumed that as much as 10% of the tubes contained within a bin that is dropped is broken.

Review of records from January 2005 to January 2008 show that an average shipment contains 725 Curies (27 TBq) to maximum of 23,751 Curies (879 TBq). Depending on the size of the shipment, a number of bins may be used to transfer the shipment to the packing and shipping area. The bins used allow have enough space to store the number of lights necessary to pack approximately two SRB Type 'A' packages (UN2915). These packages can contain as much as 1,000 Curies per package. It would therefore be conservative to assume that a bin containing 2,000 Curies (74 TBq) of product is dropped causing the release of 10% of its contents exposing a worker.

The assessment will assume that 25% of the contents would be converted to tritium oxide (HTO) and released.

The scenario will be assumed to take place in zone 1, specifically in the packaging and shipping area, this is a room that is 18.29 meters long by 7.01 meters wide and 4.57 meters high yielding a total volume of 586 m^3.

The scenario will make the most conservative assumption that the tritium concentration in the room would stay constant for the entire stay time and be equal to the initial concentration assuming no ventilation exists.

Breakages would immediately be observed by staff shortly thereafter. Personnel would move the bin from the shipping area to an area where the best direct ventilation is provided in zone 3. The personnel exposure time would therefore be much less than 2 minutes.

REVIEW OF ANALYTICAL METHOD

The analytical method, calculations and parameters used to calculate the maximum dose to a receptor must also be reviewed to ensure that they are still appropriate.

Hypothetical scenarios that result in a release to the atmosphere require the determination of the tritium concentration in the atmosphere resulting from the release. This is typically done by conventional dispersion theory in which a contaminated plume is defined. Once the concentration is known at various points along the plume, and the point established at which the plume contacts the ground elevation, the dose to an individual at ground level can be calculated.

TRITIUM CONCENTRATION IN THE ATMOSPHERE

The analytical method used in the assessments performed in 2000 by SRB consultants, Alpha-Dyne LLC was developed by D.B. Turner found in the "Workbook of Atmospheric Dispersion Estimates" from the U.S. Department of Health published in 1970. This method was used as it generally followed the same method that was used for assessing the impact to the public from an hypothetical scenario during the original licensing of the facility. The second edition, published in 1994 of Turner's "Workbook on Atmospheric Dispersion Estimates" was used for the revised calculation in this document. The changes made between the 1970 and 1994 editions was found not to affect the calculations or results.

The standard from the Canadian Standards Association on "Guidelines for Calculating Radiation Doses to the Public from a Release of Airborne Radioactive Material under Hypothetical Accident Conditions in Nuclear Reactors" (CAN/CSA-N288.2-M91) published in 1991 was also reviewed but not used for assessment of dose.

Turner presents practical applications of the continuous plume dispersion model to estimate contaminant concentrations in the air. Meteorologists estimate dispersion effects based on Pasquill's atmospheric surface layer stabilities and our calculations have followed this standard method. Concentrations are calculated as follows:

$$\chi = (Q / \pi \, \sigma_z \, \sigma_y \, V) \exp(-H^2 / 2 \, (\sigma_z)^2) \qquad (1)$$

Where,	χ	=	tritium concentration (Curies/meter cubed)
	Q	=	the rate of release (Curies/second)
	σ_y	=	empirically derived diffusion coefficient (meters) for a particular Pasquill stability in the horizontal plane
	σ_z	=	empirically derived diffusion coefficient (meters) for a particular Pasquill stability in the vertical plane
	V	=	wind velocity (meters/second)
	H	=	effective height of release (meters)

PASQUILL STABILITY

As explained by Turner, Pasquill presents a method of estimating dispersion if there are no measurements of wind fluctuation. The horizontal angular spreading of the plume at two distances downwind from the source, for different stabilities, and a graphical presentation of the height of the plume, also at various distances downwind for different stabilities, are given along with the equations to determine downwind concentrations. The technique assumes Gaussian horizontal and vertical concentration distributions converting the horizontal plume widths to σ_y and the plume heights to σ_z. Plots of these dispersion parameters on a logarithmic scale as a function of downwind distance from source to receptor, also on a logarithmic scale, are given in Figures 2.3 and 2.4 of Turner's workbook represented as Figures 6 and 7 in this document:

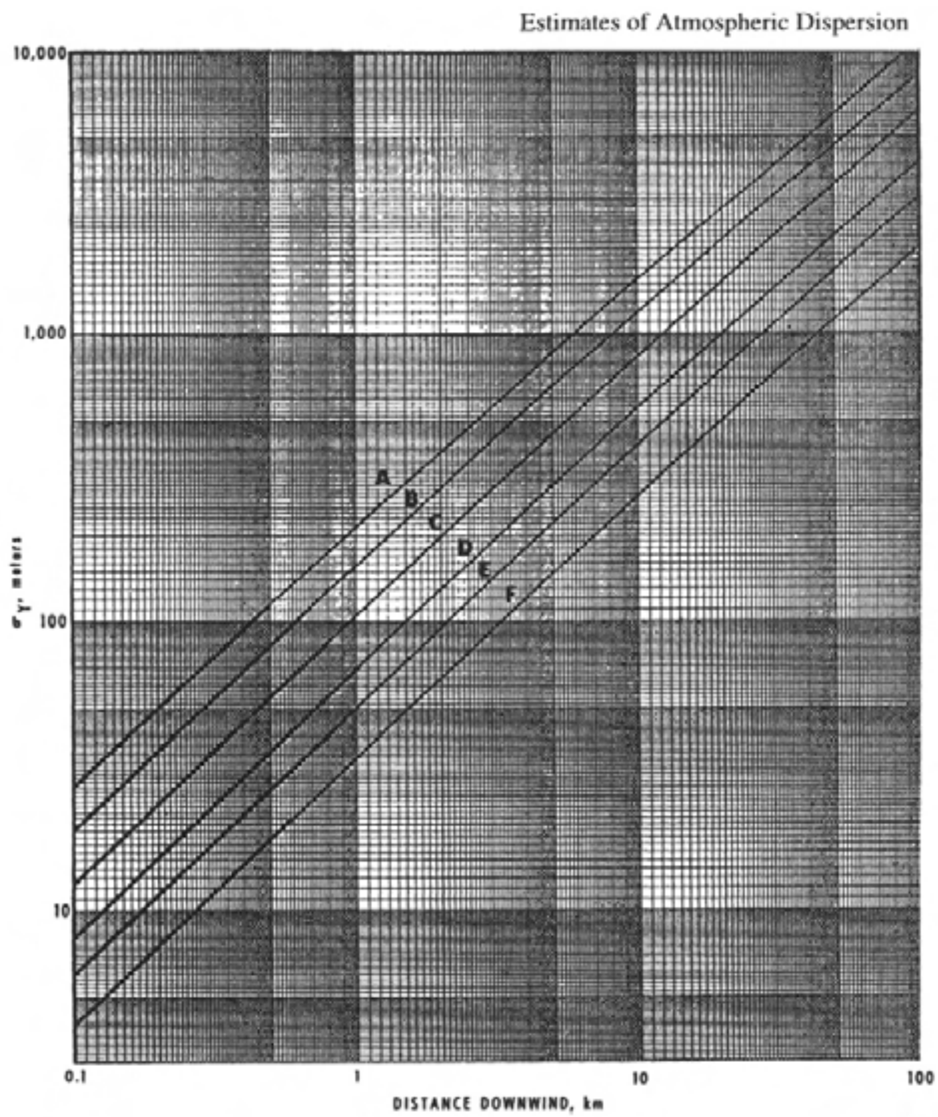

FIGURE 6: σ_y AS FUNCTION OF PASQUILL STABILITY CLASS AND DOWNWIND DISTANCE FROM THE SOURCE

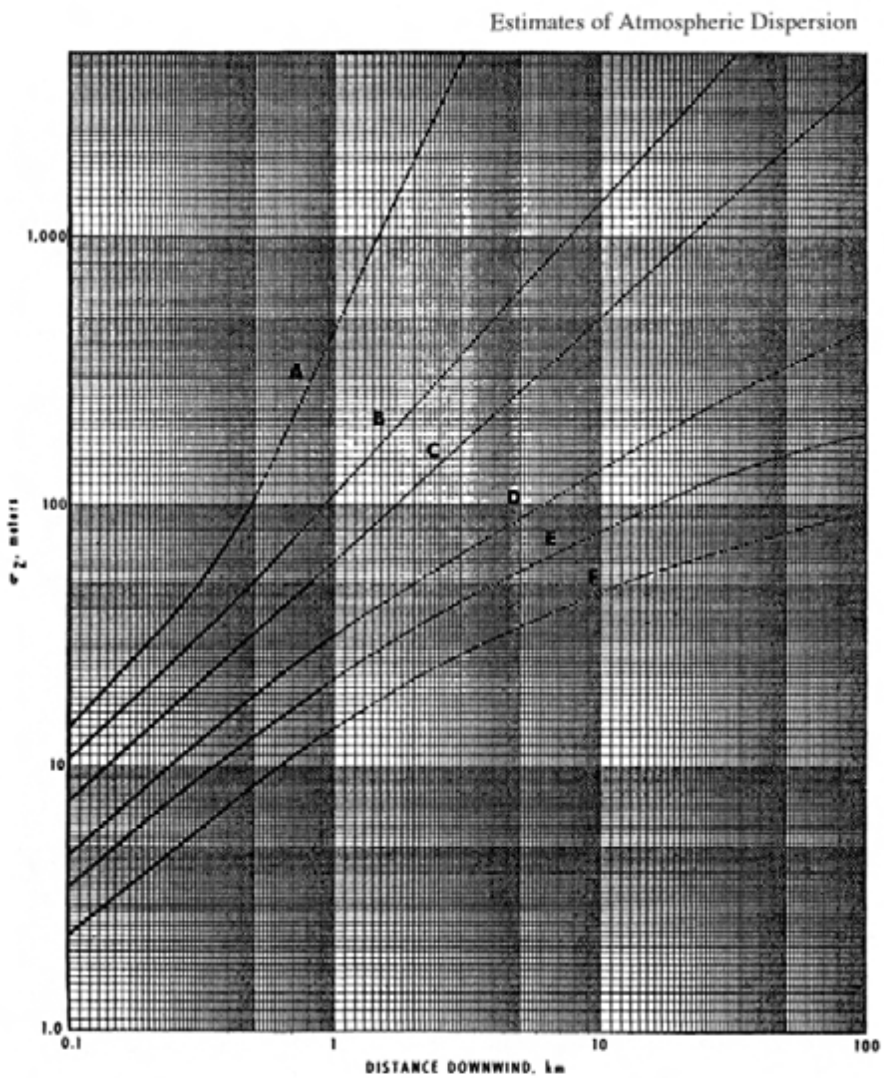

FIGURE 7: σ_z AS FUNCTION OF PASQUILL STABILITY CLASS AND DOWNWIND DISTANCE FROM THE SOURCE

Figures 6 and 7 were therefore used in assessing σ_y and σ_z as a function of downwind distance from source to receptor. Estimates for distances less than 100 meters are very unreliable and are not plotted on these figures and will therefore not be attempted as part of our assessment.

From these figures Turner's workbook also presents (Table 2.5) the values for σ_y and σ_z as a function of downwind distance from source to receptor. Table 2.5 was also duplicated in Excel format for use in our assessment, see **Appendix G**. In our assessments this Excel data is then used by another Excel spreadsheet which calculates tritium concentration in the atmosphere using equation (1).

ENVIRONMENTAL CONDITIONS

Past assessments assumed that wind data for Pembroke were the same as those observed in Chalk River which is located approximately 35 kilometres from Pembroke. The Environment Canada Website provides extensive wind data collected between 1971 and 2000 for a number of weather stations. None of these stations are located in Pembroke but two exist in Petawawa. Petawawa is located only 15 kilometres from Pembroke, 20 kilometres closer than Chalk River and should provide a better basis for assuming wind speeds for Pembroke:

TABLE 2: MONTHLY WIND SPEEDS FOR STATION PETAWAWA A

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
WIND SPEED (km/hr)	11.2	10.6	11.9	12	10.7	10.2	9.2	8.8	9.9	10.9	11.6	11.2
WIND SPEED (m/s)	3.1	2.9	3.3	3.3	3.0	2.8	2.6	2.4	2.8	3.0	3.2	3.1

TABLE 3: MONTHLY WIND SPEEDS FOR STATION PETAWAWA NAT FORESTRY

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
WIND SPEED (km/hr)	10.4	10.4	11.6	11.8	10.5	10	9.1	8.7	9.3	10.2	10.7	10.1
WIND SPEED (m/s)	2.9	2.9	3.2	3.3	2.9	2.8	2.5	2.4	2.6	2.8	3.0	2.8

Based on this data it would remain conservative to use a wind speed of 2 m/s. for all our analysis.

Looking at a summary of wind frequency data between 1989 and 2004 compiled by Levelton (2006) shows that the wind frequency is greatest to the north west which also represents the location of the critical group:

TABLE 4: WIND FREQUENCY DATA

TO	FROM	FREQUENCY
S	N	4.2%
SSW	NNE	2.5%
SW	NE	2.5%
WSW	ENE	2.4%
W	E	3.8%
WNW	ESE	10.6%
NW	SE	12.2%
NNW	SSE	4.6%
N	S	3.5%
NNE	SSW	3.7%
NE	SW	4.9%
ENE	WSW	6.3%
E	W	9.4%
ESE	WNW	10.7%
SE	NW	11.3%
SSE	NNW	7.5%

The critical group is located approximately 300 meters from the facility. Our analysis will therefore ensure that the doses in this sector are specifically defined. The most populated area of Pembroke is located directly north of the facility where the winds blow only 3.5% of the time.

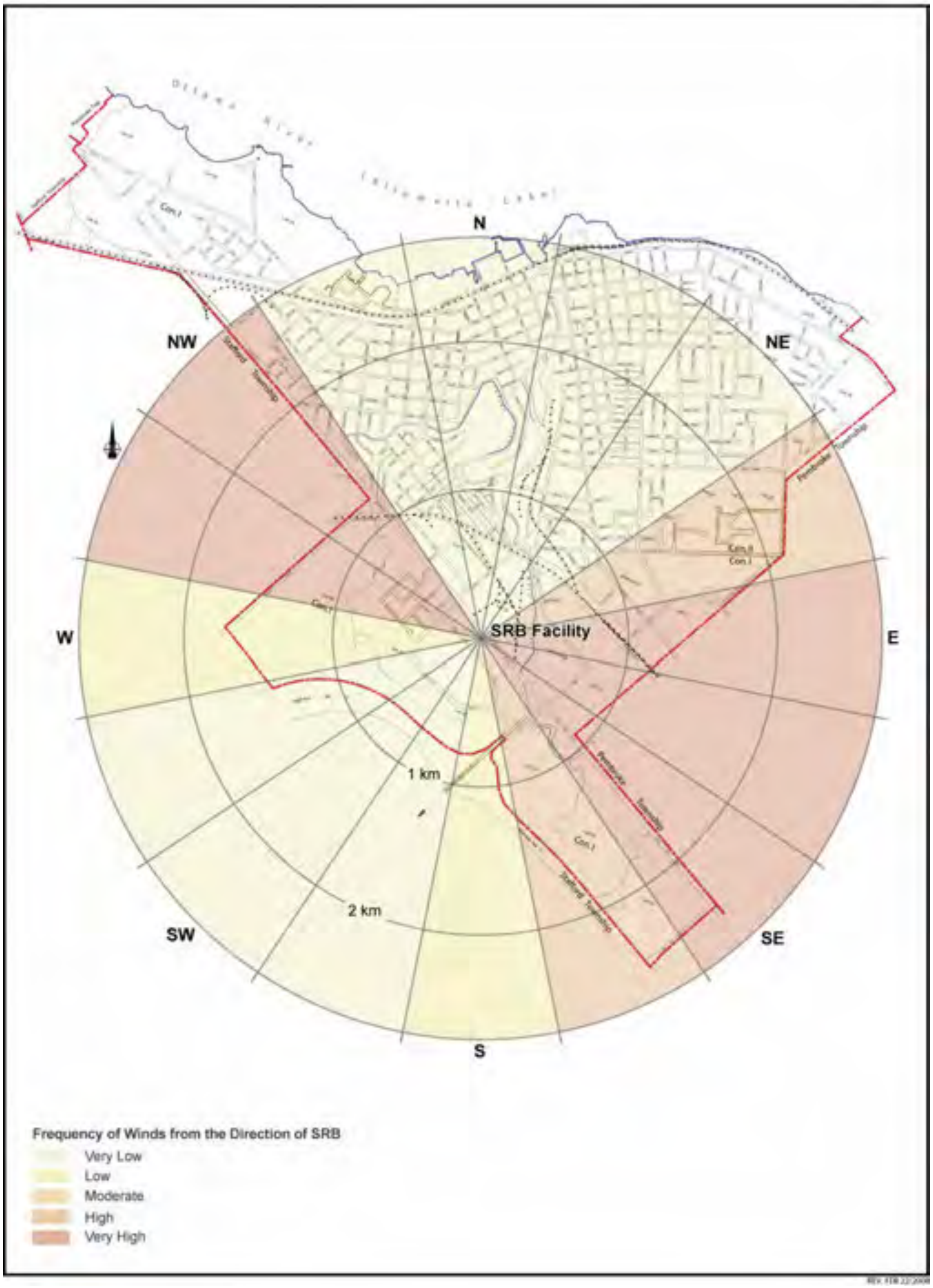

FIGURE 8: MAP OF PREDOMINANT WIND DIRECTIONS

ASSESSMENT OF DOSE

The atmospheric concentration at specific distances are then used to assess the dose to a receptor who comes in contact with a contaminated plume.

The dose to a receptor is calculated as follows:

$$D = [(\chi)\,(B)\,(DCF)\,(t)\,(\%HTO)]_{FOR\ HTO} + [(\chi)\,(B)\,(DCF)\,(t)\,(\%HT)]_{FOR\ HT} \quad (2)$$

Where,	D	=	dose to a receptor (millisieverts)
	χ	=	tritium concentration (Bq/meters^3)
	B	=	breathing rate of receptor (meters^3/minute)
	DCF	=	dose conversion factor for receptor (mSv/Bq)
	t	=	exposure time (minutes)
	%HTO	=	% of concentration which is tritium oxide
	%HT	=	% of concentration which is tritium gas

The atmospheric concentration calculated in Excel are then used by another Excel spreadsheet which calculates the dose to a receptor using equation (2).

DOSE CONVERSION FACTORS

The most conservative assessment to date which was performed by the CNSC in 2000 used accepted values of the time for dose conversion factors of 2 x 10^{-12} mSv/Bq for tritium (HT) and 4 x 10^{-8} mSv/Bq for tritium oxide (HTO), the dose conversion factor for HTO was conservatively doubled from 2 x 10^{-8} mSv/Bq to account for both skin absorption and inhalation.

Based on CAN/CSA-N288.1-M87, SRB confirms these values for a member of the public and finds them adequate to use for revised calculations. In order to address possible future questions from the public however, it was decided that values based on an the receptor being an infant would also be used. Based on CAN/CSA-N288.1-M87 the dose conversion factor for an infant is 1.2 x 10^{-11} mSv/Bq for HT and 11.6 x 10^{-8} mSv/Bq for HTO doubled from 5.8 x 10^{-8} mSv/Bq to account for both skin absorption and inhalation.

TABLE 5: DOSE CONVERSION FACTORS BASED ON CAN/CSA-N288.1-M87

	INHALATION (DCF) (Sv/Bq)		INGESTION (DCF) (Sv/Bq)	
	ADULT	INFANT	ADULT	INFANT
H-3 (HTO)	2.0E-11	5.8E-11	2.0E-11	5.8E-11
H-3 (HT)	2.4E-15	1.2E-14	-	-

INHALATION RATE

All assessments to date used a value of 1.2 m^3/hour (28.8 m^3/day) as a rate of inhalation for an adult. No reference was provided to verify or substantiate this value. The value was therefore reviewed against those from Health Canada:

TABLE 6: INHALATION RATES BASED ON HEALTH CANADA

INHALATION RATE (m^3/ day)				
INFANT	**TODDLER**	**CHILD**	**TEEN**	**ADULT**
2.1	9.3	14.5	15.8	15.8

The value was also reviewed against those from the International Commission for Radiation Protection (ICRP) Publication 71 (1995b), Table 6:

TABLE 7: INHALATION RATES BASED ON HEALTH CANADA

INHALATION RATE (m^3/ day)					
0-1 YEAR	**1-2 YEARS**	**2-7 YEARS**	**7-12 YEARS**	**12-17 YEARS**	**> 17 YEARS**
2.86	5.16	8.72	15.3	20.1	22.2

The value was also reviewed against those from CAN/CSA-N288.1-M87:

TABLE 8: INHALATION RATES BASED ON CAN/CSA-N288.1-M87

INHALATION RATE (m^3/ year)	
INFANT	**ADULT**
1.4E3	8.4E3

As the dose conversion factors used in the revised assessment will be based on the values listed in CAN/CSA-N288.1-M87, to be consistent, and based on our research the inhalation rates from CAN/CSA-N288.1-M87 of 1.4 x 10^3 m^3/year (3.84 m^3/day) for an infant and 8.4 x 10^3 m^3/year (23.01 m^3/day) for an adult will also be used and provide a conservative assessment compared the values from both ICRP and Health Canada.

CALCULATION OF THE MAXIMUM DOSE TO A RECEPTOR

Our review has reviewed hypothetical accident scenarios to ensure that these were credible. For the hypothetical accident scenarios that are still credible we have reviewed the parameters used in calculating the maximum dose to a receptor to ensure that they are adequate and to industry standards and reflective of current facility physical and operating characteristics.

Our review has also identified additional hypothetical accident scenarios that had not been previously identified. Parameters were also defined for the calculation of the maximum dose to a receptor from those additional hypothetical accident scenarios.

The maximum dose to a receptor will therefore be calculated for the following credible hypothetical accident scenarios:

- Release of the entire contents of a pyrophoric unit
- Release of the entire contents of a bulk container
- Tornado incident
- Impact of a large rogue vehicle
- Smoldering fire within the controlled area of the facility
- Release from breakage during handling
- Release from breakage during packing

RELEASE OF THE ENTIRE CONTENTS OF A PYROPHORIC UNIT

Tritium concentration "χ" in Curies/ m^3 at distances ranging between 100 meters and 25 kilometers from the source of release were calculated for all stability classes using equation (1) and the following parameters discussed on page 21:

$$\chi = (Q / \pi \, \sigma_z \, \sigma_y \, V) \exp(-h^2 / 2 \, (\sigma_z)^2) \qquad (1)$$

Q	=	the rate of release "Q" (Curies/second)
	=	release (Curies) / time of release "t" (seconds)
	=	3,000 Ci / 10 s
	=	300 Ci/s
V	=	wind velocity "V" (meters/second)
	=	2 m/s
H	=	effective height of release "H" (meters)
	=	27.8 m
σ_y	=	diffusion coefficient (meters) in the horizontal plane for all Pasquill stability classes as per Excel for in **Appendix G**
σ_z	=	diffusion coefficient (meters) in the vertical plane for all Pasquill stability classes as per Excel for in **Appendix G**

The maximum tritium concentration "χ" was found at a distance of 290 meters from the stack, at approximately the same distance as the critical group. The tritium concentration at this location was found to be 0.027 Curies/ m^3 (9.98×10^8 Bq/m^3) under Pasquill stability class C.

The tritium concentration "χ" was used to calculate the dose to a receptor (infant and adult) "D" using equation (2) and the following parameters:

$$\mathbf{D = [(\chi)\ (B)\ (DCF)\ (t)\ (\%HTO)]_{FOR\ HTO} + [(\chi)\ (B)\ (DCF)\ (t)\ (\%HT)]_{FOR\ HT}} \quad (2)$$

χ	=	tritium concentration ($Bq/meters^3$)
	=	9.98×10^8 Bq/m^3
B	=	breathing rate of receptor ($meters^3/second$)
	=	4.44×10^{-4} m^3/s (for an infant) (3.84 m^3/day)
	=	2.66×10^{-4} m^3/s (for an adult) (23.01 m^3/day)
$DCF_{FOR\ HTO}$	=	dose conversion factor for receptor for HTO (millisieverts/Bq)
	=	11.60×10^{-8} mSv/Bq (inhalation and skin absorption for an infant)
	=	4.0×10^{-8} mSv/Bq (inhalation and skin absorption for an adult)
$DCF_{FOR\ HT}$	=	dose conversion factor for receptor for HT (millisieverts/Bq)
	=	1.20×10^{-11} mSv/Bq (inhalation for an infant)
	=	2.40×10^{-12} mSv/Bq for HT (inhalation for an adult)
t	=	exposure time (minutes)
	=	10 seconds
%HTO =	=	% of concentration which is tritium oxide
	=	0.25
%HT	=	% of concentration which is tritium gas
	=	0.75

The maximum dose to a receptor from this hypothetical accident scenario was calculated to be 0.027 mSv to an adult, with the dose to an infant lower at 0.013 mSv.

All calculations results can be found in **Appendix H**.

RELEASE OF THE ENTIRE CONTENTS OF A BULK CONTAINER

Tritium concentration "χ" in Curies/ m^3 at distances ranging between 100 meters and 25 kilometers from the source of release were calculated for all stability classes using equation (1) and the following parameters discussed on page 22:

$$\chi = (Q / \pi\ \sigma_z \sigma_y V) \exp(-h^2 / 2 (\sigma_z)^2) \qquad (1)$$

Q	=	the rate of release "Q" (Curies/second)
	=	release (Curies) / time of release "t" (seconds)
	=	25,000 Ci / 10 s
	=	2,500 Ci/s
V	=	wind velocity "V" (meters/second)
	=	2 m/s
H	=	effective height of release "H" (meters)
	=	27.8 m
σ_y	=	diffusion coefficient (meters) in the horizontal plane for all Pasquill stability classes as per Excel for in **Appendix G**
σ_z	=	diffusion coefficient (meters) in the vertical plane for all Pasquill stability classes as per Excel for in **Appendix G**

The maximum tritium concentration "χ" was found at a distance of 290 meters from the stack, at approximately the same distance as the critical group. The tritium concentration at this location was found to be 0.225 Curies/ m^3 (8.32×10^9 Bq/m^3) under Pasquill stability class C.

The tritium concentration "χ" was used to calculate the dose to a receptor (infant and adult) "D" using equation (2) and the following parameters:

$$\mathbf{D = [(\chi)\,(B)\,(DCF)\,(t)\,(\%HTO)]_{FOR\ HTO} + [(\chi)\,(B)\,(DCF)\,(t)\,(\%HT)]_{FOR\ HT}} \quad (2)$$

χ	=	tritium concentration (Bq/meters^3)
	=	8.32×10^9 Bq/m^3
B	=	breathing rate of receptor (meters^3/second)
	=	4.44×10^{-4} m^3/s (for an infant) (3.84 m^3/day)
	=	2.66×10^{-4} m^3/s (for an adult) (23.01 m^3/day)
$DCF_{FOR\ HTO}$	=	dose conversion factor for receptor for HTO (millisieverts/Bq)
	=	11.60×10^{-8} mSv/Bq (inhalation and skin absorption for an infant)
	=	4.0×10^{-8} mSv/Bq (inhalation and skin absorption for an adult)
$DCF_{FOR\ HT}$	=	dose conversion factor for receptor for HT (millisieverts/Bq)
	=	1.20×10^{-11} mSv/Bq (inhalation for an infant)
	=	2.40×10^{-12} mSv/Bq for HT (inhalation for an adult)
t	=	exposure time (minutes)
	=	10 seconds
%HTO =	=	% of concentration which is tritium oxide
	=	0.25
%HT	=	% of concentration which is tritium gas
	=	0.75

The maximum dose to a receptor from this hypothetical accident scenario was calculated to be 0.222 mSv to an adult, with the dose to an infant lower at 0.107 mSv.

All calculations results can be found in **Appendix I**.

TORNADO ACCIDENT

Tritium concentration "χ" in Curies/ m^3 at distances ranging between 100 meters and 25 kilometers from the source of release were calculated for stability class A using equation (1) and the following parameters discussed on page 22:

$$\chi = (Q / \pi \, \sigma_z \sigma_y V) \exp(-h^2 / 2 (\sigma_z)^2) \qquad (1)$$

Q	=	the rate of release "Q" (Curies/second)
	=	release (Curies) / time of release "t" (seconds)
	=	97,297 Ci / 10 s
	=	9,729.7 Ci/s
V	=	wind velocity "V" (meters/second)
	=	55.5 m/s
H	=	effective height of release "H" (meters)
	=	1 m
σ_y	=	diffusion coefficient (meters) in the horizontal plane for Pasquill stability class A as per Excel for in **Appendix G**
σ_z	=	diffusion coefficient (meters) in the vertical plane for all Pasquill stability class A as per Excel for in **Appendix G**

The maximum tritium concentration "χ" was found at a distance of 100 meters from the facility, which is the closest point analyzed by our assessment. Doses closer to the facility may well be higher but estimates for distances less than 100 meters are very unreliable and were therefore not be attempted as part of our assessment. The tritium concentration at this location was found to be 0.149 Curies/ m^3 (5.51×10^9 Bq/m^3).

The Pembroke Fire Department is the responsible authority that would help SRB manage any emergency situation arising at the facility. As part of the plan which would be followed in case of an emergency, the Pembroke Fire Department would evacuate an area at least 200 meters in all directions around SRB which would help mitigate any exposure to the public. This perimeter does not include any residences.

The tritium concentration "χ" was used to calculate the dose to a receptor (infant and adult) "D" using equation (2) and the following parameters:

$$\mathbf{D = [(\chi)\ (B)\ (DCF)\ (t)\ (\%HTO)]_{FOR\ HTO} + [(\chi)\ (B)\ (DCF)\ (t)\ (\%HT)]_{FOR\ HT}} \quad (2)$$

χ	=	tritium concentration (Bq/meters^3)
	=	5.51×10^9 Bq/m^3
B	=	breathing rate of receptor (meters^3/second)
	=	4.44×10^{-4} m^3/s (for an infant) (3.84 m^3/day)
	=	2.66×10^{-4} m^3/s (for an adult) (23.01 m^3/day)
$DCF_{FOR\ HTO}$	=	dose conversion factor for receptor for HTO (millisieverts/Bq)
	=	11.60×10^{-8} mSv/Bq (inhalation and skin absorption for an infant)
	=	4.0×10^{-8} mSv/Bq (inhalation and skin absorption for an adult)
$DCF_{FOR\ HT}$	=	dose conversion factor for receptor for HT (millisieverts/Bq)
	=	1.20×10^{-11} mSv/Bq (inhalation for an infant)
	=	2.40×10^{-12} mSv/Bq for HT (inhalation for an adult)
t	=	exposure time (minutes)
	=	10 seconds
%HTO =	=	% of concentration which is tritium oxide
	=	0.25
%HT	=	% of concentration which is tritium gas
	=	0.75

The maximum dose to a receptor from this hypothetical accident scenario was calculated to be 0.147 mSv to an adult, with the dose to an infant lower at 0.071 mSv.

All calculations results can be found in **Appendix J**.

IMPACT OF A LARGE ROGUE VEHICLE

Tritium concentration "χ" in Curies/ m^3 at distances ranging between 100 meters and 25 kilometers from the source of release were calculated for stability class A using equation (1) and the following parameters discussed on page 23:

$$\chi = (Q / \pi \, \sigma_z \, \sigma_y \, V) \exp(-h^2 / 2 \, (\sigma_z)^2) \qquad (1)$$

Q	=	the rate of release "Q" (Curies/second)
	=	release (Curies) / time of release "t" (seconds)
	=	16,025 Ci / 10 s
	=	1,602.5 Ci/s
V	=	wind velocity "V" (meters/second)
	=	2 m/s
H	=	effective height of release "H" (meters)
	=	27.8 m
σ_y	=	diffusion coefficient (meters) in the horizontal plane for all Pasquill stability classes as per Excel for in **Appendix G**
σ_z	=	diffusion coefficient (meters) in the vertical plane for all Pasquill stability classes as per Excel for in **Appendix G**

The maximum tritium concentration "χ" was found at a distance of 290 meters from the stack, at approximately the same distance as the critical group. The tritium concentration at this location was found to be 0.144 Curies/ m^3 (5.33×10^9 Bq/m^3) under Pasquill stability class C.

The possibility also exists that a release results in some ground release but the quantity of tritium that would be released would be far lower than the tritium that would be released at ground level as a result of a tornado. Dose assessment from a release resulting from a tornado have already been fully assessed.

The tritium concentration "χ" was used to calculate the dose to a receptor (infant and adult) "D" using equation (2) and the following parameters:

$$\mathbf{D = [(\chi)\ (B)\ (DCF)\ (t)\ (\%HTO)]_{FOR\ HTO} + [(\chi)\ (B)\ (DCF)\ (t)\ (\%HT)]_{FOR\ HT}} \quad (2)$$

χ	=	tritium concentration (Bq/meters^3)
	=	5.33×10^9 Bq/m^3
B	=	breathing rate of receptor (meters^3/second)
	=	4.44×10^{-4} m^3/s (for an infant) (3.84 m^3/day)
	=	2.66×10^{-4} m^3/s (for an adult) (23.01 m^3/day)
$DCF_{FOR\ HTO}$	=	dose conversion factor for receptor for HTO (millisieverts/Bq)
	=	11.60×10^{-8} mSv/Bq (inhalation and skin absorption for an infant)
	=	4.0×10^{-8} mSv/Bq (inhalation and skin absorption for an adult)
$DCF_{FOR\ HT}$	=	dose conversion factor for receptor for HT (millisieverts/Bq)
	=	1.20×10^{-11} mSv/Bq (inhalation for an infant)
	=	2.40×10^{-12} mSv/Bq for HT (inhalation for an adult)
t	=	exposure time (minutes)
	=	10 seconds
%HTO =	=	% of concentration which is tritium oxide
	=	0.25
%HT	=	% of concentration which is tritium gas
	=	0.75

The maximum dose to a receptor from this hypothetical accident scenario was calculated to be 0.142 mSv to an adult, with the dose to an infant lower at 0.069 mSv.

All calculations results can be found in **Appendix K**.

SMOLDERING FIRE WITHIN THE CONTROLLED AREA OF THE FACILITY

The tritium concentration "χ" in the room was used to calculate the dose to a receptor (worker) "D" using equation (2) and the following parameters discussed on page 25:

$$\mathbf{D = [(\chi)\ (B)\ (DCF)\ (t)\ (\%HTO)]_{FOR\ HTO} + [(\chi)\ (B)\ (DCF)\ (t)\ (\%HT)]_{FOR\ HT}} \quad (2)$$

χ	=	tritium concentration (Bq/meters^3)
	=	219 Ci / 522 m^3
	=	0.42 Ci/ m^3
	=	1.55×10^{10} Bq/ m^3
B	=	breathing rate of receptor (meters^3/second)
	=	2.66×10^{-4} m^3/s (for an adult) (23.01 m^3/day)
$DCF_{FOR\ HTO}$	=	dose conversion factor for receptor for HTO (millisieverts/Bq)
	=	4.0×10^{-8} mSv/Bq (inhalation and skin absorption for an adult)
$DCF_{FOR\ HT}$	=	dose conversion factor for receptor for HT (millisieverts/Bq)
	=	2.40×10^{-12} mSv/Bq for HT (inhalation for an adult)
t	=	exposure time (minutes)
	=	300 seconds
%HTO =	=	% of concentration which is tritium oxide
	=	0.25
%HT	=	% of concentration which is tritium gas
	=	0.75

The maximum dose to a receptor (worker) from this hypothetical accident scenario was calculated to be 12.41 mSv.

All calculations results can be found in **Appendix L**.

RELEASE FROM BREAKAGE DURING HANDLING

The tritium concentration “χ” in the room was used to calculate the dose to a receptor (worker) “D” using equation (2) and the following parameters discussed on page 34:

$$\mathbf{D = [(\chi)\ (B)\ (DCF)\ (t)\ (\%HTO)]_{FOR\ HTO} + [(\chi)\ (B)\ (DCF)\ (t)\ (\%HT)]_{FOR\ HT}} \quad (2)$$

χ	=	tritium concentration (Bq/meters^3)
	=	233 Ci / 522 m^3
	=	0.446 Ci/ m^3
	=	1.65×10^{10} Bq/ m^3
B	=	breathing rate of receptor (meters^3/second)
	=	2.66×10^{-4} m^3/s (for an adult) (23.01 m^3/day)
$DCF_{FOR\ HTO}$	=	dose conversion factor for receptor for HTO (millisieverts/Bq)
	=	4.0×10^{-8} mSv/Bq (inhalation and skin absorption for an adult)
$DCF_{FOR\ HT}$	=	dose conversion factor for receptor for HT (millisieverts/Bq)
	=	2.40×10^{-12} mSv/Bq for HT (inhalation for an adult)
t	=	exposure time (minutes)
	=	120 seconds
%HTO =	=	% of concentration which is tritium oxide
	=	0.25
%HT	=	% of concentration which is tritium gas
	=	0.75

The maximum dose to a receptor (worker) from this hypothetical accident scenario was calculated to be 5.28 mSv.

All calculations results can be found in **Appendix M**.

RELEASE FROM BREAKAGE DURING PACKING

The tritium concentration "χ" in the room was used to calculate the dose to a receptor (worker) "D" using equation (2) and the following parameters discussed on page 34:

$$\mathbf{D = [(\chi)\,(B)\,(DCF)\,(t)\,(\%HTO)]_{FOR\ HTO} + [(\chi)\,(B)\,(DCF)\,(t)\,(\%HT)]_{FOR\ HT}} \quad (2)$$

χ	=	tritium concentration (Bq/meters^3)
	=	200 Ci / 586 m^3
	=	0.341 Ci/ m^3
	=	1.26×10^{10} Bq/ m^3
B	=	breathing rate of receptor (meters^3/second)
	=	2.66×10^{-4} m^3/s (for an adult) (23.01 m^3/day)
$DCF_{FOR\ HTO}$	=	dose conversion factor for receptor for HTO (millisieverts/Bq)
	=	4.0×10^{-8} mSv/Bq (inhalation and skin absorption for an adult)
$DCF_{FOR\ HT}$	=	dose conversion factor for receptor for HT (millisieverts/Bq)
	=	2.40×10^{-12} mSv/Bq for HT (inhalation for an adult)
t	=	exposure time (minutes)
	=	120 seconds
%HTO =	=	% of concentration which is tritium oxide
	=	0.25
%HT	=	% of concentration which is tritium gas
	=	0.75

The maximum dose to a receptor (worker) from this hypothetical accident scenario was calculated to be 4.04 mSv.

All calculations results can be found in **Appendix N**.

TABULATION OF RESULTS

The maximum doses to a member of the public and staff from the hypothetical worse case scenario are tabulated below:

TABLE 9: MAXIMUM DOSE TO A RECEPTOR BASED ON UP TO DATE ASSESSMENTS

SCENARIO	MAXIMUM DOSE (mSv)	RECEPTOR
RELEASE OF THE ENTIRE CONTENTS OF A PYROPHORIC UNIT	0.027	MEMBER OF THE PUBLIC
RELEASE OF THE ENTIRE CONTENTS OF A BULK CONTAINER	0.222	MEMBER OF THE PUBLIC
RELEASE FROM A TORNADO	0.147	MEMBER OF THE PUBLIC
RELEASE FROM IMPACT OF A LARGE ROGUE VEHICLE	0.142	MEMBER OF THE PUBLIC
SMOLDERING FIRE WITHIN THE CONTROLLED AREA OF THE FACILITY	12.41	STAFF
RELEASE FROM BREAKAGE DURING HANDLING	5.28	STAFF
RELEASE FROM BREAKAGE DURING PACKING	4.04	STAFF

ENVIRONMENTAL CONSIDERATION

Consideration of any possible environmental impacts from an hypothetical incident were also considered as part of the review.

In the assessment of public exposure and dose resulting from routine ongoing releases of tritium to the environment, the period of consideration is typically one year. Annual average exposure through all pathways is directly considered. This includes direct exposure to tritium in atmosphere (inhalation, skin adsorption), and secondary exposure that arises subsequent to the partitioning of the tritium in atmosphere to other environmental media (fruit and vegetables, animal produce, groundwater). When considering a period of a year, there is adequate time for occurrence of specific activity partitioning from atmosphere to other media. Depending on the media, the time required for such partitioning to occur may be in the order of several hours to days or even weeks. For deep groundwater, the period required for full equilibrium may be in the order of many years.

Since SRB proposes to resume operations under no form of precipitation, hypothetical incident scenarios are also likely to occur while operating in dry periods, further mitigating any impact on the environment by benefiting from dispersion.

When considering accidental releases of tritium that are short term (i.e., seconds or minutes in duration), it is appropriate to account for the direct atmospheric exposure pathways. Regarding the exposure that can occur only after secondary partitioning to other media, the duration of such accidental releases is too short for any meaningful degree of such partitioning to occur. Further, the ultimate degree of human exposure to such media is proportional to the time-averaged ambient atmospheric levels of tritium to which the media themselves have been exposed. This media exposure duration is in the order of several weeks to months. The environmental residence time of the accidental tritium release is relatively trivial, and unlikely to have a measurable influence on the ultimate degree of human exposure.

DISCUSSIONS

This document has provided the results of the review of existing incident scenarios for the facility and determined if these are still applicable considering the improvements made to the safety programs and procedures and the equipment and system upgrades that have been implemented over the years of operation.

The review also ensured that the hypothetical incidents identified and analyzed reflect worse case conditions, are credible and can survive scrutiny.

The review also ensured that the parameters and calculations used in defining a dose to a receptor were conservative, reflecting of current accepted values for the industry and reflect conditions that are credible based on existing operational data.

Our review has determined that as a result of improvements and changes implemented at the facility since 2000 that a number of hypothetical accident scenarios relating to fire are no longer credible. More specifically, the hypothetical scenario resulting in the total conflagration of the building due to fire and the hypothetical scenario resulting in the collapse of the mezzanine due to fire are no longer credible as a result of the sprinkler system installation and of the many other fire protection measures implemented at the facility since 2000.

Our review has also determined that as a result of improvements and changes implemented at the facility since 2000 that the release of tritium has been significantly reduced from a number of hypothetical accident scenarios that had been identified prior to 2000. More specifically the hypothetical scenario resulting in the total release of a bulk container which can now result in a release of only 25,000 Curies from 50,000 Ci as a result of the implementation of measures to reduce the amount of tritium purchased. The reduction in possession limit from 11,000 TBq to 6,000 TBq has also reduced the release of tritium associated with the occurrence of a tornado that would result in the collapse of the building. The reduction in possession limit, resulted in a lower number of tritium filled tubes stored on site has also reduced the release of tritium associated with the occurrence of the impact of a large rogue vehicle. In all doses to a member of the public from an incident, making a number of conservative assumptions range between 0.142 and 0.222 mSv, less than the regulatory requirements for a member of the public of 1 mSv.

Responder training, and pre-fire incident plan requirements would ensure that a first responder would make use of a self contained breathing apparatus. Therefore the hypothetical scenario associated with a smoldering fire at the facility would only be expected to result in a dose to a worker rather than to a first responder as defined in assessments performed up to 2000.

A systematic review of our processes and sources has also identified two new credible hypothetical scenarios that would result, under worse conditions including total ventilation failure in doses to our staff ranging between 4.04 to 5.28 mSv, near the action level observed by SRB of 5 mSv per annum but less than the regulatory requirements for a nuclear energy worker of 50 mSv per annum.

RECOMMENDATIONS

As a result of performing our review, further opportunity for improvements have been identified that would result in further mitigating the dose to a receptor from the hypothetical conditions analyzed.

A "Preventive Action Report" will be raised to address these recommendations against an expected deadline of May 1, 2008.

RELEASE FROM BREAKAGE DURING PACKING AND HANDLING

These two hypothetical scenarios result in a dose to our staff from the breakage of light sources as a result of being dropped while being carried in a bin or container from a work area to another.

As a result of extensive on the job training, according to all records available and staff interview results no occurrence of release from these scenarios has occurred since the company's inception in December 1990, it is however credible that a bin containing product is dropped while being carried from a work area to another causing a number of tubes to break.

The amount of tritium released from these hypothetical scenarios is dependent on the quantity of lights broken which can be mitigated by the number of lights being placed in a container and by providing suitable protection to those lights preventing them from breaking.

A procedure should be formalized that would best reduce the quantity of tritium within a container that is being moved from one area to another. A review of the workplace should also be undertaken to see if additional physical controls or protective gear in addition to those already in place (shock absorbing mats, ledges on work table, etc.) could be implemented that would reduce the possibility of breakage.

SMOLDERING FIRE WITHIN THE CONTROLLED AREA OF THE FACILITY

The release from this scenario is dependent on the number of tubes broken when exposed to the spray from a fire extinguisher.

The amount of tritium released from this hypothetical scenario is also dependent on the quantity of lights broken which can be mitigated by the number of lights being placed in a container and by providing suitable protection to those lights preventing them from breaking as a result of the spray from a fire extinguisher.

A procedure should be formalized that would best reduce the quantity of tritium within a container. A review of the workplace should also be undertaken to see if additional physical controls or protective gear in addition to those already in place (shock absorbing mats, ledges on work table, etc.) could be implemented that would reduce the possibility of breakage.

TORNADO ACCIDENT

Due to the uncertainty with doses to receptor within 100 meters of the facility associated with the collapse of the building as a result of a tornado, the training of first responders should be reviewed to ensure that emergency planning measures are in place and discussed with first responders to minimize the dose to a receptor that would need to access the site to rescue individuals from the collapsed building or any other reason.

IMPACT OF A LARGE ROGUE VEHICLE

The impact of a large rogue vehicle with a wall of the building can only cause a possible release of tritium from the storage room as this is the only room where tritium is stored against or near an outside wall.

A procedure should be formalized that would best reduce the quantity of tritium within this room.

CONCLUSION

It is believed that this review has demonstrated that all credible hypothetical worse incident scenarios have been identified and that sufficient controls are in place to mitigate the dose to a receptor as a result of these hypothetical incidents occurring. The risk from the facility are not large and the chance of a large scale incident are small.

Doses resulting from these incidents occurring are less than those of the regulatory limits for a member of the public and for a Nuclear Energy Worker.

A number of recommendations have been identified as a result of performing this review.

These recommendations when addressed will further mitigate dose to a receptor from hypothetical worse incident scenarios further below regulatory limits..

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2. CANADIAN STANDARDS ASSOCIATION, Guidelines for Calculating Radiation Doses to the Public from a Release of Airborne Radioactive Material under Hypothetical Accident Conditions in Nuclear Reactors, CAN/CSA-N288.2-M91, 1991.

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APPENDIX A

ATOMIC ENERGY OF CANADA LIMITED
Research Company
Chalk River Laboratories
Regulatory Services Division

NUCLEAR SAFETY NOTE

Subject: Population Densities and Estimated Doses from Accidental Releases for the SRB Tritium Lamp Plant, Pembroke

Author: Croombe F. Pensom

Date: 1990 November

Distribution: P. Doyle, SRB Technologies Inc.
B. Pullen, SRB Technologies Inc.

Information Copies

J. Graham

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FIGURES

Figure 1 = Population Density for Area 80 km Radius Centered on SRB Plant Located at TransCan Corporate Park, Pembroke

Figure 2 = Estimated Doses Experienced for Worst Case Accident at SRB Premises

ANNEX I

Sample printout from dose computation program showing parameters used in the calculations.

00.324

POPULATION DENSITIES AND ESTIMATED DOSES FROM ACCIDENTAL RELEASES FOR THE SRB TRITIUM LAMP PLANT, PEMBROKE

1. INTRODUCTION

The information supplied in this document was produced in response to a request made by the AECB to SRB Technologies [1] for further data before an operating license would be issued.

2. POPULATION DISTRIBUTION

2.1 Method

Following the guidelines of Palmer [2], an area of 80 km radius was defined centered upon the SRB plant on Boundary Road in Pembroke. Using the Provincial Highway map as the base for producing the population distribution, (it has a convenient scale of 1:700 000 which allows the area to be portrayed in reasonable detail on a B-sized drawing), township boundaries were transferred to this map from the standard 1:50 000 topographical sheets produced by the Map Office of Energy Mines and Resources [3]. Following this, the area was divided into 16 sectors of 22.5° each so that the final data could be correlated with those supplied by A. Lemire [4] — once the sectors were laid out on the map and areas of radii 20, 40 and 60 km drawn, this resulted in a total of 64 sections of area varying from 78.5 to 550 km^2 with the smallest in the immediate vicinity of the plant and the largest at the furthest distance. Having defined the segments, the population densities for each township were transferred from the census data [5].

In the majority of instances, the township boundaries lined up closely to the segments — in the instances where there was poorer correspondence, interpolation was straightforward as the townships involved were of very similar population density and type (e.g. mainly farming or unpopulated).

Due to the fact that the 1:50 000 maps vary in the age of their data (the most up-to-date is from 1985 and the least from 1972), a few of the township boundaries differed between the maps and the census data either by name or by location. In the one instance where this affected the population distribution, it was possible to interpolate from the data given on the 1:50 000 maps and similar townships — the area affected is marked on the drawing (see Figure 1).

A few of the urban areas (e.g. Deep River in Ontario and Campbell's Bay in Quebec) are enumerated separately from the townships and have been marked by name on the map (see Figure 1) and the individual populations listed in a short table. It should be noted that both Pembroke and Renfrew are urban areas that are a few kilometers in area — they are shown on the figure cross-hatched.

001325

3. ESTIMATED DOSES FOR WORST POSTULATED ACCIDENT

3.1 Assumptions

The worst scenario adopted for estimating possible doses to the public, is for the complete inventory ***from one intermediate uranium bed*** to be released into the environment: this value was taken to be 56 TBq of tritium gas. For the predictions to be the most conservative, 100% conversion to tritium oxide was assumed as the oxide is 10^4 more toxic than the elemental form [6]. The dose calculations are performed assuming that the receptor is sited directly beneath the central axis of the plume. It was assumed that the release of the stated amount of tritium took place over a period of 10 seconds.

3.2 Preliminaries

The site was visited to observe the layout and get some figures required for the plume calculations. Measurements were taken of:

- stack diameters;
- stack distances from building; and
- distance and size of nearby building(s).

In addition, SRB provided release data and exhaust volume rates; from these were derived the efflux velocities.

A summary of the typical parameters required for the calculation is provided in Annex I which is the printout provided by the QuickBASIC program during a calculation.

3.3 Method

In order to do the calculations, use was made of a QuickBASIC program developed in the Regulatory Services Division that implements the guidelines of the Canadian Standard for hypothetical releases N288.2 [7]. The use of this program meant that calculations could be repeated for a variety of conditions with relative ease.

To decide on the most conservative weather conditions, several program runs were made for distances of 2.5, 15 and 70 km using Pasquill A and F stabilities and wind speeds of 1, 2 and 5 $m.s^{-1}$. The most conservative weather was Pasquill F with a wind speed of 2 $m.s^{-1}$. This is accounted for by the fact that the stack is so near the ground that the deviations, σ_y and σ_z, show that the plume touches the ground within a short distance of the stack regardless of the weather conditions — for further distances, the higher doses are clearly delivered when the plume is tightly structured which occurs with a very stable atmosphere (Pasquill F) and low wind speed. It

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should be observed that the model tends to break down with large distances and the values predicted for the 70 km radii should be treated with caution.

From these initial observations, the weather stability and wind speed were selected and the program run for varying distances and differing terrains. The terrains were primarily type 4 (rural areas with mixed farming or small villages) and type 5 (forested areas or ordinary cities) but one segment was type 1 (lawn grass or open bodies of water) and a few were type 3 (open grassland). For all distances, the terrain was taken to be the most frequent found between the plant and the selected distance. The results are expressed as the dose that would be experienced *by one person* in the segment under the conditions already cited. The results are provided in Figure 2.

It was found that the adjacent building need not be taken into account for building wake effects as it was further away than three times its height (the building is 5 m high and 20 m away).

Entrainment effect of the main building **was** allowed for as the stacks are only 5.3 meters from the plant wall. Due to the closeness in characteristics of the two stacks, and the similarity between the doses that would be expereienced form a rlease from each, the 11 m stack was chosen for hte calculations as it gave a more conservative figure.

3.4 Findings

These are presented in Figure 2 and represent the dose, in μSv, that would be received by a person standing in the center of the sector directly under the plume axis.

4. REFERENCES

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PLUME

Program parameters for run of: 90-11-01 at 13:50:41

Selected radionuclides released (see listing below).

Distance from release = 15000 m
Ventilation Delay = 17 s

Wind Speed = 2.0 m.s-1
Pasquill stability = F
Pasquill constants are:
a1 = .0638 , a2 = .00136 , b1 = .783 , b2 = .672 , c3 = .04
Weather stability is: stable, windy and was provided

Duration of release = 10 s, or "Instantaneous or Short-Term"
Time correction factor = 1.00

Terrain is Rural areas w. mixed farming, tall bushes or sm. villages
Terrain constants are:
z sub zero = .4 , c1 = 5.16 , c2 = 18.6 , d1 = -.098 , d2 = -.225

Height of stack = 12 m, referenced to stack base.
Internal stack diameter = .58 m

Efflux velocity = 6.5 m.s-1
delta h sub d = 0.00 m
First corrected height = 12.00 m
Nearby building height = 5.00 m
delta h sub n = 0.00 m
Second corrected height = 12.00 m

There are no building wake effects or else nearby building does not satisfy criteria for modifying plume (see N288.2 pages 20 and 21).

Finite cloud correction (where applicable) applied with Rsh = .85

Sigma sub y = 379.47 m
Sigma sub z = 68.72 m

Chi/Q = 60.11E-07 s.m-3

Travel time = 7517.0 s

Summary of released nuclides and their contributions to final dose:

Nuclide	Rel. Qty. Bq	Decay Constant	Decay Factor	Immersion contrib. Sv	Inhalation contrib. Sv
HTO	5.60E+13	1.78E-09	1.00E+00	0.00E+00	3.70E-06

Total Dose Immersion = 0.00E+00 Sv, Inhalation = 3.70E-06 Sv

TOTAL DOSE OVERALL = 3.70E-06 Sv +1000%, -90%

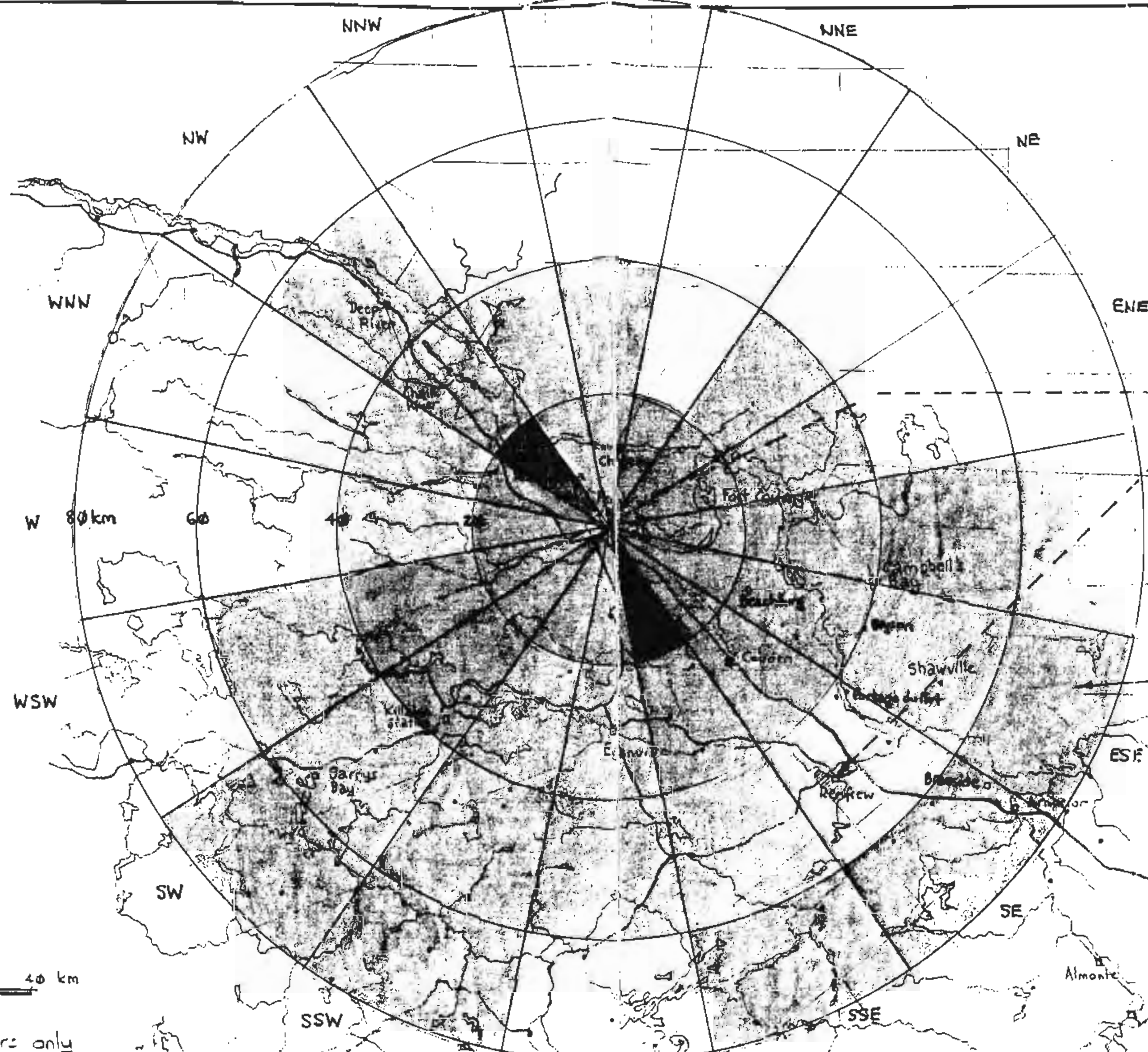
ANNEX I

COLOR KEY

population density persons.km^{-2}

0
1
3
5
10
15
20
30
40

ALL DATA TAKEN FROM 1986 CENSUS



POPULATIONS OF URBAN AREAS ENUMERATED AND LISTED SEPARATELY FROM TOWNSHIPS

		(density)
Barry's Bay	1 141	(387)
Beachburg	664	(161)
Braeside	582	(242)
Bryson	787	(253)
Campbell's Bay	874	(284)
Chalk River	923	(416)
Chapeau	450	(64)
Cobden	1 028	(556)
Deep River	4 602	(560)
Eganville	1 241	(34)
Fort Coulonge	1 449	(421)
Pembroke	14 131	(953)
Petawawa	5 580	(929)
Portage du Fort	337	(74)
Renfrew	8 314	(679)
Shawville	1 574	(299)

urban areas

no data: interpolated from adjacent townships and geographic details

SCALE 1: 700 000

10 0 10 20 30 40 km

only major highways shown
separately counted population centers only

001331

PARTS LIST	
DRAWING LIST	
DESCRIPTION	REFERENCE DWG

REV	DATE	REVISION	BY	APP'D

SURFACE FINISH PER ASA B46.1 (USE R.M.S. ROUGHNESS INDEX)
ALL MACHINED SURFACES EXCEPT AS NOTED

A E C L INTERNAL INSPECTION

PARTS | ASSEMBLY
FUNCTIONAL TEST
OTHER

LIMITS ON DIMENSIONS UNLESS OTHERWISE SPECIFIED
FRACTIONS ± DECIMALS ± ANGLES ±

SCALE

POPULATION DENSITY FOR AREA 80 km RADIUS CENTERED ON SRB PLANT LOCATED AT TRANSCAN CORPORATE PARK, PEMBROKE

SUBMITTED DATE
APP'D. DATE

REGULATORY SERVICES DIVISION

ATOMIC ENERGY OF CANADA LIMITED
CHALK RIVER ONTARIO, CANADA

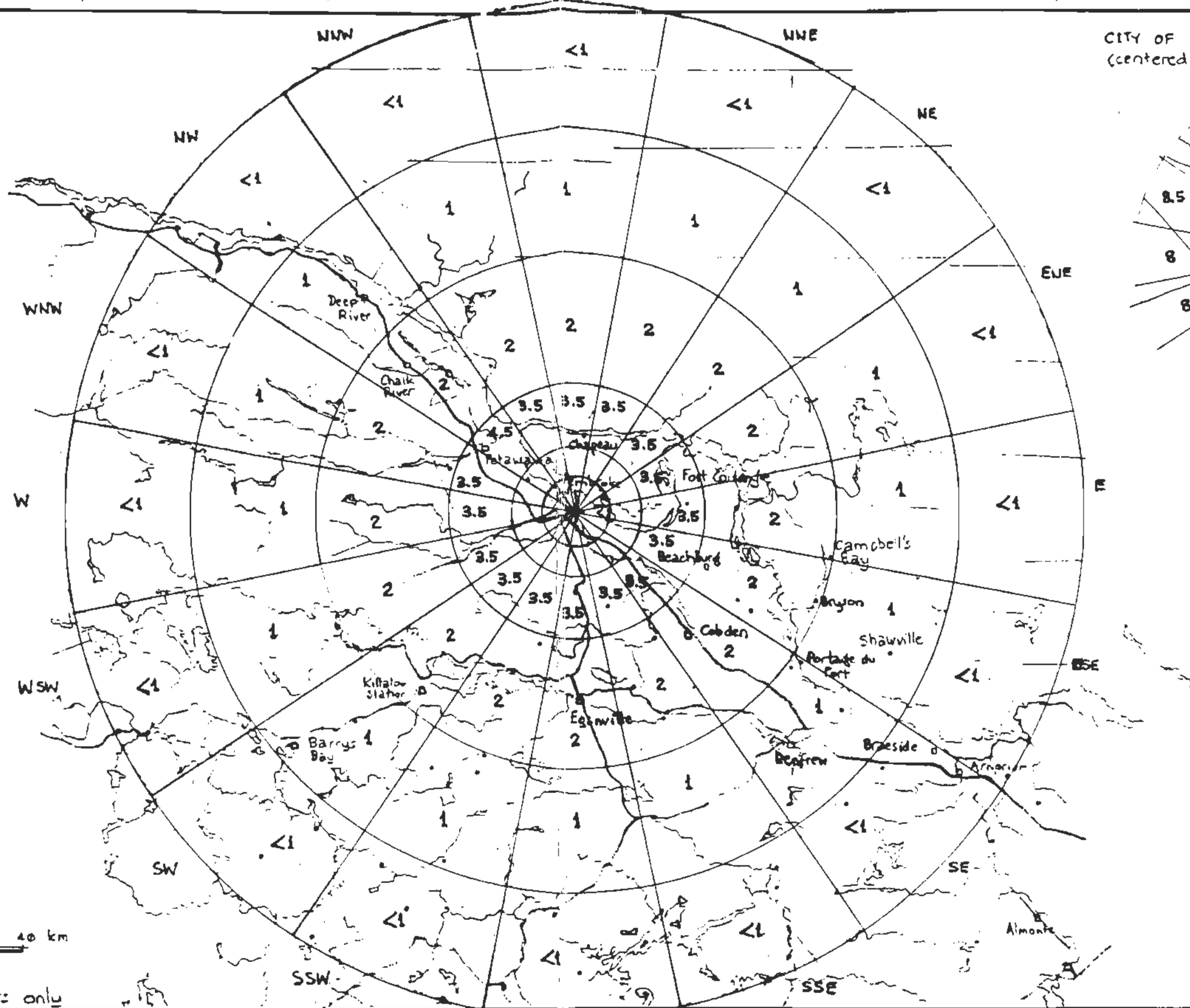
DR'N Croomie & Persson DATE 90-10-3
CHK'D DATE

BLDG No	CODE	CLASS

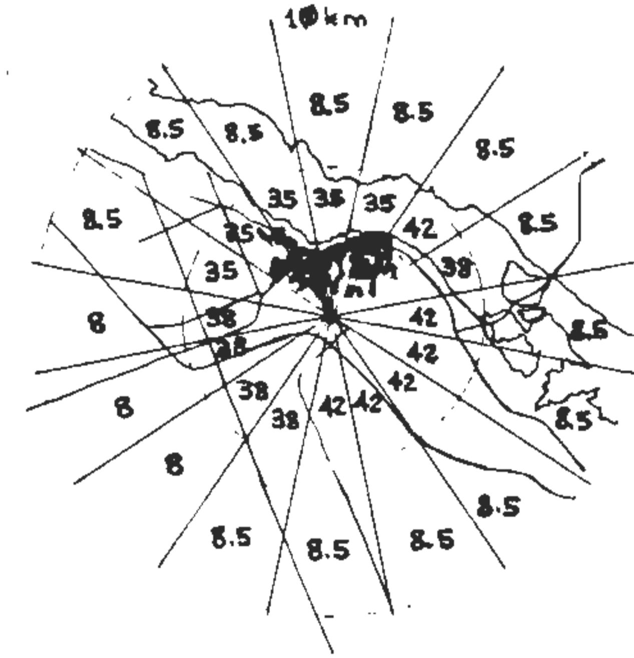
B-
REV. No

DOSES ARE μSv

ALL VALUES ROUNDED TO NEAREST Ø.5 μSv



CITY OF PEMBROKE ENLARGED.
(centered on SRB premises)



001332

SCALE
1: 700 000
10 Ø 10 20 30 40 km

only major highways shown
separately counted population centers only

DATE	REVISION	BY	APP'D

SURFACE FINISH PER ASA B46 1 (USE R M S ROUGHNESS INDEX)
ALL MACHINED SURFACES EXCEPT AS NOTED

A E C L INTERNAL INSPECTION

PARTS | ASSEMBLY

FUNCTIONAL TEST

OTHER

LIMITS ON DIMENSIONS UNLESS OTHERWISE SPECIFIED
FRACTIONS = DECIMALS = ANGLES =

SCALE

ESTIMATED DOSES EXPERIENCED FOR WORST CASE ACCIDENT AT SRB PREMISES

NSN - Ø71

SUBMITTED DATE
APP'D DATE

ATOMIC ENERGY OF CANADA LIMITED
CHALK RIVER ONTARIO CANADA

PARTS LIST
DRAWING LIST
DESCRIPTION | REFERENCE

DRN Croombe + Penson DATE 9Ø
CHK'D DATE
BLDG NO CODE CLA

B- FIGURE 2.
REV NO

APPENDIX B

Atomic Energy Control Board
Commission de contrôle de l'énergie atomique

Ottawa Canada
K1P 5S9

BMD 90-192

CCEA AECB
287427

Your file Votre référence

Our file Notre référence

15-1-11341

21 November, 1990

le 21 novembre 1990

MEMORANDUM

TO: Members
Atomic Energy Control Board

FROM: Director General
Directorate of Fuel Cycle and Materials Regulations

PURPOSE: Decision

SUBJECT: Saunders-Roe (Canada) Inc. Licensing for a Gaseous Tritium Light Source Manufacturing Facility

SUMMARY:

An application has been received from Saunders-Roe (Canada) Inc. to operate a gaseous tritium light source (GTLS) manufacturing facility in the city of Pembroke, Ontario. In the proposed manufacturing process, glass tubes will be filled with tritium gas in a high vacuum gas transfer system then flame-sealed to produce the finished product that is used in such products as self-luminous emergency exit signs.

NOTE DE SERVICE

AUX: Membres de la Commission de contrôle de l'énergie atomique

DU: Directeur général
Direction général de la réglementation des matières nucléaires et des radioéléments

BUT: Décision

OBJET: Permis d'installation de fabrication de sources lumineuses au tritium gazeux de Saunders-Roe (Canada) Inc.

SOMMAIRE:

La CCEA a reçu une demande de permis de Saunders-Roe (Canada) Inc. situé dans la ville de Pembroke (Ontario) pour exploiter une usine de fabrication de sources lumineuses au tritium gazeux. Dans le processus de fabrication proposé, des tubes de verre seront remplis de tritium gazeux dans un système de transfert gazeux à grand vide et scellée à la flamme pour

.../2

001291

Review of the Saunders-Roe submission . which included examination of procedures, details of the facility, derived release limit calculations and collective dose calculations has been completed. Board staff are satisfied that under normal operating conditions doses to staff and members of the public would not be significant, and under accident conditions would be small. A similar facility has been operating in Canada for approximately one year without incident.

produire la source lumineuse. Les agents de la CCEA ont terminé l'examen de la demande qui a compris l'évaluation de leur procédures, les détails de l'usine, les calculs des limites opérationnelles dérivées et les calculs de dose collective, et croient que, dans les conditions normales d'exploitation, les doses aux employés et aux membres du public seraient négligeables et que, dans les conditions d'accident, seraient faibles. Une usine semblable fonctionne au Canada depuis un an sans incident.

It is recommended that the attached licence be issued to Saunders-Roe (Canada) Inc. pursuant to Section 7 of the Atomic Energy Control Regulations.

Il est recommandé que le permis ci-joint soit délivré à Saunders-Roe (Canada) Inc. en vertu de l'article 7 de la Loi sur le contrôle de l'énergie atomique.

J. Beare

90-3087

Saunders-Roe (Canada) Inc.

Licensing of Gaseous Tritium Light Source Manufacturing Facility

Relevant Factors:

A) Assessment

1) The review process has included consultation with the Radiation Protection Division, the Safety Evaluation Division, Waste and Impact Division and the Safeguards and Security Division. The applicant has adequately addressed Board staff concerns. Board staff have done an initial environmental evaluation under the Federal Environmental Assessment Review Process.

B) Plant Description

1) Bulk Tritium will be received primarily from Ontario Hydro and Oak Ridge National Laboratories, in the form of uranium tritide in steel Type B transportation flasks each containing 1.11 PBq (30,000 Ci), and transferred through the application of heat and vacuum from the shipping container to smaller steel pyrophoric uranium production containers. No more than 56 TBq (1500 Ci) will be placed in one container. The production container is attached to the filling rig, phosphor coated glass tubes are attached to the manifold with thick walled pressure tubing and tritium gas is allowed to enter the manifold system and the tubes. When the preset filling pressure has been reached, the manifold valve is closed. The gas-filled tubes are sealed off by hand using a gas flame and all excess tritium in the system is reabsorbed back on to the pyrophoric uranium bed in the steel production container.

2) The maximum permitted inventory of tritium on site at any given time will be 9259 TBq (250,000 Ci) as follows:

   a) 7224 TBq (195,000 Ci) in Type B shipping containers;
   b) 185 TBq (5,000 Ci) in the filling apparatus;
   c) 1850 TBq (50,000 Ci) in the form of finished product.

3) The tube filling apparatus is contained in a ventilated cabinet, the airflow from which will be exhausted to atmosphere by means of two high velocity, continuously monitored exhaust systems. The stack monitoring system is capable of differentiating between molecular tritium gas and tritium oxide. Monitoring will be effected continuously in the production areas. Environmental monitoring of the factory premises and surrounding area, within a two mile radius of the facility, will be carried out every two months and will consist of collecting swabs, water and snow samples and analyzing them by liquid scintillation counting.

4) At peak capacity, the facility is expected to employ 25 workers.

C) Doses to Staff and Public

1) The average dose commitment for one year at the applicant's facility in the U.K., that has operated for more than 29 years, is 2.94 mSv. The applicant expects exposures to workers at Saunders-Roe (Canada) Inc. not to exceed this value.

2) Based also on experience at their plant in England, it is expected that the weekly airborne release will not exceed 4150 GBq (112 Curies) during routine operation. Stack monitoring has shown that of this release, 12% is normally in the form of tritiated water, but values as high as 18% have been recorded. Using this higher value, the weekly release represents 0.4% of the Derived Release Limit calculated for this site. Based upon the current population distribution, this represents an annual population dose of 0.009 person-Sieverts (0.9 person-rem).

It has been estimated that to reduce the airborne releases to near zero, the addition of a molecular sieve catalytic oxidizer/dryer, which would cost approximately $100,000 plus operating and maintenance costs, would be necessary. Since the expected doses are already very low, this additional expense is not reasonable in the opinion of Board staff. A dryer could be installed at a later date if experience shows that releases are higher than predicted.

3) In terms of estimated doses to members of the public from an accidental release of tritium, the worst design basis accident is the release of the total inventory of one transportation container [1110 TBq (30,000 curies)] to the environment and that 100% of the tritium would be converted to tritium oxide. It is also assumed that the receptor is sited directly beneath the central axis of the plume and that the release of tritium would take place over a period of 10 seconds. Under the most conservative weather conditions, the maximum estimated dose would be 0.84 millisieverts (84 millirem) and the collective dose would be 2.4 person - Sv (244 person-rem).

D) Other Factors

1) The "active area" is within a block wall constructed room in which will be located the filling apparatus, the splitting rig, the production containers and the bulk tritium container. The bulk tritium container will be contained in an inner container within a metal drum, which will be contained in a metal cabinet which will be securely bolted to the wall.

Security arrangements have been reviewed by the Safeguards and Security Division and judged to be satisfactory. For security reasons details of the security arrangements are not included in this BMD.

2) The estimated monthly production of radioactive waste from this facility will consist of:

   1) solids such as glass stubs, gloves, shoe coverings and tissue
   2) liquids such as decontamination fluid and contaminated vacuum pump oil

The estimated monthly production of waste will involve approximately 25 GBq (680 mCi) of tritium. Disposal of radioactive waste will be at the Chalk River Nuclear Laboratories of Atomic Energy of Canada Limited.

From the environmental point of view, there are no significant non-radioactive releases from the plant.

3) The possibility of explosion has also been considered. Based on a worst case credible accident consisting of the release of 1110 TBq (30,000 Curies) of tritium contained in one flask, the minimum explosive concentration of Hydrogen (4%) would not be possible at this facility.

4) A press conference was held in Pembroke by the officials of the City on 25 September 1990 for the local media. Copies of press clippings together with a copy of the tape which was aired on local television on 26 September 1990 and 27 September 1990, have been provided to the AECB. The chief administration officer of the city of Pembroke has informed us that public response has been positive.

5) Board staff conclude on the basis of their initial environmental evaluation that there will be no significant effect on the environment from radiological or non-radiological effects. Board staff also conclude that public concerns are not such as to make a public review by EARP panel desirable. As a result, Board staff conclude that this "proposal" should be permitted to proceed and that it not be referred to the Minister of the Environment for public review.

6) A similar plant has been operating near Peterborough Ontario for approximately 1 year without incident.

7) The plant will have on site management by staff who collectively have more than 46 years of experience in this type of operation.

E) <u>Conclusions</u>

1) Board staff conclude that the doses to workers will be as low as reasonably achievable, social and economic factors being taken into account and that the effects on the environment and the public are not significant.

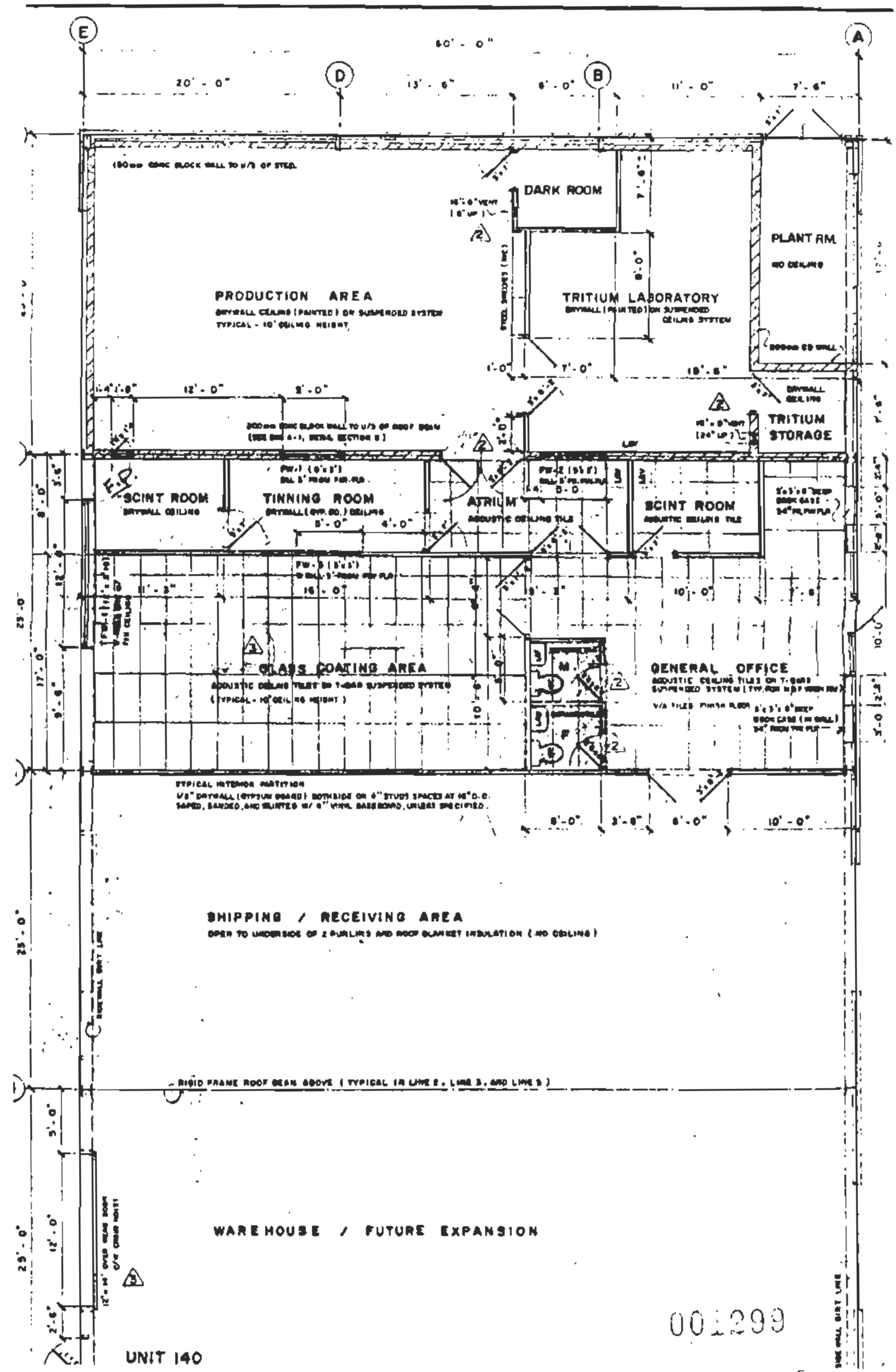
2) The risk from accidents is sufficiently low that there will be no significant impact on the public or the environment.

3) Security arrangements proposed for this facility are satisfactory.

<u>Recommendation</u>

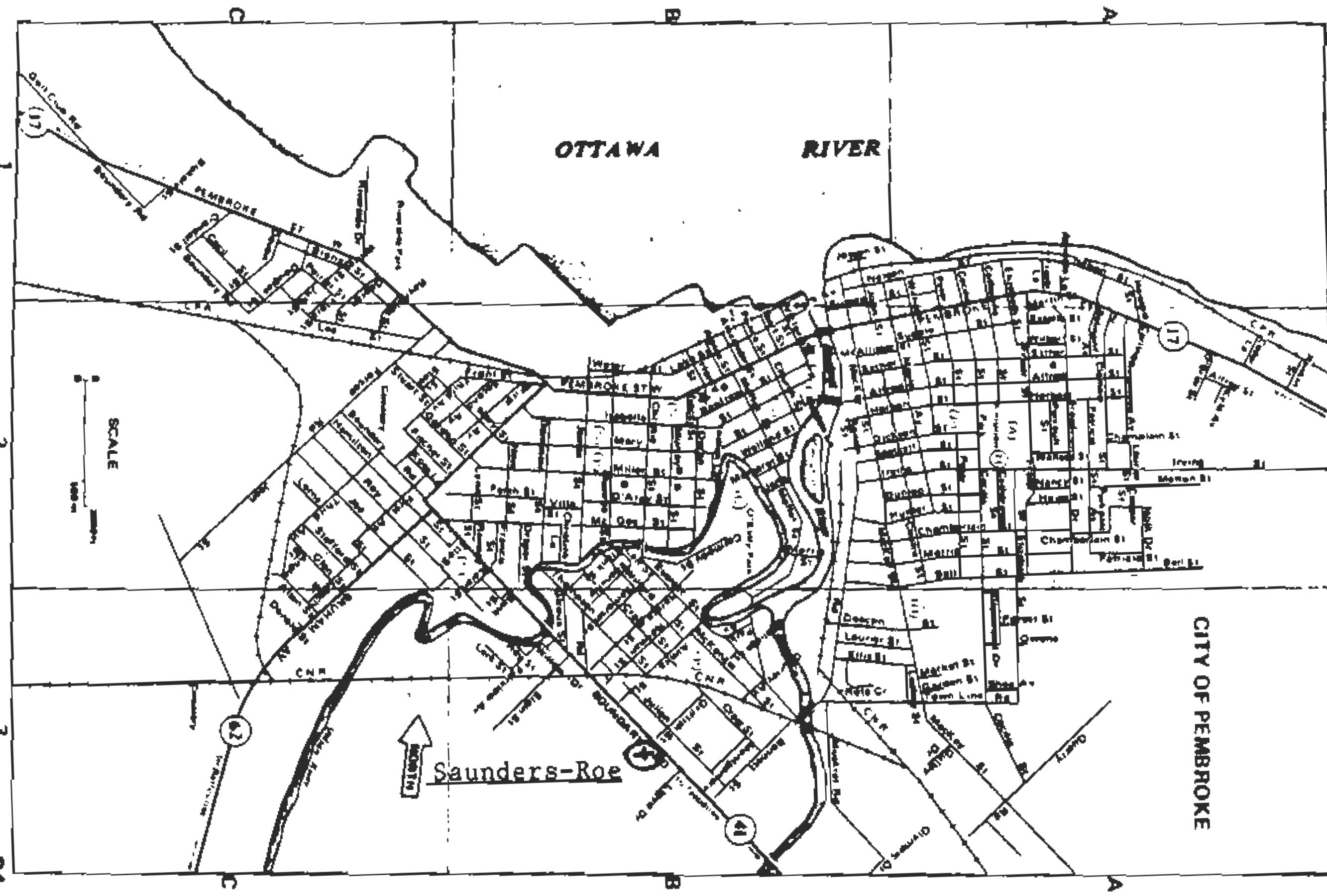
Board staff recommend that a licence authorizing the manufacture of gaseous tritium light sources be issued to Saunders-Roe Canada Inc., pursuant to Section 7 of the Atomic Energy Control Regulations. A copy of the proposed licence is attached.

90-3644



PRODUCTION AREA
DARK ROOM
TRITIUM LABORATORY
PLANT RM.
TRITIUM STORAGE
SCINT ROOM
TINNING ROOM
ATRIUM
SCINT ROOM
GLASS COATING AREA
GENERAL OFFICE
SHIPPING / RECEIVING AREA
WAREHOUSE / FUTURE EXPANSION
UNIT 140

001299



OTTAWA RIVER
Saunders-Roe
NORTH
SCALE
CITY OF PEMBROKE
PEMBROKE ST W
BOUNDARY RD
CNR
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Atomic Energy Control Board — Commission de contrôle de l'énergie atomique

5-11341-92

RADIOISOTOPE LICENCE — PERMIS RADIOISOTOPE

Licence Number — Numéro de permis

I) LICENSEE

The Atomic Energy Control Board issues this licence to:

Saunders-Roe (Canada) Inc.
320 Boundary Road, No. 140
Pembroke, ON
K8A 6X9

hereinafter 'the licensee'.

II) PERIOD

This licence is issued for the period of 13/12/90 to 31/12/92.

III) LICENSED ACTIVITY

This licence is issued for the

POSSESSION, IMPORTATION and USE

of the radioactive prescribed substance or the device containing the radioactive prescribed substance described in Section IV for :

manufacturing of sealed sources (851)

IV) RADIOACTIVE PRESCRIBED SUBSTANCE

ITEM	DESCRIPTION	POSSESSION LIMIT UNSEALED SOURCES	MAXIMUM ACTIVITY PER SEALED SOURCE	TYPE OF DEVICE
1	Hydrogen 3	9259 terabecquerels	n/a	n/a

The amount of radioactivity for the radioactive prescribed substance referred to in each item, or, where more than one such substance is included under that item, the sum of the individual radioactivities, shall not exceed the possession limit for unsealed sources, or the maximum activity per sealed source in accordance with the provisions of the above table.

'Sealed Source' means a radioactive prescribed substance sealed in a capsule or having a bonded cover, the capsule or cover being strong enough to prevent contact with and dispersion of the radioactive material under the conditions of use and wear for which it was designed, and includes the capsule or cover.

When a device is listed opposite a radioactive prescribed substance, the said substance is to be used only in that device.

V) LOCATION

Subject to the conditions of this licence, the radioactive prescribed substance(s) may be

used or stored at:
Saunders-Roe (Canada) Inc.
320 Boundary Road, No. 140
Pembroke, ON

VI) CONDITIONS

In addition to the Atomic Energy Control Regulations, the licensee shall comply with the following conditions:

1. The licensed activity shall be carried out in accordance with the submissions from P. Doyle to R. Walker dated May 14, 1990, from B. Pullen to R. Gauthier dated June 25, 1990, from A. Lamire to R. Gauthier dated July 24, 1990, from B. Pullen to R. Gauthier dated September 21, 1990, from B. Pullen to R. Gauthier dated October 2, 1990, from B. Pullen to R. Gauthier dated October 17, 1990, from B. Pullen to R. Gauthier dated November 2, 1990.

2. Nothing in this licence authorizes the importation of:
   a) more than 37 TBq of hydrogen 3, or
   b) a radioactive prescribed substance with atomic number greater than 89 with the exception of americium-241.

.../ 2

3. This licence, or a copy thereof, shall be conspicuously posted at all specific locations listed in Section V and shall be available at all other locations where the radioactive prescribed substances listed in Section IV are used or stored.

4. The licensee shall not transfer any radioactive prescribed substances procured under the authority of this licence to any person who is prohibited pursuant to the Atomic Energy Control Regulations from possessing such radioactive prescribed substances.

ATOMIC ENERGY CONTROL BOARD

BY ______________________
W.R. Brown Manager
Radioisotopes and
Transportation Division.

APPENDIX C

SAFETY ANALYSIS REPORT

By: J. A. Tompkins and L. E. Leonard

For:

Potential Radiological Impact
From Hypothetical Release of Tritium
At the SRB Technologies, Canada Facility
Located at 320 Boundary Road
Pembroke, Ontario

Prepared By:

Alpha-Dyne, LLC

4944 Ten Oaks Road
Dayton, Maryland 21036

And

5416 Jason's Way
Albuquerque, New Mexico 87111

January 15, 1996

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Dayton, Maryland 21036

And

5416 Jason's Way
Albuquerque, New Mexico 87111

Submitted By:

J. A. Tompkins, Date

L.E. Leonard 1/13/96 Date

Reviewed By:

S. J. Leonard 1-13-96 Date

Abstract

Operational changes at the SRB Technologies, (Canada) manufacturing facility in Pembroke, Ontario required an evaluation of potential safety and health effects caused by the hypothetical release of large quantities of tritium. This potential risk has developed due to the receipt and storage of a large inventory (approximately 300,000 Ci.) of tritium-filled glass tubes. This inventory is intended to be reclaimed and recycled into new products. Until that is accomplished, the potential risk to the public health and safety through accidents involving this inventory were evaluated. Three accident scenarios were evaluated and potential radiological doses calculated. Only the scenario in which a major building fire releases the total inventory as HTO resulted in significant exposure potential.

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Appendix B: Dispersion Data and Resultant Dose Tables B1

1. INTRODUCTION

This report was prepared at the request of SRB Technologies, Inc. (SRBT) . It considers changes in the operating parameters at the SRBT manufacturing facilities located at 320 Boundary Road, Pembroke, Ontario, Canada. In the following, we evaluate the health and safety implications of on-site storage of a large inventory of tritium gas encapsulated in glass tubes. SRBT operates the Pembroke facility (the Plant) under a nuclear material operating and possession license issued by the Atomic Energy Control Board (AECB) of Canada. Previous safety analyses have been performed by Pensom [1] and submitted to AECB during the license review process as part of a letter [2] in October of 1990. This report builds upon this previous work to provide additional health and safety information which reflects the recent change in the glass encapsulated tritium inventory currently at the Plant.

2. BACKGROUND

2.1 Operations: The SRBT Plant is engaged in two primary operational processes involving the handling of tritium gas.

- The filling of small (<2.5 Ci.) glass tubes with dry (<1% HTO) tritium gas to produce self-luminous products.
- The reclamation of tritium gas from previously used self-luminous devices for recycle into new glass-encapsulated self-luminous products,

2.2 Purchase of Surplus Tritium Tubes: In October of 1993 SRBT purchased a large inventory of self-luminous devices from the U. S. Department of Energy (DOE) under a surplus material sales agreement [3]. These devices had been manufactured between 1982 and 1986 [4] as experimental airport edge lights for military and civilian applications where electric power was not available. These units were deployed in various locations including Alaska and northern Ontario [5]. The units themselves were in two forms: cylindrical wands containing 1, 2, or 3 tritium-filled light tubes, and rectangular panels containing 4, 6, 7, or 8 tritium filled tubes. In total the DOE reported [6] that approximately 359,931[1] Ci. (±5%) of total tritium activity (decayed to 10/95) were [1]transferred to SRBT as part of the surplus sale. This material was transported to the SRBT Plant in approximately 31 intermittent air express shipments between January 1994 and October 1995.

In addition, SRBT received 502 tritium-filled self-luminous tubes from surplus wands owned by the State of Alaska in October of 1995. Each of these tubes contained approximately 50 Ci. (decayed to 10/95) totaling 25,100 Ci. of tritium activity.

[1] These numbers remain approximate until a final inventory has reconciled the ship/receive data, the decayed activity and the total tube count.

It was determined [7] that from the above sources a total of approximately 10,695[1] surplus tubes were received at the SRBT Plant containing a total of 385,596 Ci. of tritium activity.

2.3 Reclamation Process: It was intended that as part of the routine operations of the SRBT Plant, the above described inventory of surplus tritium-filled tubes would be processed in the reclamation unit on a more or less continuous basis beginning in February 1994, when the first units arrived, and continuing until all the glass tube inventory had been eliminated. The recovered tritium was to be placed on pyrophoric uranium (PU) beds where it would be used, as needed, to produce new self-luminous products. In this way the reclamation of tritium from the surplus tubes would feed a continuous process that would be assimilated by the new product production and thus keep the inventory in glass reduced.

A number of events conspired to thwart the routine operation of the reclamation/recycle process as described. As a result, a large tritium inventory accumulated in glass tubes until at present approximately 300,000 Ci. remains in storage in glass awaiting reclamation next the plant.

2.4 Operational Changes: Since the current inventory of tritium-filled glass tubes is a totally unique situation [This material represents the only known collection of large (>10 Ci each) self-luminous tubes] a temporary change in the SRBT Plant operating plan will be necessary to reduce the imbalance in tritium in glass versus tritium in PU beds and return the total tritium inventory to compliance with the governing AECB operating and possession license. Until this one-time inventory begins to shrink by reclamation, the question has been raised as to the effect on Plant safety.

3. PURPOSE

Calculations performed and discussed in this report are intended to address this safety concern. Our purpose is to establish the safety and health related radiological impacts of the most credible worst-case accidents which might occur at the SRBT Plant under the operating conditions which exist in January 1996. In the worst case, tritium is released from the large inventory of tritium-filled glass tubes. The analysis performed in this report considers only the safety and health implications related to potential tritium exposures from accidents. Other safety and health issues are not considered here.

4. RADIOLOGICAL SAFETY ANALYSIS

4.1 Assumptions: In general it is assumed that radiological risk at the SRBT Plant in all operational aspects remain as described in previous safety analysis [1],[2] with the single exception of the current inventory of tritium stored in glass tubes awaiting reclamation. This basic assumption further implies that potential exposure to workers associated with the handling and processing of the reclamation inventory is covered within the compliance envelope of the previous safety analysis as well. We may also assume that the safety implications are directly proportional to the size of the glass-filled inventory. Therefore, any reduction of the inventory would have a proportional impact on the risk of potential exposure.

The fundamental assumption of this analysis therefore, is that there is a previously unevaluated radiological risk posed by the existence of the unusually large glass tube tritium inventory and, the nature of the risk is determined by:

- Total activity at risk
- Concentration of the stored tritium within the building
- Vulnerability of the storage area
- Most probable form of accidental release
- Pathways of release
- Meteorological conditions affecting dispersion and transport
- Exposure potential

4.1.1 Radioactive Source Term: We assume that the total activity of the radioactive source at risk in 300,000 Ci. of tritium contained in glass, of which 1.5% is in the form of HTO and 98.5% is in the form of T_2 gas. This inventory is currently stored as follows within the Plant building at 320 Boundary Road:

- Approximately 35,000 Ci. of total activity remain in fully assembled wand-type units enclosed in sealed Lexan™ housings. These are stored beneath the fume hood in the assembly area.

- Approximately 265,000 Ci. are stored in a concrete block enclosed storage closet at the extreme north end of the building separated by about 50 ft. from the above inventory. Within this closet, approximately 22,000 Ci are stored in a fire-proof safe as bare glass tubes. Approximately 11,250 Ci. remain in the original wand-type housings, and the balance of the activity is stored as bare glass tubes in plastic bins placed on metal shelves.

4.1.2 Accidental Release Scenarios: To assess the maximum credible tritium release and potential radiation exposures resulting from accidents impacting the above source-term we consider three distinct scenarios:

4.1.2.1 Release From a Tornado Impacting the Building: We assume that the building is subjected to sustained winds with a velocity in excess of 55.5 m/sec. for an indefinite period, until the structure becomes unstable, causing a violent collapse. As a result, the glass-contained inventory is dispersed by the violence of the wind along with other flying debris. We assume that a portion (50%) of the inventory will be immediately broken on collapse and released into the atmosphere within a ten second period. The release occurs as 147,750 Ci. T_2 and 2,250 Ci. as HTO. In this scenario it is assumed that other smaller releases could occur subsequent to the initial release, but these would have a minimal impact compared to the initial release and will not be evaluated. Due to the violence of the storm and the collapse of the building the release is assumed to occur at ground level.

4.1.2.2 Release From the Impact of a Large Rogue Motor Vehicle: We assume that a large (>10,000 kg) motor vehicle impacts the north side of the building collapsing the outside wall and penetrating the storage room, breaking a significant portion of the tube inventory (23%) releasing 59,100 Ci. as T_2 and 900 Ci. as HTO. Due to the violence of the impact, the total release is assumed to occur within a 10 second period. The front of the vehicle is assumed to come to rest penetrating the outside wall of the building. Thus, tritium is released into the ventilation system of the existing building, resulting in an external building release at the height of building exhaust stack (approximately 12 m).

4.1.2.3 Release From a Total Conflagration of the Building By Fire: We assume that a fire consumes the entire structure, releasing the entire inventory of tritium contained in glass. Since it is necessary to raise the temperature of the glass tubes to 650°C before enough softening of the glass is achieved to release the contained tritium, it is assumed that the release occurs over a period of 1 hour. It is further assumed that since the release can only occur at such high temperatures, all of the tritium is oxidized on release, causing the condition of greatest radiological risk potential (the biological impact of HTO is approximately 14,000 times greater than T_2). Tritium release resulting from a building fire has been studied by Jensen [8]. The implications of the release height from which dispersion occurs is very important. Since any fire necessary to raise the specified inventory to the minimum release temperature would require large volumes of air for combustion, it thus creates a very large thermal plume. The tritium is released and turbulently mixed in this rapidly rising plume. It is assumed that the effective dispersion of the tritium occurs well above the ground surface. This will be discussed below under "Environmental Conditions."

4.1.3 Environmental Conditions: Tables 1 and 2 in Appendix A show typical wind speeds and directions as well as other meteorological data for the Chalk River area which we assume applies to Pembroke as well. For all scenarios, we assume that the aggregate plume drift is to the northeast from the plant, causing the greatest potential exposure to the population center of Pembroke. Based on Table 2, this assumption suggests that, in reality, such condition would occur only about 10% of the time. All other potential wind directions would tend to move a contaminated plume originating at the Plant away from the population center of Pembroke. Therefore, the potential for exposure to the majority of the population of Pembroke from any release from the plant can be considered relatively low. We assume the following additional environmental conditions during the occurrence of the three accident scenarios described.

4.1.3.1 Tornado Accident: The storm occurs in summer and the stability of the atmospheric conditions during the storm are extremely violent and turbulent. The direction and velocity of the wind are constantly changing, but the mean dispersion wind velocity is 55 m/s in the direction described above.

4.1.3.2 Vehicle Accident: The accident is assumed to occur in the winter on a day which is more stable than average with a mean wind velocity of 2 m/s. This velocity is assumed to be a conservative estimate since, according to Table 1, the average wind velocity for the period Dec through Mar is 3.2 m/s. The direction is again toward the center of the community.

4.1.3.3 Fire Scenario: The fire takes place during a period of stable atmospheric conditions. We evaluate two such conditions: The first, which assumes a day-time fire, probably occurring in the winter, and the second, which assumes a night-time fire under very cold conditions when an extremely stable inversion in the adiabatic lapse rate exists at low altitude. As with the vehicle scenario, we assume an aggregate plume drift at a rate of 2 m/s in the direction of the center of Pembroke, as described above.

4.2 Analytical Method: The analytical method to determine radiological impact requires first the assessment of the tritium concentration in the atmosphere resulting from the release. This is done by conventional dispersion theory in which a contaminated plume is defined. Once the concentration is known at various points along the plume, and the point established at which the plume contacts the ground elevation, the dose to an individual at ground level can be calculated.

4.2.1 Tritium concentration in the atmosphere: The analytical method is taken from Turner [8]. This method generally follows the one used by Pensom [1] for the previous safety analysis prepared for the Plant. In the referenced work, Turner presents methods of practical applications of the continuous plume dispersion model to estimate contaminant concentrations in the air. Meteorologists estimate dispersion effects based on Pasquill's atmospheric surface layer stabilities and our calculations have followed this standard method. In general, the concentrations follow the behavior of :

$$\chi = (Q/\pi\ \sigma_y \sigma_z V)\mathrm{EXP}(-h^2/2\sigma_z^2)$$

where:

χ = the tritium concentration in µCi/cc
Q = the rate of release in Ci/sec
σ_y & σ_z are the empirically derived diffusion coefficients (in m) for a particular Pasquill stability in the horizontal and vertical planes, respectively
V = wind velocity in m/s
h = effective contaminant release height in meters

σ_y & σ_z have been derived for various Pasquill stability conditions through field observations and listed in Turner [9].

4.2.2 Determination of Dose: Once the atmospheric concentration has been determined spatially, it is then possible to determine the potential radiological exposure to an individual who comes in contact with a contaminated plume. The method which we use here to calculate dose uses internal dose conversion factors based upon ICRP 30 [10] and is calculated as follows:

Committed Dose Effective Equivalent (CEDE) = (QI)(IDCF)

where:

QI = Quantity of intake which is, the concentration derived as above (μCi/cc) x Breathing Rate* (cc/sec) x time (sec)

IDCF = Inhalation dose conversion factor for tritium which is 6.35E-5 Rem/μCi for HTO and 4.4E-9 Rem/μCi for T_2 and includes allowance for cutaneous absorption of tritium

*Breathing Rate used in these calculations is conservatively assumed to be equal to 20 liters/min which is the rate for an individual doing light work [11].

4.2.3 Calculations: Calculations were performed for the three tritium release scenarios using the methods described above in a Microsoft Excel spreadsheet application of the Turner model [9]. Pasquill stabilities were selected as follows for these calculations and will be discussed further in subsequent sections.

- **Tornado** Pasquill A which assumes the most unstable atmospheric conditions
- **Vehicle** Pasquill C which assumes slightly unstable atmospheric conditions typical of daylight conditions with slight to moderate insolation
- **Fire** Pasquill C which assumes slightly unstable atmospheric conditions typical of daylight conditions with slight to moderate insolation with a constant but shallow thermal gradient in the adiabatic lapse rate. Such a condition would result in a thermal plume release height of about 100 m as a conservatively low elevation and,

  Pasquill F which assumes moderately stable atmospheric conditions typical of a cold winter night in which there is an inversion in the adiabatic lapse rate which effectively caps the vertical extent of the plume and thus lowers the assumed thermal plume release height to about 50 m, a very conservative height.

Such calculations allow us to identify the potential dose to an individual on the ground along the center line of the plume. Worst case exposures require the individual to remain on the centerline at the point of greatest concentration for the entire duration of the plume passage.

4.3 Results

4.3.1 Highest Dose for Tornado Accident Scenario: Committed Effective Dose Equivalent (CEDE) = [0.7 mRem (0.007 mSv)] from HTO + [3.2E-3 mRem (3.2E-5 mSv)] from T_2 to an individual standing at the point of highest concentration (100 m downwind from release) and it assumes that the recipient is exposed for the entire duration of the contaminated plume passage.

4.3.2 Highest Dose for Vehicle Impact Scenario: CEDE = [17 mRem (0.17 mSv) from HTO] + [8.02E-2 mRem (8.0E-4 mSv)] from T_2. Again the recipient is assumed to stand downwind at the point of maximum concentration (70 m from release) for the full duration of the contaminated plume passage.

4.3.3 Highest Dose for Fire Scenario for Pasquill C: CEDE = 46 mRem (0.46 mSv) HTO to an individual standing downwind of the release at the point of highest concentration (1000 m from release) for the duration of the contaminated plume passage.

4.3.4 Highest Dose for Fire Scenario for Pasquill F: CEDE = 71 mRem (0.71 mSv) HTO to an individual standing downwind of the release at the point of highest concentration (4000 m from release) for the duration of the contaminated plume passage.

4.4 Discussion of Results: For both the tornado and vehicle incident, the *continuous* release calculation method was used:. Since these releases were assumed to occur over a 10-second period, it might have been more appropriate to use the *puff* release calculation method which is slightly more complex (see Turner [9]. However, since the *continuous* release method would tend to predict higher concentrations, this short-cut was considered an acceptable and more conservative approximation. As is seen below, these two scenarios prove to be of small consequence in any case.

4.4.1 Dose Potential from Tornado: The violent atmospheric conditions place the greatest dose potential very close to the building (100 m). From the data presented in Appendix B, it can be readily seen that the same atmospheric instability causes the plume concentrations to quickly disperse with distance. Since it is unrealistic to expect individuals to remain in the open during such conditions and since the contamination so rapidly dissipates, the radiological impact of this scenario is considered very low.

4.4.2 Dose Potential from Vehicle: As with the tornado, the greatest dose potential from this scenario occurs very close to the building (70 m) and again rapidly disperses with distance (0.8mRem @ 1000 m). It is conceivable that an employee or curious passerby could be effected with a 1 to 10 mRem dose while near the building. However, as with the tornado, the overall radiological risk potential of a vehicle impact is considered small.

4.4.3 Dose Potential from Fire: It is only the fire scenario which offers a significant radiological impact to the general population of Pembroke and the surrounding environs.

The point of highest dose potential occurs along the centerline of the plume 4000 m downwind of the release from the most stable atmospheric assumption. An examination of a map of the Pembroke area suggests that 4000 m along the centerline of a plume drifting toward the center of the community from the plant would place the most exposed individual on the bank of the Ottawa River, NE of the center of town. From the weather data presented in Appendix A, there is only about a 10% probability that the prevailing winds would create this effect. The remaining 90% probability for wind drift would move the plume in directions away from significantly populated areas.

Figure 1 shows the dose potential as a function of distance from the release. Still assuming a plume drift toward the center of town, it can be seen from the graph that although the maximum potential dose from the fire occurs during the most stable atmospheric condition (Pasquill F), the risk to the population residing in Pembroke is about equivalent for both atmospheric conditions. Note that the two lines cross at a point approximately 2000 m from the release which is approximately at the population center of Pembroke. Exposure to the plume at this point would result in a maximum dose of about 35 mRem, much less than the maximum dose received at a distance of 4 km from the release. The graph also suggests that the potential doses from a fire generated accident under any chosen Pasquill atmospheric stability for the majority of the people in Pembroke (a distance of 1-3 km from the plant) would not exceed the range of 10 to 60 mRem in the worst case.

In addition, when determining the potential dose, we have not considered normal human behavior which suggests that individuals would not voluntarily remain in a smoke plume for the full duration of the radiological plume passage.

In this initial safety report, we have not attempted to definitively determine the probabilities for the occurrence of a fire accident as analyzed. Those probabilities would have to consider the following:

- The probability of significant fire occurrence at the plant.
- The maximum potential fire duration from the plant building.
- The maximum potential fuel loading within the plant building.
- The fire resistance of the storage area within the plant.
- The probability that the fire suppression would not be effective.

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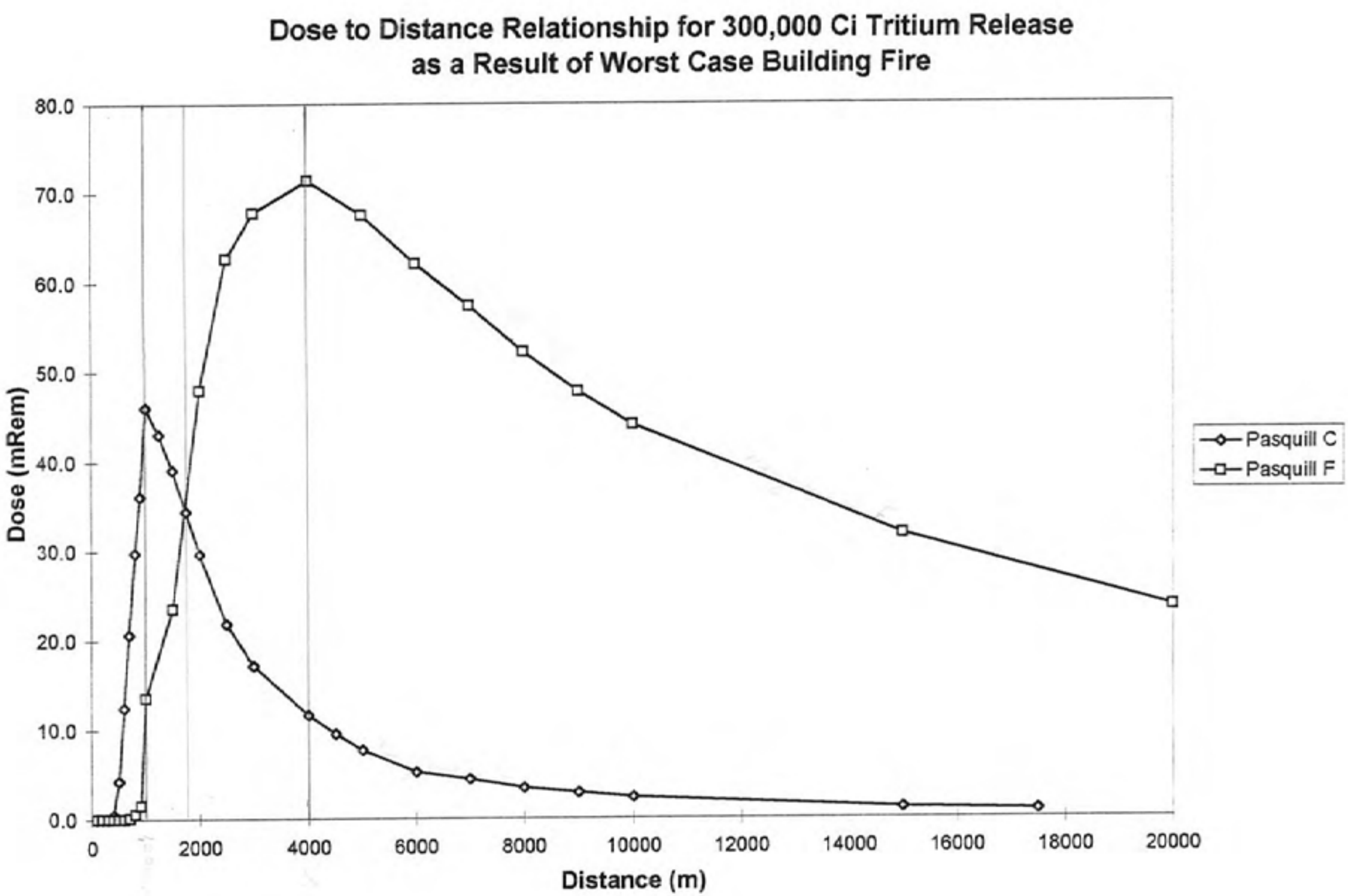
Figure 1.



Dose to Distance Relationship for 300,000 Ci Tritium Release
as a Result of Worst Case Building Fire
Dose (mRem)
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
Distance (m)
Pasquill C
Pasquill F

Table 1

METEOROLOGICAL DATA FOR PEMBROKE

MONTH	TEMP (°C)	WIND SPEED (m/s)	PRECIPITATION RAIN (mm)	SNOW (cm)	TOTAL (mm)
Jan	-11.4	3.1	9.4	42.8	52.2
Feb	-10.1	3.0	8.1	37.2	45.3
Mar	-3.2	3.3	26.6	29.6	56.2
Apr	5.3	3.5	47.6	9.5	57.1
May	11.8	2.9	74.4	1.0	75.4
Jun	16.9	2.4	83.0	0.0	83.0
Jul	19.3	2.7	78.7	0.0	78.7
Aug	17.3	2.4	84.6	0.0	84.6
Sep	12.8	3.1	83.9	0.0	83.9
Oct	6.9	3.4	77.6	1.8	79.4
Nov	0.2	3.3	48.1	26.2	74.3
Dec	-8.2	3.3	15.0	46.1	61.1
Annual	**4.8**	**3.04**	**637.0**	**194.2**	**831.2**

Notes: 1. Temperature and precipitation are based on measurements made at Atomic Energy of Canada Ltd., Chalk River Laboratory (CRL) over the period 1963-1995.These should be fairly representative of values at Pembroke.

2. Wind speed is based on data for the period 1990-1994 from the 30-m level of the Perch Lake tower on CRL property adjusted to equal the annual average of the 10-m wind speed at the Petawawa Military Camp. Given the small month-to-month variation, the speeds should be fairly representative of 10-m speeds at Pembroke (10-m is the standard observation level).

Table 2.

WIND ROSE DATA

Direction from which the wind blows		Frequency*
N	(349° - 11°)	0.0463
NNE	(11-34)	0.0208
NE	(34-56)	0.0193
ENE	(56-79)	0.0177
E	(79-101)	0.0470
ESE	(101-124)	0.1120
SE	(124-146)	0.1130
SSE	(146-169)	0.0446
S	(169-191)	0.0410
SSW	(191-214)	0.0291
SW	(214-236)	0.0351
WSW	(236-259)	0.0466
W	(259-281)	0.1320
WNW	(281-304)	0.1180
NW	(304-326)	0.1130
NNW	(326-349)	0.0727

*These values are based on data from Base Petawawa for the period 1979-1988 inclusive.

ATMOSPHERIC DISPERSION MODEL*

Tornado Scenario

Q =	225	Release Rate (Ci/s)
V =	55.5	Wind Speed (m/s)
h =	1	Release Height (m)

Pasquill A

X (m)**	σ_z	σ_y	χ
100	14	27	3.41E-03
200	27	50	9.55E-04
300	48	74	3.63E-04
400	74	94	1.85E-04
500	105	115	1.07E-04
600	155	135	6.17E-05
700	210	155	3.96E-05
800	290	175	2.54E-05
900	360	195	1.84E-05
1000	450	215	1.33E-05
1500	1050	300	4.10E-06
2000	1900	390	1.74E-06
2500	3100	470	8.86E-07
3000	4500	550	5.21E-07

*Taken from the Workbook of Atmospheric Dispersion Estimates U.S. HEW, Public Health Service Report No. PB-191482, 1970.

**These distances represent a reasonable distance from the release site, since closer proximity would likely result in fatality from the tornado itself.

ATMOSPHERIC DISPERSION MODEL*			
Vehicle Impact Scenario			
Q =	90	Release Rate (Ci/s)	
V =	2	Wind Speed (m/s)	
h =	12	Release Height (m)	
Pasquill C			
X (m)	σ_z	σ_y	χ
10	0.8	1.2	2.07E-48
30	2.3	3.7	2.07E-06
50	3.9	6.3	5.13E-03
70	5.4	8.9	2.52E-02
100	8	12.5	4.65E-02
200	14	18.5	3.83E-02
300	20	34	1.76E-02
400	26	44	1.13E-02
500	32	55	7.59E-03
600	38	66	5.43E-03
700	43	75	4.27E-03
800	49	85	3.34E-03
900	55	96	2.65E-03
1000	66	104	2.05E-03
1250	74.5	126	1.51E-03
1500	94.5	154	9.76E-04
1750	105	175	7.74E-04
2000	125	195	5.85E-04
2500	148	245	3.94E-04
3000	172	285	2.91E-04
4000	206	370	1.88E-04
4500	240	400	1.49E-04
5000	270	450	1.18E-04
6000	340	540	7.80E-05
7000	360	610	6.52E-05
8000	420	680	5.01E-05
9000	450	760	4.19E-05
10000	500	840	3.41E-05
15000	740	1180	1.64E-05
17500	850	1350	1.25E-05
20000	940	1500	1.02E-05

ATMOSPHERIC DISPERSION MODEL*

Fire Scenario - Moderately Unstable Atmosphere

Q =	83.3	Release Rate (Ci/s)
V =	2	Wind Speed (m/s)
h =	100	Release Height (m)

Pasquill C

X (m)	σ_z	σ_y	χ
10	0.8	1.2	0.00E+00
30	2.3	3.7	0.00E+00
50	3.9	6.3	9.25E-144
70	5.4	8.9	9.40E-76
100	8	12.5	1.56E-35
200	14	18.5	4.27E-13
300	20	34	7.27E-08
400	26	44	7.11E-06
500	32	55	5.71E-05
600	38	66	1.66E-04
700	43	75	2.75E-04
800	49	85	3.97E-04
900	55	96	4.81E-04
1000	66	104	6.13E-04
1250	74.5	126	5.74E-04
1500	94.5	154	5.20E-04
1750	105	175	4.58E-04
2000	125	195	3.95E-04
2500	148	245	2.91E-04
3000	172	285	2.28E-04
4000	206	370	1.55E-04
4500	240	400	1.27E-04
5000	270	450	1.02E-04
6000	340	540	6.92E-05
7000	360	610	5.81E-05
8000	420	680	4.51E-05
9000	450	760	3.78E-05
10000	500	840	3.09E-05
15000	740	1180	1.50E-05
17500	850	1350	1.15E-05
20000	940	1500	9.35E-06

*Taken from the Workbook of Atmospheric Dispersion Estimates U.S. HEW, Public Health Service Report No. PB-191482, 1970.

ATMOSPHERIC DISPERSION MODEL*

Fire Scenario - Moderately Stable Atmosphere

Q =	83.3	Release Rate (Ci/s)
V =	2	Wind Speed (m/s)
h =	50	Release Height (m)

Pasquill F

X (m)	σ_z	σ_y	χ
100	2.3	2	6.89E-103
200	4	7.5	5.20E-35
300	5.6	11	1.05E-18
400	7	14.5	1.09E-12
500	8.5	17.5	2.73E-09
600	9.8	21	1.43E-07
700	11	24	1.64E-06
800	12	27.5	6.82E-06
900	13	31	2.02E-05
1000	14	34	4.73E-05
1500	18	50	3.11E-04
2000	21.5	65	6.35E-04
2500	24	76	8.30E-04
3000	26.5	94	8.98E-04
4000	30.5	120	9.45E-04
5000	34	148	8.94E-04
6000	37	175	8.22E-04
7000	40	200	7.59E-04
8000	42	225	6.91E-04
9000	44	250	6.32E-04
10000	47	275	5.82E-04
15000	54	380	4.21E-04
20000	60	500	3.12E-04
30000	68	720	2.07E-04
40000	74	940	1.52E-04
50000	78	1100	1.26E-04
60000	83	1300	1.02E-04
70000	86	1500	8.68E-05

*Taken from the Workbook of Atmospheric Dispersion Estimates U.S. HEW, Public Health Service Report No. PB-191482, 1970.

APPENDIX D

SAFETY ANALYSIS REPORT

By

J. A. Tompkins

For

**Potential Radiological Impact
From Hypothetical Release of Tritium
From a Smoldering Fire Incident
At the SRB Technologies, Canada Facility
Located at 320 Boundary Road
Pembroke, Ontario**

Prepared by:

**Alpha-Dyne, LLC
1060-A 49th Street
Los Alamos, NM 87544**

October 16, 2000

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Submitted by:

J.A. Tompkins 10-18-00

J.A. Tompkins, CHP **Date**

Reviewed by:

10/18/00

L.E. Leonard, P.E. **Date**

Abstract

In January 1996, alpha-Dyne, LLC prepared a Safety Analysis Report entitled, "Potential Radiological Impact from Hypothetical Release of Tritium at the SRB Technologies, Canada Facility Located at 320 Boundary Road, Pembroke, Ontario". Although the 1996 Safety Analysis Report outlined the worst case scenario, questions recently have arisen as to the potential radiological impact resulting from a smoldering fire at the facility. This potential incident was not analyzed in the 1996 report. This report provides a supplement to the 1996 analysis which analyzes for the smoldering fire incident.

1. Introduction

This report was prepared at the request of SRB Technologies, Inc. (SRBT). It considers the radiological impacts at the SRBT tritium lamp/device manufacturing facility located at 320 Boundary Road, Pembroke, Ontario, Canada resulting from an incident involving a smoldering fire within the controlled area of the facility. This report may be considered a supplement to previous safety analyses of the facility. The conclusions of this report should be considered independent of previous analyses.

2. Background

The SRBT plant/facility is engaged in two primary operational processes involving the handling of tritium gas.

- The filling of small glass tubes with dry (<1% HTO) tritium gas to produce self-luminous products
- The reclamation of tritium gas from previously used self-luminous devices for recycle into new glass-encapsulated self-luminous products.

3. Purpose

The fundamental assumption for this analysis is that there exists a previously unevaluated potential radiological risk posed by a tritium release scenario which has been posed as follows:

A fire breaks out somewhere within the Pembroke facility which is not a total conflagration. Rather, it is a slow burning, smoldering fire. The fire could cause release of tritium directly, or more probably, merely damages the structure and its contents. But the detection and fighting of the fire by the first responders causes collateral damage which results in a tritium release. This poses the question, "What would be the radiological risk to the first responders?" The risk to the most highly affected individual in the immediate area of the tritium release will be evaluated.

4. Assumptions

A smoldering fire, by definition,[i] burns with no visible flame and produces smoke, and is likely to be localized to an accumulation of combustible material and to spread slowly. This analysis will construct a scenario by which firemen are required to enter the facility to fight a smoldering fire. The firemen, in their efforts to extinguish the fire, will use sufficient force to break from water or other physical force, a large number of light source tubes, causing a tritium release. This analysis will not attempt to predict the probability for this type of fire in the SRBT facility. It will, rather, assume that such an incident could occur and will attempt to predict the radiological impact within one realistic set of assumptions.

It is assumed that if a fireman were to use a high-pressure hose to extinguish the fire, it is possible that sufficient mechanical force might be imparted to break significant numbers of tritium filled glass tubes.

4.1 Tritium Locations within the SRBT Facility

There are three primary areas in the SRBT facility where large inventories of tritium are stored. They are the fireproof room (location #30), the filling machines, and the main assembly room (location #20).

- In the fireproof room, tritium is stored on metal shelves in the form of tritium filled glass tubes. This room is small, contains little in the way of combustible loading, and its enclosing walls are designed to create a 1 hour fire barrier. This location would be the least likely location to initiate or sustain a smoldering fire.

- On the filling machines, tritium is stored on metal tritide traps which are rated as US Department of Transportation (DOT) special form shipping containers. Special form containers are designed to withstand temperatures in excess of 800°C for longer than 30 minutes[ii] without venting of the tritium inventory on the traps. Direct release from a smoldering fire or mechanical damage from a fire hose is unlikely to fracture the stainless steel shell or cause release of tritium from the tritide trap.

- In the assembly rooms, assembled and partially assembled devices containing tritium in Pyrex® brand borosilicate glass tubes are stored in drawers and exposed on bench tops. Borosilicate glass is highly resistant to breakage from thermal shock, and requires temperatures in excess of 820°C to cause softening of the glass sufficient to cause a tritium release. Thermal shock to the light source tubes is typically not a problem. In one manufacturing process, the borosilicate light source tubes are sealed with an oxyacetylene torch at one end of the tube while the other end is soaking in liquid nitrogen (-200°C). That is a thermal differential across the tube of 1400°C (+1200°C to -200°C). Although there is a low combustible loading in the assembly room, the borosilicate glass tubes are susceptible to mechanical shock, such as might be caused by a high pressure fire hose. Thus, the assembly rooms in the SRBT facility are the most probable locations for a smoldering fire scenario in which tritium tubes are made vulnerable.

4.2 Source Term

The largest vulnerable accumulation of unassembled, bare tritium light source tubes in the main assembly room would be a single bucket containing 100 individual 2.19 Ci light source tubes[iii] at the beginning of a cycle of assembling 100 exit signs. The 2.19 Ci tube is the longest and hence the most vulnerable to a mechanically induced fracture. Assuming that a smoldering fire would be localized within the assembly room, it is realistic to also assume that this single bucket of tubes in the proximity of the fire would present a likely target for potential damage from the fire hose.

4.3 Response Time

Once alerted, the average response time of the Pembroke Fire Department[iv] and the contracted security firm[v] are 3.3 min. and 2 min., respectively. For a smoldering fire, it is assumed that it would be initiated and proceed slowly without detection for some period of time, thus the actual response time is not used in this analysis.

4.4 Release Scenario

A forceful encounter with the stream of high-pressure water is likely to impart sufficient mechanical energy to fracture a few light source tubes, such as those in a transfer bucket. Partially assembled devices are less likely to be affected by the applied force since light source tubes are already shock mounted to a component of the device. Items containing light source tubes stored in cabinets and drawers are unlikely to be mechanically affected by the force exerted by a high-pressure hose. Only the material openly exposed is considered vulnerable. Thus, if a bucket containing 100 individual 2.19 Ci light source tubes (the longest and most fragile tube in the SRBT inventory) was accidentally hit by a jet of water from a fire hose which was intended to extinguish the localized smoldering fire, and 100 % of the tubes were broken, this could be considered as a worse case credible accident in the assembly room. It is this incident that will be analyzed in terms of potential radiological exposure to fire fighting personnel within the SRBT facility.

5. Analysis

The risk to personnel responding to release of tritium in a fire response incident will be evaluated by estimating the potential tritium intake and the resulting radiation dose to the most highly affected individual.

5.1 Metrics

Assembly Room volume:	198 m^3
Release Duration:	immediate
Quantity of tritium released:	219 Ci (100 times 2.19 Ci tubes)
Initial T_2O content as water vapor:	1.5%
Initial T_2 content as dry gas	98.5%
Fire personnel stay time:	15 minutes

5.2 Average concentration during stay of affected personnel

The concentration of the tritium oxide and dry tritium gas in the room air is calculated separately below. It should be noted that the internal dose factor for tritium oxide is approximately 10,000 times higher than that for dry gas. Therefore, in spite of the fact that the dry tritium gas poses the highest concentration of tritium in the room, as shown below, its affect on dose is relatively small. It is included here, however, for completeness.

A calculation of tritium concentration at the end of fire personnel stay time in the affected room is performed as follows:

$$C = C_{00}\, e^{-((\text{removal rate} \times T)/Vrm)} + C_{0G}\, e^{-((\text{removal rate} \times T)/Vrm)}$$

where

C = concentration of T_20 at time T (Ci/ m^3) + concentration of T_2 at time T (Ci/ m^3)

C_{00} = initial concentration of T_20 (Ci/m^3) = (219 Ci x 0.015)/198 m^3) = 0.017 Ci T_20/m^3

C_{0G} = initial concentration of T_2 (Ci/m^3) = (219 Ci x 0.985)/198 m^3) = 1.09 Ci T_2/m^3

Removal rate = rate at which air is exhausted from assembly room (m^3/min.)

V_{rm} = volume of the affected room = 198 m^3

T = the elapsed at which concentration is needed (min.) = 15 min.

The most conservative assumption is that the tritium concentration in the room is equal to the initial concentrations of C_{00},+ C_{0G} and that it stays at that concentration for the entire stay time of the responder personnel. This assumption is conservative since the room is well ventilated, however for the purposes of this calculation, it is assumed that the ventilation system has failed.

While it is possible that some of the tritium gas in the room will undergo oxidation during the stay time of the responders, this potential contribution of additional tritium oxide to the room is not considered to be significant since there is no open flame source (this is a smoldering fire) and under normal conditions, the conversion rate of T_2 to T_2O and HTO is typically only a few percent per day according to studies by Jensen and Traub[v].

5.3 Determination of Dose to Personnel

Once the room concentration of both oxide and dry tritium gas has been determined (above), it is then possible to determine the potential radiological exposure to an individual who enters the affected room. The method we will use here to calculate dose uses internal dose conversion factors based upon ICRP 30[vii] and is calculated as follows:

Committed Effective Dose Equivalent (CEDE) = QI x IDCF

QI = Quantity of Intake, which is the concentration of tritium in the room air (derived above, µCi/cc) times the breathing rate[viii] (20,000 cc/min) x time (min.)

$IDCF_0$ = Internal dose conversion factor for 6.35E-5 Rem/µCi for T_20.
$IDCF_G$ = Internal dose conversion factor for 4.4E-9 Rem/µCi for T_2.

$CEDE_0$ = 6.35E-5 Rem/µCi x (0.017 µCi/cc x 20,000 cc/min x 15 min) = 0.324 Rem = 3.2 mSv
$CEDE_G$ = 4.4E-9 Rem/µCi x (1.09 µCi/cc x 20,000 cc/min x 15 min) = 0.001 Rem = 0.01 mSv

The total dose resulting from both oxide and dry gas is, therefore, 3.2 mSv. Note, however, that the contribution to the dose from the dry gas is only 0.4 %.

6. Potential Mitigation of the Resulting Dose

6.1 Ventilation

Even with the assumption that the mechanical ventilation has failed, some free ventilation will occur, and under any circumstance, the tritium concentration at the end of the responders' stay time would be less than the initial concentration.

6.2 Personnel Protection Equipment (PPE)

The above calculated dose is also potentially mitigated by two pieces of PPE typically worn by fire fighters entering interior spaces of a smoke-filled building to fight a smoldering fire; a positive demand self contained breathing apparatus (SCBA) and a fire fighter's water proof coverall. If a firefighter is wearing SCBA, he is not breathing tritium contaminated air (protection factor is >10,000). This would eliminate almost any tritium absorption by the lungs. If the fire fighter is wearing his waterproof coverall, he is avoiding some subcutaneous adsorption of T_20 water vapor, which is about 50% of the CEDE for oxide calculated above (ICRP 30[vi]). Thus, typical items of PPE worn by fire fighters in a smoldering fire environment will mitigate the predicted dose to responding personnel.

6.3 Practical Aspects of Tritium Oxide Concentration

One possible mitigating factor that would reduce the potential dose calculated above is the effect of the cold water stream from the fire hose mixing with tritium gas released from fractured tubes. When the tubes are broken as a result of the impact of the water stream, the tritiated water vapor that was released would contribute more than 99 % of the dose calculated above. The dry tritium gas released would account for approximately the remaining 0.4 % of the dose to the affected first responder. It is most probable that when the cold water stream comes in contact with the released tritiated water vapor and dry tritium gas, some of the vapor will change state and be swept along with the fire suppression water stream because of the lower vapor pressure of tritiated water. This will reduce the amount of tritiated water vapor contributing to the dose and, as a result, will have a mitigating effect upon the largest contributor of the dose to the affected individual. Qualitatively then, it is probable that the dose from the water stream impact scenario could actually be lower than what was calculated above.

7.0 Conclusion

The calculations for tritium release from the impact of the water stream from a fire hose while fighting fire in a controlled area was predicted to be 3.2 mSv to the most affected individual, that being the first responder. The mitigating factors discussed suggest that this dose prediction is conservative with respect to the given incident scenario within the SRB Pembroke facility.

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[i] Glossary of Fire Investigation Terms, Brian Brown & Associates, Inc.

[ii] AECB, Board Member Document, BMD 91-60, 91-02-18.

[iii] SRB Part No. 128145G0330A, largest Ci content (2.19 Ci T_2) and longest tube in the exit signs (most fragile).

[iv] Pembroke Fire Department, 1999 Annual Report, p. 6, Emergency response times.

[v] Alarm Bridge private communication to SRB, 10-11-00.

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[v] Traub, R.J. and G.A. Jensen, Tritium Radioluminescent Devices Health and Safety Manual, Pacific National Laboratory Report PNL-10620 Section 2.6.3 Environmental Chemistry p 2.8, June 1995.

[vii] International Council on Radiation Protection, "Limits for Intakes of Radionuclides by Workers", ICRP Publication 30 Part 1, Pergamon Press, Oxford; 1978.

[viii] Breathing rate is for an adult male doing light work, International Council on Radiation Protection, "Reference Man", ICRP Publication 26, Pergamon Press, Oxford, 1972

APPENDIX E

SAFETY ANALYSIS REPORT

By

J. A. Tompkins

For

**Potential Radiological Impact
from Hypothetical Release of Tritium
from a Smoldering Fire Incident
that Causes Structural Failure of the Mezzanine
at the SRB Technologies, Canada Facility
Located at 320 Boundary Road
Pembroke, Ontario**

Prepared by:

**Alpha-Dyne, LLC
1060-A 49th Street
Los Alamos, NM 87544**

November 6, 2000

SAFETY ANALYSIS REPORT

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Submitted by:

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Date

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Abstract

In January 1996, alpha-Dyne, LLC prepared a Safety Analysis Report entitled, "Potential Radiological Impact from Hypothetical Release of Tritium at the SRB Technologies, Canada Facility Located at 320 Boundary Road, Pembroke, Ontario". Although the 1996 Safety Analysis Report outlined the worst case scenario, questions recently have arisen as to the potential radiological impact resulting from a smoldering fire at the facility. This potential incident was analyzed in the October, 2000 report. This report provides a supplement to the October, 2000 analysis which analyzes for the localized fire incident that causes a major structural failure within the SRB Technologies facility.

1. Introduction

This report was prepared at the request of SRB Technologies, Inc. (SRBT). It considers the radiological impacts at the SRBT tritium lamp/device manufacturing facility located at 320 Boundary Road, Pembroke, Ontario, Canada resulting from an incident involving a localized fire within the controlled area of the facility, which causes a major structural failure within the building. This incident was not previously analyzed, as it was not considered to be a worst case radiological incident for the facility. This report may be considered a supplement to the October, 2000 safety analyses of the facility. The conclusions of this report should be considered independent of previous analyses.

2. Background

The SRBT plant/facility is engaged in two primary operational processes involving the handling of tritium gas.

- The filling of small glass tubes with dry (<1% HTO) tritium gas to produce self-luminous products
- The reclamation of tritium gas from previously used self-luminous devices for recycle into new glass-encapsulated self-luminous products.

3. Purpose

The fundamental assumption for this analysis is that there remains an unevaluated incident scenario, which under a rare coincidence of circumstances, could result in potential radiological risk posed by a tritium release as follows:

A fire breaks out somewhere within the mezzanine area of the Pembroke facility, which is not a total conflagration. Rather, it is a localized fire. This fire burns rapidly sufficient to attack the structure supporting the mezzanine. This fire is unlikely to cause release of tritium directly since there is no tritium product at the point of highest heat.

The fundamental assumption of this scenario is that packaged tritium product resides in the shipping area below the mezzanine. An undetected fire damages the structural integrity of the mezzanine above the storage area. This results in a major internal structural collapse of the mezzanine such that debris falls upon the product inventory causing a tritium release within that portion of the building. This poses the question, "What would be the radiological risk to the first responders?" The risk to the most highly affected individual in the immediate area of the tritium release will be evaluated.

Note that according to facility staff packaged tritium product has traditionally resided in this area on a very limited basis (for 3-4 business hours only on the day of shipment). Since traditionally the facility is been occupied with a full working staff during periods when shipments take place, it is highly unlikely that a fire in the mezzanine area could go undetected for any significant period of time.

4. Assumptions

This analysis will construct a scenario by which firemen are required to enter the facility to fight an intense and localized fire after the fallen debris has caused a tritium release. The firemen, in their efforts to extinguish the fire, will enter a portion of the facility adjacent to the collapsed portion. The collapse is presumed to occur when the product shipping room contains the largest quantity of material ever likely to be shipped at one time (20,000 Ci of tritium). The firemen will stay in that area of the building long enough to determine the extent of the collapse and the potential need for fire suppression, about 15 minutes. This analysis will not attempt to predict the probability for this type of fire in the SRBT facility. It will, rather, assume that such an incident does occur and will attempt to predict the radiological impact within the required set of assumptions.

4.1 Tritium Locations within the SRBT Facility

It has been requested that a specific analysis of the shipping area be made for the initiating event of a structural collapse of the mezzanine storage area. The maximum shipment of material from this area is 20,000 Ci of tritium product in Type A shipping containers. Material typically sits in the shipping room for a few hours prior to shipment.

In the shipping room, assembled devices containing tritium in Pyrex® brand borosilicate glass tubes are stored for periods of time of up to 4 hours in their shipping packages. Borosilicate glass is highly resistant to breakage from thermal shock, and requires temperatures in excess of 820°C to cause softening of the glass sufficient to cause a tritium release. Thermal shock to the light source tubes is typically not a problem. In one manufacturing process, the borosilicate light source tubes are sealed with an oxyacetylene torch at one end of the tube while the other end is soaking in liquid nitrogen (-200°C). That is a thermal differential across the tube of 1400°C (+1200°C to -200°C). Although there is little combustible loading in the shipping room, the borosilicate glass tubes are susceptible to mechanical shock, such as might be caused by the collapse of the mezzanine structure above the ceiling.

4.2 Source Term

The tritium in the shipping room is packaged in DOT Type A shipping containers which will protect the devices from all but the most direct mechanical shock. It is assumed that 20,000 Ci of tritium are present in the shipping room.

4.3 Response Time

Once alerted, the average response time of the Pembroke Fire Department[i] and the contracted security firm[ii] are 3.3 min. and 2 min., respectively. For this analysis, it is assumed that a fire would be initiated and proceed rapidly without detection for some period of time, thus the actual response time is not used in this analysis.

4.4 Release Scenario

A forceful encounter with debris from mezzanine structure above the shipping room is the source of mechanical energy for this release. As previously stated, it is assumed that the shipping room contains a maximal loading of 20,000 Ci. It is unrealistic to assume that any large fraction of the tubes will be broken, since the walls of the room and furnishings will tend to absorb most of the mechanical shock prior to structural elements landing on the shipping packages. The shipping packages themselves are designed and tested to resist heavy impacts. It is then assumed that 10% of the tubes are broken. Thus about 2,000 Ci of tritium would be released into the building volume occupied by the mezzanine and the rooms immediately under the mezzanine. It is further assumed that fire fighters will arrive and enter the facility just as the release occurs, in order to receive the highest dose. It is this incident that will be analyzed in terms of potential radiological exposure to fire fighting personnel within the SRBT facility.

5. Analysis

The risk to personnel responding to release of tritium in a fire response incident will be evaluated by estimating the potential tritium intake and the resulting radiation dose to the most highly affected individual.

5.1 Metrics

Volume associated with the mezzanine area and associated rooms:	700 m^3
Release Duration:	immediate
Quantity of tritium released:	2000 Ci (10% of material present)
Initial T_2O content as water vapor:	1.5%
Initial T_2 content as dry gas	98.5%
Fire personnel stay time:	15 minutes

5.2 Average concentration during stay of affected personnel

The concentration of the tritium oxide and dry tritium gas in the room air is calculated separately below. It should be noted that the internal dose factor for tritium oxide is approximately 10,000 times higher than that for dry gas. Therefore, in spite of the fact that the dry tritium gas poses the highest concentration of tritium in the room, as shown below, its affect on dose is relatively small. It is included here, however, for completeness.

A calculation of tritium concentration at the end of fire personnel stay time in the affected room is performed as follows:

$$\mathbf{C = C_{00}\, e^{-((removal\ rate\ x\ T)/Vrm)} + C_{0G}\, e^{-((removal\ rate\ x\ T)/Vrm)}}$$

where

C = concentration of T_20 at time T (Ci/ m^3) + concentration of T_2 at time T (Ci/ m^3)

C_{00} = initial concentration of T_20 (Ci/m^3) = (2,000 Ci x 0.015)/700 m^3) = 0.043 Ci T_20/m^3

C_{0G} = initial concentration of T_2 (Ci/m^3) = (2,000 Ci x 0.985)/700 m^3) = 2.81 Ci T_2/m^3

Removal rate = rate at which air is exhausted from assembly room (m^3/min.)

V_{rm} = volume of the affected room = 700 m^3

T = the elapsed at which concentration is needed (min.) = 15 min.

The most conservative assumption is that the tritium concentration in the effected volume is equal to the initial concentrations of C_{00},+ C_{0G} and that it stays at that concentration for the entire stay time of the responder personnel. This assumption is conservative since the building is well ventilated, however for the purposes of this calculation, it is assumed that the ventilation system has failed.

While it is possible that some of the tritium gas in the room will undergo oxidation during the stay time of the responders, this potential contribution of additional tritium oxide to the room is not considered to be significant. Under normal conditions, the conversion rate of T_2 to T_2O and HTO is typically only a few percent per day according to studies by Jensen and Traub.[iv]

5.3 Determination of Dose to Personnel

Once the concentration of both oxide and dry tritium gas has been determined (above), it is then possible to determine the potential radiological exposure to an individual who enters the affected room. The method we will use here to calculate dose uses internal dose conversion factors based upon ICRP 30[iiii] and is calculated as follows:

Committed Effective Dose Equivalent (CEDE) = QI x IDCF

QI = Quantity of Intake, which is the concentration of tritium in the room air (derived above, μCi/cc) times the breathing rate[ivi] (20,000 cc/min) x time (min.)

$IDCF_0$ = Internal dose conversion factor for 6.35E-5 Rem/μCi for T_20.
$IDCF_G$ = Internal dose conversion factor for 4.4E-9 Rem/μCi for T_2.

$CEDE_0$ = 6.35E-5 Rem/μCi x (0.043 μCi/cc x 20,000 cc/min x 15 min) = 0.819 Rem = 8.2 mSv
$CEDE_G$ = 4.4E-9 Rem/μCi x (2.81 μCi/cc x 20,000 cc/min x 15 min) = 0.004 Rem = 0.04 mSv

The total dose resulting from both oxide and dry gas is, therefore, 8.2 mSv. Note, however, that the contribution to the dose from the dry gas is only 0.4 %.

6. Potential Mitigation of the Resulting Dose

6.1 Ventilation

Even with the assumption that the mechanical ventilation has failed, some free ventilation will occur, and under any circumstance, the tritium concentration at the end of the responders' stay time would be less than the initial concentration.

A major structural collapse of the mezzanine structure would likely force a large volume of air into adjacent areas of the facility and thus increase the internal volume available for mixing of the released tritium oxide.

A major structural failure within the building also argues for a large rapidly burning fire, not a smoldering fire. A larger fire, sufficient to cause the collapse major structural elements of the building, is more likely to cause the building shell to fail as well and develop into a full conflagration with resulting thermal plume. Such a release was analyzed in our 1996 SAR[v] for the SRB facility.

6.2 Personnel Protection Equipment (PPE)

The above calculated dose is also potentially mitigated by two pieces of PPE typically worn by fire fighters entering interior spaces of a smoke-filled building to fight the fire; a positive demand self contained breathing apparatus (SCBA) and a fire fighter's waterproof coverall. If a firefighter is wearing an SCBA, he is not breathing tritium contaminated air (protection factor is >10,000). The SCBA would contribute to dose avoidance of 50% of the CEDE (ICRP 30[vi]).

If the fire fighter is wearing his waterproof coverall, he is avoiding some subcutaneous adsorption of T_20 water vapor, which is about 50% of the CEDE for oxide calculated above. However the protection factor for mitigating the subcutaneous dose is difficult to quantify.

According to facility personnel, the Pembroke fire department has indicated that it would be normal practice to wear SCBA when fighting an interior fire at the SRB facility.

6.3 Practical Aspects of Tritium Oxide Concentration

One possible mitigating factor that would reduce the potential dose calculated above is the effect of the cold water stream from the fire hose mixing with tritium gas released from fractured tubes. When the tubes are broken as a result of the impact of the water stream, the tritiated water vapor that was released would contribute more than 99 % of the dose calculated above. The dry tritium gas released would account for approximately the remaining 0.4 % of the dose to the affected first responder. It is most probable that when the cold water stream comes in contact with the released tritiated water vapor and dry tritium gas, some of the vapor will change state and be swept along with the fire suppression water stream because of the lower vapor pressure of tritiated water. This will reduce the amount of tritiated water vapor contributing to the dose and, as a result, will have a mitigating effect upon the largest contributor of the dose to the affected individual. Qualitatively then, it is probable that the dose from the water stream impact scenario could actually be lower than what was calculated above.

6.4 Probability of Occurrence

The probability of occurrence of this incident is low. Tritium product rarely resides in the affected area. If the estimated shipping was four times a month, then the percent of time in a month that product would be located in the shipping area would be less than 2% of the total time in month or about 6% of the business hours in a month. Additionally, since product only resides in this area during business hours, the probability of a fire remaining undetected in this area and increasing in intensity sufficient to cause the incident analyzed, is also of low probability.

Note that through correspondence with the facility representative, it has been stated that the practice of storing packaged product beneath the mezzanine structure will be discontinued.

7.0 Conclusion

The tritium release from the impact of the fallen mezzanine structure was calculated to be 8.2 mSv to the unprotected individual. A first responder equipped with SCBA would have this potential dose reduced by at least half. The mitigating factors discussed suggest that this dose prediction is conservative with respect to the given incident scenario within the SRB Pembroke facility. Further the probability of occurrence of this incident is expected to be low.

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[i] Pembroke Fire Department, 1999 Annual Report, p. 6, Emergency response times.
[ii] Alarm Bridge private communication to SRB, 10-11-00.
[iii] Traub, R.J. and G.A. Jensen, Tritium Radioluminescent Devices Health and Safety Manual, Pacific National Laboratory Report PNL-10620 Section 2.6.3 Environmental Chemistry p 2.8, June 1995.
[iv] International Council on Radiation Protection, "Limits for Intakes of Radionuclides by Workers", ICRP Publication 30 Part 1, Pergamon Press, Oxford; 1978.
[v] Breathing rate is for an adult male doing light work, International Council on Radiation Protection, "Reference Man", ICRP Publication 26, Pergamon Press, Oxford, 1972
[vi] Tompkins, J.A. and L.E. Leonard, Safety Analysis Report "Potential Radiological Impact from Hypothetical Release of Tritium at the SRB Technologies, Canada Facility Located at 320 Boundary Road, Pembroke, Ontario, January 1996.

APPENDIX F

A. Aly, M. James, P. Thompson, L. Truong

42-1-3-0

C. Carrier

November 23, 2000

Review of accident scenarios for SRB Technologies Environmental Assessment

1- Introduction:

The CEA Act requires that environmental assessments consider the environmental effects of **malfunctions or accidents that may reasonably occur** in connection with the project. In the context of the environmental assessment for SRB Technologies (Canada) Inc., a review of the documented assessments in the history file of accident scenarios and malfunctions for the facility has been carried out.

The following summarizes the results of this review. Some of the consequences from the events had to be recalculated to account for modifications to the facility since the assessments were submitted, to use currently accepted values for dose conversion factors for tritium and tritium oxide, and modify some of the analysis assumptions when these were not found to be conservative or consistent between scenarios. Assumptions used in the updated assessment are provided in Table 1.

Table 1 - Assumptions used in updated accident analysis

Parameter	Value
Maximum tritium inventory in a transportation container	50,000 Ci
Wind speed	1 m/s
Conservative Stability Class for effective stack height of 28 m*	Pasquill A
Nearest receptor	100 m
Wind direction	toward receptor
Roughness length	0.4 m
Dose conversion factor for HTO (includes skin absorption and inhalation)	$4x10^{-8}$mSv/Bq
Dose conversion factor for elemental tritium	$2x10^{-12}$mSv/Bq
Dilution factor for stack release at 100 m	$1.5x10^{-4}$ s/m^3
Duration of release	Short term
Breathing rate	1.2 m^3/h

* An approximate effective stack height for a 2m/s wind was used (28m)

2- Accident and Malfunctions Scenarios:

As part of the licensing for the facility, the following scenarios were assessed:

1) Release of the full tritium content of bulk container through the facility stack (50,000 Ci release of tritium oxide, stack release);

2) Hot fire leading to total destruction of the facility and high plume loss of tritium inventory (300,000 Ci release of tritium oxide, hot thermal plume elevated release);

3) Limited fire with fire suppression leading to limited inventory loss (219 Ci tritium release, 1.5% in the form of tritium oxide, 98.5% in the form of elemental tritium, stack release);

4) Medium size fire leading to limited inventory loss (2000 Ci tritium release, 1.5% in the form of tritium oxide, 98.5% in the form of elemental tritium);

5) Vehicular impact leading to damage to the building and limited loss of tritium inventory (60,000 Ci tritium releases, 1.5% in the form of tritium oxide, 98.5% in the form of elemental tritium, stack release); and

6) Tornado leading to damage to the building and limited loss of tritium inventory (150,000 Ci tritium release, 1.5% in the form of tritium oxide, 98.5% in the form of elemental tritium, ground level release).

The above scenarios were reassessed using current assumptions on stack height, dose conversion factors, dilution factors, and maximum content of a transportation container. The following sections describes the assumption used in the updated assessment. Table 2 and 3 summarize the results of the analyses using original and current assumptions.

Table 2 - Results of original accident analysis

Scenario	Public Dose at 100 m (μSv)	Operator/intervenor dose (mSv)
Bulk container release	840	not assessed
Hot fire	710	not assessed
Medium fire	not assessed	8.2
Small fire	not assessed	3.2
Vehicle impact	171	not assessed
Tornado	7	not assessed

Table 3 - Result of updated accident analysis

Scenario	Public Dose at 100 m (μSv)	Operator/intervenor dose (mSv)
Bulk container release	4000	not assessed
Hot fire	1655	not assessed
Medium fire	not assessed	19
Small fire	less than 1uSv	7.5
Vehicle impact	65	not assessed
Tornado	16	not assessed

a) Tritium content of Bulk container released through the facility stacks:

This assessment was submitted in support of the initial licensing for the facility [1, 2]. In BMD 90-192, this scenario is considered the worst design basis accident for the facility. It consists of the release of the total inventory of one transportation container (30,000 Ci) to the environment through the facility stacks. The highest dose calculated for a member of the public was 840 μSv.

The assumptions used in the assessment were generally conservative: full conversion to tritium oxide and a short term release (i.e., 10 seconds) were considered, and conservative weather conditions were used. The assumption that the release is fully evacuated to the stack appears reasonable since processing from the bulk container is only done while ventilation is in operation. However, the assessment suggests that the closest point where the dose was assessed was 2.5 km from the facility which is not conservative.

This scenario was reassessed with the following new assumptions:

- the release was increased to the current maximum allowable limit for the transportation container (i.e., 50,000Ci)

- the effective stack height was increased from 11 m to 28 m. The increased height results from removal of caps on the stacks thus allowing crediting vertical momentum of the released effluents

- current dose conversion factors
- new dilution factor

Under those conditions, the calculated dose to the public at 100 m from the facility is approximately 4mSv. Although estimates for distances less than 100 m are very unreliable and could be higher, it appears reasonable to assume, due to the significant conservatism used for this scenario, that 4mSv is an acceptable assessment of the bounding dose to the target group.

b) Large fire scenario with large thermal plume

This scenario assumes complete destruction of the facility by a fire, total release of the tritium inventory, full conversion to tritium oxide, and effective dispersion of the tritium by a large thermal plume. This scenario was assessed at the time of original submission and found acceptable. The dose calculations have been updated to consider currently accepted values for dose conversion factors for tritium oxide, the result is provided in Table 3.

c) Limited fire with fire suppression leading to limited inventory loss (219 Ci stack release)

This scenario was primarily carried out to assess doses to workers and emergency response personnel in case of a small fire scenario at the facility. It assumes a small smoldering fire having insufficient intensity to cause a release of tritium from light tubes due to the low temperature. A release of 219 Ci of tritium (1.5% in the form of tritium oxide and 98.5% in the form of elemental tritium) is assumed and would result from actions taken to extinguish the fire. Although a detailed review of this scenario was not carried out, the assumptions and methodology used in the assessment appear generally conservative if the release involves new tubes; the proportion of tritium oxide could be significantly higher if the incident involved reclaimed units (literature suggests that the proportion of tritium oxide increases as tube age[3], and could be higher than 10%), and doses to workers and response personnel would be essentially proportional to this concentration of tritium oxide in the release.

CNSC staff were not convinced that this proposed scenario is bounding and therefore requested that the further analysis described in d) below be submitted.

The dose estimate from the licensee submission has been reevaluated using current dose conversion factor for tritium oxide and elemental tritium. The result is provided in Table 3.

Doses outside the facility were not assessed as part of the original assessment. Based on the same dilution factor as in a) above, the calculated dose to individuals located at 100 m from the facility would be less than 1μSv.

d) Medium size fire

As in c) above, the purpose of this scenario was primarily to assess doses to workers and emergency responders. In this case, 2000 Ci of tritium (1.5% tritium oxide and 98.5% elemental tritium) is released in the working areas. The dose estimates to these individuals was recalculated using current dose conversion factors; results are provided in Table 3.

The specialist review for this scenario suggested that by using other assumptions this scenario could result in larger dose estimates to workers and emergency responders. As a result, it was recommended that further fire safety analysis of the facility be carried out and actions be taken to ensure the facility is compliant with the fire code. In the interim, and as agreed by the licensee, procedural measures were implemented to limit the total quantities of tritium that can be stored in sensitive areas.

e) Vehicular impact leading to damage to the building and limited loss of tritium inventory

For this scenario, it is assumed that as a result of a vehicular impact on the building, 20% of the inventory is released (60,000 Ci). 98.5% of the released is assumed to be in the form of elemental tritium (59,100 Ci) and 1.5% in the form of tritium oxide (900 Ci). The release is assumed to be evacuated through the facility stack. Using these assumptions, this scenario is bounded by scenario a) above (due to the much higher radio toxicity of tritium oxide).

The consequences of this scenario were reassessed using the assumptions used in a) (stack release). The resulting dose to an individual located 100 m from the facility is provided in Table 3.

f) Tornado event:

This scenario assumes a violent collapse of the facility building and release of 50% of the tritium inventory (147,750 Ci in for elemental tritium and 2,250 Ci in the form of tritium oxide). The original review of this scenario [4] judged it to be generally acceptable, although some questions remained with regards to the assumptions. Nevertheless, it was concluded that this scenario was bounded by scenario b) above. Results of the assessment were updated using current assumptions on dose conversion factors and provided in table 3.

4- Operational occurrences:

Review of the history file does not suggest that a systematic review of malfunctions and anticipated operational occurrences has been carried out for this facility. However, this situation may be justified by the design of the facility which is assumed to confine and exhaust accidental releases from the facility, by the presence of alarming tritium air monitors, and emergency procedures for dealing with the situation where air contamination levels are exceeded.

In the context of this environmental assessment, various anticipated operational occurrence scenarios were discussed, including breakage of tritium light sources, loss of electrical supply, and failure of an exhaust air ventilation fan [5]. According to the licensee, all these scenarios have occurred at the facility, and in some cases have resulted in tritium air concentrations in working areas (specifically zone 3s) requiring evacuation of these areas; actual maximum levels reached are unknown.

In spite of the lack of specific information on this matter, dosimetry and effluent monitoring results indicate that, since 1996 doses and releases from all sources, including normal operation, malfunctions and operational occurrences are acceptably small.

5. Other scenarios:

In the above scenarios, the tritium is assumed to be released through the facility stack, to be carried upwards into the atmosphere in a hot plume of air from a fire, or to be dispersed in the atmosphere due to the severe weather conditions (e.g., the tornado event). Other types of events that could result in ground-level releases (such as from variations on the vehicle impact and fire events) could result in higher doses to members of the public. A worst case estimate would lead to 25 μSv/Ci of tritium oxide released from the ground level, to a target group located 100m from the facility (assumptions for this estimation are provided in Table 4).

However, as part of the licensing, the project office has concluded [6] that with appropriate preventative measures, and compliance with the appropriate codes, these events will have a small probability of occurrence during the lifetime of the facility.

Table 4 - Assumptions in calculation of dose estimate for a ground release

Effective release height	0 m
Conservative weather condition for effective stack height for 100 m distance	Pasquill F
Duration of release	Short term
Dilution factor for stack release at 100 m	5×10^{-2} s/m^3
Wind speed	1 m/s
Breathing rate	1.2 m^3/h

References:

[1] "Population Densities and Estimated Doses from Accidental Releases for the SRB Tritium Lamp Plant, Pembroke", C.F. Pensom, AECL document NSN-SRD-071, Revision 0, November 1990.

[2] "Saunders-Roe (Canada) Inc. Licensing for a Gaseous Tritium Light Source Manufacturing Facility", BMD 90-192, 21 November 1990.

[3] "Tritium Radioluminescent Devices Health and Safety Manual" section 2.7.1, R.J. Traub and G.A. Jensen, Pacific National Laboratory Report PNL-10620 UC-610, June 1995.

[4] "Review of SRB Technologies' Safety Analysis Report of January 1996 (SAWR 3490)", Internal memo, J.K. Presley to R.A. Chamberlain, 18 January 1996.

[5] E-mail from Mike James to C. Carrier and A. Aly, "Events which could lead to a ground level release at SRB", 8 November 2000.

[6] Personal communication from S. MacDougall.

APPENDIX G

	σ_Y					
KM	A	B	C	D	E	F
0.1	26.9	19.3	12.5	8.2	6.12	4.07
0.11	29.30	21.00	13.60	8.96	6.69	4.45
0.12	31.60	22.70	14.70	9.71	7.25	4.82
0.13	34.00	24.50	15.90	10.50	7.81	5.19
0.14	36.30	26.20	17.00	11.20	8.36	5.56
0.15	38.60	27.90	18.10	11.90	8.91	5.92
0.16	40.90	29.50	19.20	12.70	9.46	6.29
0.17	43.20	31.20	20.30	13.40	10.00	6.65
0.18	45.50	32.90	21.40	14.10	10.50	7.01
0.19	47.70	34.50	22.50	14.80	11.10	7.37
0.20	50.00	36.20	23.60	15.60	11.60	7.73
0.21	52.20	37.80	24.70	16.30	12.20	8.08
0.22	54.40	39.40	25.80	17.00	12.70	8.44
0.23	56.60	41.00	26.90	17.70	13.20	8.79
0.24	58.80	42.70	27.90	18.40	13.80	9.14
0.25	61.00	44.30	29.00	19.10	14.30	9.50
0.26	63.20	45.90	30.10	19.80	14.80	9.85
0.27	65.30	47.50	31.10	20.50	15.30	10.20
0.28	67.50	49.00	32.20	21.20	15.90	10.50
0.29	69.60	50.60	33.20	21.90	16.40	10.90
0.30	71.80	52.20	34.30	22.60	16.90	11.20
0.31	73.90	53.80	35.30	23.30	17.40	11.60
0.32	76.00	55.30	36.40	24.00	17.90	11.90
0.33	78.10	56.90	37.40	24.70	18.40	12.30
0.34	80.20	58.50	38.50	25.40	19.00	12.60
0.35	82.30	60.00	39.50	26.10	19.50	12.90
0.36	84.40	61.50	40.50	26.70	20.00	13.30
0.37	86.50	63.10	41.60	27.40	20.50	13.60
0.38	88.60	64.60	42.60	28.10	21.00	14.00
0.39	90.60	66.20	43.60	28.80	21.50	14.30
0.40	92.70	67.70	44.60	29.50	22.00	14.60
0.41	94.80	69.20	45.70	30.10	22.50	15.00
0.42	96.80	70.70	46.70	30.80	23.00	15.30
0.43	98.90	72.20	47.70	31.50	23.50	15.60
0.44	101.00	73.80	48.70	32.10	24.00	16.00
0.45	103.00	75.30	49.70	32.80	24.50	16.30
0.46	105.00	76.80	50.70	33.50	25.00	16.60
0.47	107.00	78.30	51.80	34.20	25.50	17.00
0.48	109.00	79.80	52.80	34.80	26.00	17.30
0.49	111.00	81.30	53.80	35.50	26.50	17.60
0.50	113.00	82.80	54.80	36.10	27.00	18.00
0.55	123.00	90.20	59.80	39.40	29.50	19.60
0.60	133.00	97.50	64.70	42.70	31.90	21.20
0.65	143.00	105.00	69.60	46.00	34.40	22.90
0.70	152.00	112.00	74.50	49.20	36.80	24.50
0.75	162.00	119.00	79.30	52.40	39.20	26.10
0.80	171.00	126.00	84.10	55.60	41.50	27.60
0.85	181.00	133.00	88.90	58.70	43.90	29.20
0.90	190.00	140.00	93.70	61.90	46.30	30.80
0.95	199.00	147.00	98.40	65.00	48.60	32.30
1.00	209.00	154.00	103.00	68.10	50.90	33.90
1.05	218.00	161.00	108.00	71.20	53.30	35.40
1.10	227.00	168.00	112.00	74.30	55.60	37.00
1.15	236.00	175.00	117.00	77.40	57.90	38.50
1.20	245.00	181.00	122.00	80.40	60.20	40.00
1.25	254.00	188.00	126.00	83.50	62.40	41.50
1.30	263.00	195.00	131.00	86.50	64.70	43.00
1.35	272.00	201.00	135.00	89.50	67.00	44.50
1.40	281.00	208.00	140.00	92.60	69.20	46.00
1.45	289.00	215.00	145.00	95.60	71.50	47.50
1.50	298.00	221.00	149.00	98.50	73.70	49.00
1.55	307.00	228.00	154.00	102.00	75.90	50.50
1.60	316.00	234.00	158.00	104.00	78.10	52.00
1.65	324.00	241.00	163.00	107.00	80.40	53.50
1.70	333.00	247.00	167.00	110.00	82.60	54.90
1.75	341.00	254.00	171.00	113.00	84.80	56.40
1.80	350.00	260.00	176.00	116.00	87.00	57.90
1.85	358.00	267.00	180.00	119.00	89.20	59.30
1.90	367.00	273.00	185.00	122.00	91.30	60.80
1.95	375.00	279.00	189.00	125.00	93.50	62.20
2.00	384.00	286.00	193.00	128.00	95.70	63.70
2.10	400.00	298.00	202.00	134.00	100.00	66.60
2.20	417.00	311.00	211.00	139.00	104.00	69.40
2.30	433.00	324.00	220.00	145.00	109.00	72.30
2.40	450.00	336.00	228.00	151.00	113.00	75.10
2.50	466.00	348.00	237.00	157.00	117.00	77.90
2.60	482.00	361.00	245.00	162.00	121.00	80.80
2.70	498.00	373.00	254.00	168.00	126.00	83.60
2.80	515.00	385.00	262.00	173.00	130.00	86.40
2.90	530.00	397.00	271.00	179.00	134.00	89.10
3.00	546.00	409.00	279.00	185.00	138.00	91.90
3.10	562.00	421.00	287.00	190.00	142.00	94.70
3.20	578.00	433.00	296.00	196.00	146.00	97.40
3.30	594.00	445.00	304.00	201.00	151.00	100.00
3.40	609.00	457.00	312.00	207.00	155.00	103.00
3.50	625.00	469.00	321.00	212.00	159.00	106.00
3.60	640.00	481.00	329.00	218.00	163.00	108.00
3.70	656.00	492.00	337.00	223.00	167.00	111.00
3.80	671.00	504.00	345.00	229.00	171.00	114.00
3.90	686.00	516.00	353.00	234.00	175.00	116.00
4.00	701.00	527.00	361.00	239.00	179.00	119.00
4.10	716.00	539.00	370.00	245.00	183.00	122.00
4.20	732.00	550.00	378.00	250.00	187.00	125.00
4.30	747.00	562.00	386.00	255.00	191.00	127.00
4.40	762.00	573.00	394.00	261.00	195.00	130.00
4.50	777.00	585.00	402.00	266.00	199.00	133.00
4.60	791.00	596.00	410.00	271.00	203.00	135.00
4.70	806.00	608.00	418.00	277.00	207.00	138.00
4.80	821.00	619.00	426.00	282.00	211.00	140.00
4.90	836.00	630.00	434.00	287.00	215.00	143.00
5.00	851.00	641.00	442.00	292.00	219.00	146.00
5.50	923.00	697.00	481.00	319.00	238.00	159.00
6.00	995.00	752.00	520.00	344.00	258.00	172.00
6.50	1,066.00	807.00	559.00	370.00	277.00	184.00
7.00	1,136.00	861.00	597.00	395.00	296.00	197.00
7.50	1,205.00	914.00	635.00	421.00	315.00	210.00
8.00	1,274.00	967.00	672.00	446.00	333.00	222.00
8.50	1,342.00	1,020.00	710.00	470.00	352.00	234.00
9.00	1,409.00	1,071.00	747.00	495.00	370.00	247.00
9.50	1,475.00	1,123.00	784.00	519.00	389.00	259.00
10.00	1,541.00	1,174.00	820.00	544.00	407.00	271.00
15.00	2,174.00	1,666.00	1,175.00	779.00	583.00	388.00
20.00	2,769.00	2,133.00	1,515.00	1,005.00	752.00	501.00
25.00	3,337.00	2,580.00	1,843.00	1,223.00	916.00	610.00

σ_Z						
A	B	C	D	E	F	KM
13.9	10.6	7.44	4.65	3.53	2.33	0.1
15.40	11.60	8.12	5.05	3.82	2.51	0.11
16.90	12.60	8.79	5.45	4.10	2.70	0.12
18.40	13.50	9.46	5.84	4.38	2.88	0.13
19.90	14.50	10.10	6.23	4.66	3.06	0.14
21.40	15.50	10.80	6.62	4.93	3.24	0.15
23.00	16.40	11.40	7.00	5.20	3.41	0.16
24.50	17.40	12.10	7.38	5.46	3.58	0.17
26.10	18.30	12.70	7.76	5.72	3.76	0.18
27.70	19.30	13.40	8.13	5.98	3.93	0.19
29.30	20.20	14.00	8.50	6.24	4.09	0.20
31.00	21.20	14.70	8.87	6.49	4.25	0.21
32.60	22.20	15.30	9.23	6.75	4.41	0.22
34.30	23.20	15.90	9.60	7.00	4.57	0.23
36.00	24.20	16.60	9.96	7.24	4.72	0.24
37.70	25.20	17.20	10.30	7.49	4.88	0.25
39.60	26.20	17.80	10.70	7.74	5.03	0.26
41.50	27.20	18.50	11.00	7.98	5.18	0.27
43.50	28.20	19.10	11.40	8.22	5.33	0.28
45.50	29.20	19.70	11.70	8.46	5.48	0.29
47.40	30.10	20.30	12.10	8.70	5.62	0.30
49.70	31.10	20.90	12.40	8.92	5.77	0.31
52.00	32.10	21.60	12.70	9.13	5.92	0.32
54.30	33.10	22.20	13.10	9.35	6.06	0.33
56.60	34.10	22.80	13.40	9.56	6.20	0.34
59.00	35.10	23.40	13.70	9.77	6.35	0.35
61.30	36.10	24.00	14.00	9.98	6.49	0.36
63.80	37.00	24.60	14.30	10.20	6.63	0.37
66.20	38.00	25.20	14.60	10.40	6.77	0.38
68.70	39.00	25.80	15.00	10.60	6.91	0.39
71.20	40.00	26.40	15.30	10.80	7.05	0.40
74.30	41.10	27.00	15.60	11.00	7.19	0.41
77.40	42.20	27.70	15.90	11.20	7.32	0.42
80.60	43.30	28.30	16.20	11.40	7.46	0.43
83.90	44.40	28.90	16.50	11.60	7.59	0.44
87.20	45.50	29.50	16.80	11.80	7.73	0.45
90.60	46.60	30.10	17.10	12.00	7.86	0.46
94.00	47.70	30.60	17.40	12.20	8.00	0.47
97.50	48.90	31.20	17.70	12.40	8.13	0.48
101.00	50.00	31.80	18.00	12.60	8.26	0.49
105.00	51.10	32.40	18.30	12.80	8.40	0.50
126.00	56.70	35.40	19.80	13.80	9.05	0.55
154.00	62.40	38.30	21.20	14.70	9.69	0.60
182.00	68.10	41.20	22.60	15.60	10.30	0.65
213.00	73.90	44.10	24.00	16.50	10.90	0.70
247.00	79.70	47.00	25.40	17.40	11.50	0.75
283.00	85.60	49.90	26.80	18.30	12.00	0.80
322.00	91.50	52.70	28.10	19.10	12.50	0.85
363.00	97.40	55.50	29.50	20.00	13.00	0.90
407.00	103.00	58.30	30.80	20.80	13.50	0.95
454.00	109.00	61.10	32.10	21.60	14.00	1.00
503.00	115.00	63.80	33.10	22.30	14.40	1.05
555.00	121.00	66.70	34.10	23.00	14.80	1.10
610.00	127.00	69.50	35.10	23.60	15.20	1.15
668.00	134.00	72.20	36.10	24.30	15.70	1.20
728.00	140.00	75.00	37.10	24.90	16.10	1.25
791.00	146.00	77.70	38.00	25.50	16.50	1.30
857.00	152.00	80.50	38.90	26.10	16.90	1.35
925.00	158.00	83.20	39.90	26.70	17.30	1.40
996.00	164.00	85.90	40.80	27.30	17.60	1.45
1,071.00	171.00	88.60	41.70	27.90	18.00	1.50
1,148.00	177.00	91.30	42.60	28.50	18.40	1.55
1,227.00	183.00	94.00	43.40	29.10	18.80	1.60
1,310.00	189.00	96.70	44.30	29.70	19.20	1.65
1,395.00	196.00	99.30	45.20	30.20	19.50	1.70
1,484.00	202.00	102.00	46.00	30.80	19.90	1.75
1,575.00	208.00	105.00	46.90	31.30	20.20	1.80
1,669.00	215.00	107.00	47.70	31.90	20.60	1.85
1,766.00	221.00	110.00	48.50	32.40	20.90	1.90
1,866.00	227.00	113.00	49.30	33.00	21.30	1.95
1,968.00	234.00	115.00	50.20	33.50	21.60	2.00
2,182.00	247.00	121.00	51.80	34.40	22.20	2.10
2,408.00	260.00	126.00	53.30	35.40	22.80	2.20
2,646.00	273.00	131.00	54.90	36.30	23.30	2.30
2,895.00	286.00	136.00	56.40	37.20	23.90	2.40
3,156.00	299.00	141.00	57.90	38.00	24.40	2.50
3,430.00	312.00	147.00	59.40	38.90	25.00	2.60
3,715.00	325.00	152.00	60.80	39.80	25.50	2.70
4,012.00	338.00	157.00	62.30	40.60	26.00	2.80
4,321.00	351.00	162.00	63.70	41.40	26.50	2.90
4,643.00	365.00	167.00	65.10	42.20	27.00	3.00
4,977.00	378.00	172.00	66.40	43.00	27.40	3.10
5,000.00	392.00	177.00	67.70	43.80	27.80	3.20
5,000.00	405.00	182.00	69.00	44.60	28.20	3.30
5,000.00	419.00	187.00	70.20	45.40	28.60	3.40
5,000.00	432.00	192.00	71.50	46.10	29.00	3.50
5,000.00	446.00	197.00	72.70	46.90	29.40	3.60
5,000.00	459.00	202.00	73.90	47.60	29.70	3.70
5,000.00	473.00	207.00	75.10	48.30	30.10	3.80
5,000.00	486.00	212.00	76.30	49.10	30.50	3.90
5,000.00	500.00	217.00	77.50	49.80	30.80	4.00
5,000.00	514.00	222.00	78.70	50.40	31.20	4.10
5,000.00	528.00	227.00	79.80	51.00	31.50	4.20
5,000.00	541.00	232.00	81.00	51.60	31.90	4.30
5,000.00	555.00	237.00	82.10	52.20	32.20	4.40
5,000.00	569.00	242.00	83.20	52.80	32.60	4.50
5,000.00	583.00	247.00	84.30	53.40	32.90	4.60
5,000.00	597.00	252.00	85.40	54.00	33.20	4.70
5,000.00	611.00	257.00	86.50	54.60	33.60	4.80
5,000.00	625.00	262.00	87.60	55.10	33.90	4.90
5,000.00	639.00	266.00	88.70	55.70	34.20	5.00
5,000.00	709.00	291.00	94.00	58.50	35.80	5.50
5,000.00	780.00	315.00	99.00	61.10	37.20	6.00
5,000.00	852.00	339.00	104.00	63.60	38.60	6.50
5,000.00	924.00	362.00	109.00	66.00	40.00	7.00
5,000.00	997.00	386.00	113.00	68.40	41.20	7.50
5,000.00	1,070.00	410.00	118.00	70.60	42.30	8.00
5,000.00	1,144.00	433.00	122.00	72.80	43.40	8.50
5,000.00	1,218.00	456.00	127.00	75.00	44.40	9.00
5,000.00	1,292.00	479.00	131.00	77.00	45.40	9.50
5,000.00	1,367.00	502.00	135.00	79.10	46.40	10.00
5,000.00	2,133.00	728.00	170.00	95.60	54.90	15.00
5,000.00	2,924.00	947.00	200.00	109.00	60.30	20.00
5,000.00	3,735.00	1,161.00	227.00	119.00	64.90	25.00

APPENDIX H

RELEASE FROM A PYROPHORIC UNIT

Release (curies)	3,000.0
Time of release "t" (seconds)	10.0
Wind velocity "V" (meters/second)	2.0
Effective height of release "H" (meters)	27.8
Rate of release "Q" (curies/second)	300.0
Percentage of release that is HTO	25.0
Percentage of release that is HT	75.0

	σ_y					
KM	A	B	C	D	E	F
0.1	26.9	19.3	12.5	8.2	6.12	4.07
0.11	29.30	21.00	13.60	8.96	6.69	4.45
0.12	31.60	22.70	14.70	9.71	7.25	4.82
0.13	34.00	24.50	15.90	10.50	7.81	5.19
0.14	36.30	26.20	17.00	11.20	8.36	5.56
0.15	38.60	27.90	18.10	11.90	8.91	5.92
0.16	40.90	29.50	19.20	12.70	9.46	6.29
0.17	43.20	31.20	20.30	13.40	10.00	6.65
0.18	45.50	32.90	21.40	14.10	10.50	7.01
0.19	47.70	34.50	22.50	14.80	11.10	7.37
0.20	50.00	36.20	23.60	15.60	11.60	7.73
0.21	52.20	37.80	24.70	16.30	12.20	8.08
0.22	54.40	39.40	25.80	17.00	12.70	8.44
0.23	56.60	41.00	26.90	17.70	13.20	8.79
0.24	58.80	42.70	27.90	18.40	13.80	9.14
0.25	61.00	44.30	29.00	19.10	14.30	9.50
0.26	63.20	45.90	30.10	19.80	14.80	9.85
0.27	65.30	47.50	31.10	20.50	15.30	10.20
0.28	67.50	49.00	32.20	21.20	15.90	10.50
0.29	69.60	50.60	33.20	21.90	16.40	10.90
0.30	71.80	52.20	34.30	22.60	16.90	11.20
0.31	73.90	53.80	35.30	23.30	17.40	11.60
0.32	76.00	55.30	36.40	24.00	17.90	11.90
0.33	78.10	56.90	37.40	24.70	18.40	12.30
0.34	80.20	58.50	38.50	25.40	19.00	12.60
0.35	82.30	60.00	39.50	26.10	19.50	12.90
0.36	84.40	61.50	40.50	26.70	20.00	13.30
0.37	86.50	63.10	41.60	27.40	20.50	13.60
0.38	88.60	64.60	42.60	28.10	21.00	14.00
0.39	90.60	66.20	43.60	28.80	21.50	14.30
0.40	92.70	67.70	44.60	29.50	22.00	14.60
0.41	94.80	69.20	45.70	30.10	22.50	15.00
0.42	96.80	70.70	46.70	30.80	23.00	15.30
0.43	98.90	72.20	47.70	31.50	23.50	15.60
0.44	101.00	73.80	48.70	32.10	24.00	16.00
0.45	103.00	75.30	49.70	32.80	24.50	16.30
0.46	105.00	76.80	50.70	33.50	25.00	16.60
0.47	107.00	78.30	51.80	34.20	25.50	17.00
0.48	109.00	79.80	52.80	34.80	26.00	17.30
0.49	111.00	81.30	53.80	35.50	26.50	17.60
0.50	113.00	82.80	54.80	36.10	27.00	18.00
0.55	123.00	90.20	59.80	39.40	29.50	19.60
0.60	133.00	97.50	64.70	42.70	31.90	21.20
0.65	143.00	105.00	69.60	46.00	34.40	22.90
0.70	152.00	112.00	74.50	49.20	36.80	24.50
0.75	162.00	119.00	79.30	52.40	39.20	26.10
0.80	171.00	126.00	84.10	55.60	41.50	27.60
0.85	181.00	133.00	88.90	58.70	43.90	29.20
0.90	190.00	140.00	93.70	61.90	46.30	30.80
0.95	199.00	147.00	98.40	65.00	48.60	32.30
1.00	209.00	154.00	103.00	68.10	50.90	33.90
1.05	218.00	161.00	108.00	71.20	53.30	35.40
1.10	227.00	168.00	112.00	74.30	55.60	37.00
1.15	236.00	175.00	117.00	77.40	57.90	38.50
1.20	245.00	181.00	122.00	80.40	60.20	40.00
1.25	254.00	188.00	126.00	83.50	62.40	41.50
1.30	263.00	195.00	131.00	86.50	64.70	43.00
1.35	272.00	201.00	135.00	89.50	67.00	44.50
1.40	281.00	208.00	140.00	92.60	69.20	46.00
1.45	289.00	215.00	145.00	95.60	71.50	47.50
1.50	298.00	221.00	149.00	98.50	73.70	49.00
1.55	307.00	228.00	154.00	102.00	75.90	50.50
1.60	316.00	234.00	158.00	104.00	78.10	52.00
1.65	324.00	241.00	163.00	107.00	80.40	53.50
1.70	333.00	247.00	167.00	110.00	82.60	54.90
1.75	341.00	254.00	171.00	113.00	84.80	56.40
1.80	350.00	260.00	176.00	116.00	87.00	57.90
1.85	358.00	267.00	180.00	119.00	89.20	59.30
1.90	367.00	273.00	185.00	122.00	91.30	60.80
1.95	375.00	279.00	189.00	125.00	93.50	62.20
2.00	384.00	286.00	193.00	128.00	95.70	63.70
2.10	400.00	298.00	202.00	134.00	100.00	66.60
2.20	417.00	311.00	211.00	139.00	104.00	69.40
2.30	433.00	324.00	220.00	145.00	109.00	72.30
2.40	450.00	336.00	228.00	151.00	113.00	75.10
2.50	466.00	348.00	237.00	157.00	117.00	77.90
2.60	482.00	361.00	245.00	162.00	121.00	80.80
2.70	498.00	373.00	254.00	168.00	126.00	83.60
2.80	515.00	385.00	262.00	173.00	130.00	86.40
2.90	530.00	397.00	271.00	179.00	134.00	89.10
3.00	546.00	409.00	279.00	185.00	138.00	91.90
3.10	562.00	421.00	287.00	190.00	142.00	94.70
3.20	578.00	433.00	296.00	196.00	146.00	97.40
3.30	594.00	445.00	304.00	201.00	151.00	100.00
3.40	609.00	457.00	312.00	207.00	155.00	103.00
3.50	625.00	469.00	321.00	212.00	159.00	106.00
3.60	640.00	481.00	329.00	218.00	163.00	108.00
3.70	656.00	492.00	337.00	223.00	167.00	111.00
3.80	671.00	504.00	345.00	229.00	171.00	114.00
3.90	686.00	516.00	353.00	234.00	175.00	116.00
4.00	701.00	527.00	361.00	239.00	179.00	119.00
4.10	716.00	539.00	370.00	245.00	183.00	122.00
4.20	732.00	550.00	378.00	250.00	187.00	125.00
4.30	747.00	562.00	386.00	255.00	191.00	127.00
4.40	762.00	573.00	394.00	261.00	195.00	130.00
4.50	777.00	585.00	402.00	266.00	199.00	133.00
4.60	791.00	596.00	410.00	271.00	203.00	135.00
4.70	806.00	608.00	418.00	277.00	207.00	138.00
4.80	821.00	619.00	426.00	282.00	211.00	140.00
4.90	836.00	630.00	434.00	287.00	215.00	143.00
5.00	851.00	641.00	442.00	292.00	219.00	146.00
5.50	923.00	697.00	481.00	319.00	238.00	159.00
6.00	995.00	752.00	520.00	344.00	258.00	172.00
6.50	1,066.00	807.00	559.00	370.00	277.00	184.00
7.00	1,136.00	861.00	597.00	395.00	296.00	197.00
7.50	1,205.00	914.00	635.00	421.00	315.00	210.00
8.00	1,274.00	967.00	672.00	446.00	333.00	222.00
8.50	1,342.00	1,020.00	710.00	470.00	352.00	234.00
9.00	1,409.00	1,071.00	747.00	495.00	370.00	247.00
9.50	1,475.00	1,123.00	784.00	519.00	389.00	259.00
10.00	1,541.00	1,174.00	820.00	544.00	407.00	271.00
15.00	2,174.00	1,666.00	1,175.00	779.00	583.00	388.00
20.00	2,769.00	2,133.00	1,515.00	1,005.00	752.00	501.00
25.00	3,337.00	2,580.00	1,843.00	1,223.00	916.00	610.00

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A	B	C	D	E	F	KM
13.9	10.6	7.44	4.65	3.53	2.33	0.1
15.40	11.60	8.12	5.05	3.82	2.51	0.11
16.90	12.60	8.79	5.45	4.10	2.70	0.12
18.40	13.50	9.46	5.84	4.38	2.88	0.13
19.90	14.50	10.10	6.23	4.66	3.06	0.14
21.40	15.50	10.80	6.62	4.93	3.24	0.15
23.00	16.40	11.40	7.00	5.20	3.41	0.16
24.50	17.40	12.10	7.38	5.46	3.58	0.17
26.10	18.30	12.70	7.78	5.72	3.76	0.18
27.70	19.30	13.40	8.13	5.98	3.93	0.19
29.30	20.20	14.00	8.50	6.24	4.09	0.20
31.00	21.20	14.70	8.87	6.49	4.25	0.21
32.60	22.20	15.30	9.23	6.75	4.41	0.22
34.30	23.20	15.90	9.60	7.00	4.57	0.23
36.00	24.20	16.60	9.96	7.24	4.72	0.24
37.70	25.20	17.20	10.30	7.49	4.88	0.25
39.60	26.20	17.80	10.70	7.74	5.03	0.26
41.50	27.20	18.50	11.00	7.98	5.18	0.27
43.50	28.20	19.10	11.40	8.22	5.33	0.28
45.50	29.20	19.70	11.70	8.46	5.48	0.29
47.40	30.10	20.30	12.10	8.70	5.62	0.30
49.70	31.10	20.90	12.40	8.92	5.77	0.31
52.00	32.10	21.60	12.70	9.13	5.92	0.32
54.30	33.10	22.20	13.10	9.35	6.06	0.33
56.60	34.10	22.80	13.40	9.56	6.20	0.34
59.00	35.10	23.40	13.70	9.77	6.35	0.35
61.30	36.10	24.00	14.00	9.98	6.49	0.36
63.80	37.00	24.60	14.30	10.20	6.63	0.37
66.20	38.00	25.20	14.60	10.40	6.77	0.38
68.70	39.00	25.80	15.00	10.60	6.91	0.39
71.20	40.00	26.40	15.30	10.80	7.05	0.40
74.30	41.10	27.00	15.60	11.00	7.19	0.41
77.40	42.20	27.70	15.90	11.20	7.32	0.42
80.60	43.30	28.30	16.20	11.40	7.46	0.43
83.90	44.40	28.90	16.50	11.60	7.59	0.44
87.20	45.50	29.50	16.80	11.80	7.73	0.45
90.60	46.60	30.10	17.10	12.00	7.86	0.46
94.00	47.70	30.60	17.40	12.20	8.00	0.47
97.50	48.90	31.20	17.70	12.40	8.13	0.48
101.00	50.00	31.80	18.00	12.60	8.26	0.49
105.00	51.10	32.40	18.30	12.80	8.40	0.50
128.00	56.70	35.40	19.80	13.80	9.05	0.55
154.00	62.40	38.30	21.20	14.70	9.69	0.60
182.00	68.10	41.20	22.60	15.60	10.30	0.65
213.00	73.90	44.10	24.00	16.50	10.90	0.70
247.00	79.70	47.00	25.40	17.40	11.50	0.75
283.00	85.60	49.90	26.80	18.30	12.00	0.80
322.00	91.50	52.70	28.10	19.10	12.50	0.85
363.00	97.40	55.50	29.50	20.00	13.00	0.90
407.00	103.00	58.30	30.80	20.80	13.50	0.95
454.00	109.00	61.10	32.10	21.60	14.00	1.00
503.00	115.00	63.90	33.10	22.30	14.40	1.05
555.00	121.00	66.70	34.10	23.00	14.80	1.10
610.00	127.00	69.50	35.10	23.60	15.20	1.15
668.00	134.00	72.20	36.10	24.30	15.70	1.20
728.00	140.00	75.00	37.10	24.90	16.10	1.25
791.00	146.00	77.70	38.00	25.50	16.50	1.30
857.00	152.00	80.50	38.90	26.10	16.90	1.35
925.00	158.00	83.20	39.90	26.70	17.30	1.40
996.00	164.00	85.90	40.80	27.30	17.60	1.45
1,071.00	171.00	88.60	41.70	27.90	18.00	1.50
1,148.00	177.00	91.30	42.60	28.50	18.40	1.55
1,227.00	183.00	94.00	43.40	29.10	18.80	1.60
1,310.00	189.00	96.70	44.30	29.70	19.20	1.65
1,395.00	196.00	99.30	45.20	30.20	19.50	1.70
1,484.00	202.00	102.00	46.00	30.80	19.90	1.75
1,575.00	208.00	105.00	46.90	31.30	20.20	1.80
1,669.00	215.00	107.00	47.70	31.90	20.60	1.85
1,766.00	221.00	110.00	48.50	32.40	20.90	1.90
1,866.00	227.00	113.00	49.30	33.00	21.30	1.95
1,968.00	234.00	115.00	50.20	33.50	21.60	2.00
2,182.00	247.00	121.00	51.80	34.40	22.20	2.10
2,408.00	260.00	126.00	53.30	35.40	22.80	2.20
2,646.00	273.00	131.00	54.90	36.30	23.30	2.30
2,895.00	286.00	136.00	56.40	37.20	23.90	2.40
3,156.00	299.00	141.00	57.90	38.00	24.40	2.50
3,430.00	312.00	147.00	59.40	38.90	25.00	2.60
3,715.00	325.00	152.00	60.80	39.80	25.50	2.70
4,012.00	338.00	157.00	62.30	40.60	26.00	2.80
4,321.00	351.00	162.00	63.70	41.40	26.50	2.90
4,643.00	365.00	167.00	65.10	42.20	27.00	3.00
4,977.00	378.00	172.00	66.40	43.00	27.40	3.10
5,000.00	392.00	177.00	67.70	43.80	27.80	3.20
5,000.00	405.00	182.00	69.00	44.60	28.20	3.30
5,000.00	419.00	187.00	70.20	45.40	28.60	3.40
5,000.00	432.00	192.00	71.50	46.10	29.00	3.50
5,000.00	446.00	197.00	72.70	46.90	29.40	3.60
5,000.00	459.00	202.00	73.90	47.60	29.70	3.70
5,000.00	473.00	207.00	75.10	48.30	30.10	3.80
5,000.00	486.00	212.00	76.30	49.10	30.50	3.90
5,000.00	500.00	217.00	77.50	49.80	30.80	4.00
5,000.00	514.00	222.00	78.70	50.40	31.20	4.10
5,000.00	528.00	227.00	79.80	51.00	31.50	4.20
5,000.00	541.00	232.00	81.00	51.60	31.90	4.30
5,000.00	555.00	237.00	82.10	52.20	32.20	4.40
5,000.00	569.00	242.00	83.20	52.80	32.60	4.50
5,000.00	583.00	247.00	84.30	53.40	32.90	4.60
5,000.00	597.00	252.00	85.40	54.00	33.20	4.70
5,000.00	611.00	257.00	86.50	54.60	33.60	4.80
5,000.00	625.00	262.00	87.60	55.10	33.90	4.90
5,000.00	639.00	266.00	88.70	55.70	34.20	5.00
5,000.00	709.00	291.00	94.00	58.50	35.80	5.50
5,000.00	780.00	315.00	99.00	61.10	37.20	6.00
5,000.00	852.00	339.00	104.00	63.60	38.60	6.50
5,000.00	924.00	362.00	109.00	66.00	40.00	7.00
5,000.00	997.00	386.00	113.00	68.40	41.20	7.50
5,000.00	1,070.00	410.00	118.00	70.60	42.30	8.00
5,000.00	1,144.00	433.00	122.00	72.80	43.40	8.50
5,000.00	1,218.00	456.00	127.00	75.00	44.40	9.00
5,000.00	1,292.00	479.00	131.00	77.00	45.40	9.50
5,000.00	1,367.00	502.00	135.00	79.10	46.40	10.00
5,000.00	2,133.00	728.00	170.00	95.60	54.90	15.00
5,000.00	2,924.00	947.00	200.00	109.00	60.30	20.00
5,000.00	3,735.00	1,161.00	227.00	119.00	64.90	25.00

RELEASE FROM A PYROPHORIC UNIT

	χ (Curies/m^3)					
KM	A	B	C	D	E	F
0.1	1.73E-02	7.49E-03	4.77E-04	2.17E-08	7.53E-14	6.16E-31
0.11	2.07E-02	1.11E-02	1.23E-03	2.77E-07	5.90E-12	9.85E-27
0.12	2.31E-02	1.46E-02	2.49E-03	2.02E-06	1.67E-10	3.50E-23
0.13	2.44E-02	1.73E-02	4.23E-03	9.35E-06	2.50E-09	1.87E-20
0.14	2.49E-02	2.00E-02	6.30E-03	3.25E-05	2.29E-08	3.35E-18
0.15	2.49E-02	2.21E-02	8.89E-03	8.98E-05	1.35E-07	2.57E-16
0.16	2.44E-02	2.35E-02	1.12E-02	2.02E-04	6.04E-07	8.23E-15
0.17	2.37E-02	2.45E-02	1.39E-02	4.00E-04	2.05E-06	1.61E-13
0.18	2.28E-02	2.50E-02	1.60E-02	7.13E-04	5.90E-06	2.44E-12
0.19	2.18E-02	2.54E-02	1.84E-02	1.15E-03	1.46E-05	2.25E-11
0.20	2.08E-02	2.53E-02	2.01E-02	1.71E-03	3.23E-05	1.40E-10
0.21	1.97E-02	2.52E-02	2.20E-02	2.43E-03	6.25E-05	7.11E-10
0.22	1.87E-02	2.49E-02	2.32E-02	3.26E-03	1.15E-04	3.01E-09
0.23	1.77E-02	2.45E-02	2.42E-02	4.24E-03	1.94E-04	1.10E-08
0.24	1.67E-02	2.39E-02	2.54E-02	5.30E-03	3.00E-04	3.24E-08
0.25	1.58E-02	2.33E-02	2.59E-02	6.36E-03	4.55E-04	9.24E-08
0.26	1.49E-02	2.26E-02	2.63E-02	7.71E-03	6.59E-04	2.24E-07
0.27	1.41E-02	2.19E-02	2.68E-02	8.69E-03	9.06E-04	5.03E-07
0.28	1.33E-02	2.13E-02	2.69E-02	1.01E-02	1.20E-03	1.06E-06
0.29	1.25E-02	2.05E-02	2.70E-02	1.11E-02	1.56E-03	2.06E-06
0.30	1.18E-02	1.98E-02	2.68E-02	1.25E-02	1.97E-03	3.69E-06
0.31	1.11E-02	1.91E-02	2.67E-02	1.34E-02	2.39E-03	6.50E-06
0.32	1.05E-02	1.85E-02	2.65E-02	1.43E-02	2.83E-03	1.10E-05
0.33	9.88E-03	1.78E-02	2.63E-02	1.55E-02	3.34E-03	1.72E-05
0.34	9.32E-03	1.72E-02	2.59E-02	1.63E-02	3.83E-03	2.63E-05
0.35	8.80E-03	1.66E-02	2.55E-02	1.70E-02	4.37E-03	4.01E-05
0.36	8.33E-03	1.60E-02	2.51E-02	1.78E-02	4.94E-03	5.73E-05
0.37	7.87E-03	1.54E-02	2.46E-02	1.84E-02	5.57E-03	8.05E-05
0.38	7.45E-03	1.49E-02	2.42E-02	1.90E-02	6.14E-03	1.10E-04
0.39	7.07E-03	1.43E-02	2.38E-02	1.98E-02	6.72E-03	1.48E-04
0.40	6.70E-03	1.38E-02	2.33E-02	2.03E-02	7.32E-03	1.95E-04
0.41	6.32E-03	1.34E-02	2.28E-02	2.08E-02	7.91E-03	2.51E-04
0.42	5.97E-03	1.29E-02	2.23E-02	2.11E-02	8.51E-03	3.15E-04
0.43	5.64E-03	1.24E-02	2.18E-02	2.15E-02	9.11E-03	3.96E-04
0.44	5.33E-03	1.20E-02	2.14E-02	2.18E-02	9.71E-03	4.80E-04
0.45	5.05E-03	1.16E-02	2.09E-02	2.20E-02	1.03E-02	5.89E-04
0.46	4.79E-03	1.12E-02	2.04E-02	2.22E-02	1.09E-02	7.03E-04
0.47	4.54E-03	1.08E-02	1.99E-02	2.24E-02	1.14E-02	8.38E-04
0.48	4.31E-03	1.04E-02	1.95E-02	2.26E-02	1.20E-02	9.81E-04
0.49	4.10E-03	1.01E-02	1.90E-02	2.27E-02	1.25E-02	1.14E-03
0.50	3.89E-03	9.73E-03	1.86E-02	2.28E-02	1.31E-02	1.32E-03
0.55	2.96E-03	8.28E-03	1.66E-02	2.28E-02	1.54E-02	2.40E-03
0.60	2.29E-03	7.11E-03	1.48E-02	2.23E-02	1.70E-02	3.79E-03
0.65	1.81E-03	6.14E-03	1.33E-02	2.16E-02	1.82E-02	5.30E-03
0.70	1.46E-03	5.37E-03	1.19E-02	2.07E-02	1.90E-02	6.92E-03
0.75	1.19E-03	4.74E-03	1.06E-02	1.97E-02	1.95E-02	8.56E-03
0.80	9.82E-04	4.20E-03	9.74E-03	1.87E-02	1.98E-02	9.85E-03
0.85	8.16E-04	3.75E-03	8.87E-03	1.77E-02	1.97E-02	1.10E-02
0.90	6.90E-04	3.36E-03	8.10E-03	1.68E-02	1.96E-02	1.21E-02
0.95	5.88E-04	3.04E-03	7.43E-03	1.59E-02	1.93E-02	1.31E-02
1.00	5.02E-04	2.75E-03	6.84E-03	1.50E-02	1.90E-02	1.40E-02
1.05	4.35E-04	2.50E-03	6.29E-03	1.42E-02	1.85E-02	1.45E-02
1.10	3.79E-04	2.29E-03	5.86E-03	1.35E-02	1.80E-02	1.49E-02
1.15	3.31E-04	2.10E-03	5.42E-03	1.28E-02	1.75E-02	1.53E-02
1.20	2.91E-04	1.93E-03	5.03E-03	1.22E-02	1.70E-02	1.59E-02
1.25	2.58E-04	1.78E-03	4.72E-03	1.16E-02	1.65E-02	1.61E-02
1.30	2.29E-04	1.65E-03	4.40E-03	1.11E-02	1.60E-02	1.63E-02
1.35	2.05E-04	1.54E-03	4.14E-03	1.06E-02	1.55E-02	1.64E-02
1.40	1.84E-04	1.43E-03	3.88E-03	1.01E-02	1.50E-02	1.65E-02
1.45	1.66E-04	1.33E-03	3.64E-03	9.71E-03	1.46E-02	1.64E-02
1.50	1.50E-04	1.25E-03	3.44E-03	9.31E-03	1.41E-02	1.64E-02
1.55	1.35E-04	1.17E-03	3.24E-03	8.88E-03	1.37E-02	1.64E-02
1.60	1.23E-04	1.10E-03	3.08E-03	8.62E-03	1.33E-02	1.64E-02
1.65	1.12E-04	1.04E-03	2.91E-03	8.27E-03	1.29E-02	1.63E-02
1.70	1.03E-04	9.76E-04	2.77E-03	7.95E-03	1.25E-02	1.61E-02
1.75	9.43E-05	9.22E-04	2.64E-03	7.65E-03	1.22E-02	1.60E-02
1.80	8.66E-05	8.75E-04	2.49E-03	7.36E-03	1.18E-02	1.58E-02
1.85	7.99E-05	8.25E-04	2.40E-03	7.10E-03	1.15E-02	1.57E-02
1.90	7.37E-05	7.85E-04	2.27E-03	6.85E-03	1.12E-02	1.55E-02
1.95	6.82E-05	7.48E-04	2.17E-03	6.61E-03	1.09E-02	1.54E-02
2.00	6.32E-05	7.08E-04	2.09E-03	6.37E-03	1.06E-02	1.52E-02
2.10	5.47E-05	6.45E-04	1.90E-03	5.96E-03	1.00E-02	1.47E-02
2.20	4.75E-05	5.87E-04	1.75E-03	5.63E-03	9.53E-03	1.43E-02
2.30	4.17E-05	5.37E-04	1.62E-03	5.28E-03	9.00E-03	1.39E-02
2.40	3.66E-05	4.95E-04	1.51E-03	4.97E-03	8.59E-03	1.35E-02
2.50	3.25E-05	4.57E-04	1.40E-03	4.68E-03	8.22E-03	1.31E-02
2.60	2.89E-05	4.22E-04	1.30E-03	4.45E-03	7.86E-03	1.27E-02
2.70	2.58E-05	3.92E-04	1.22E-03	4.21E-03	7.46E-03	1.24E-02
2.80	2.31E-05	3.66E-04	1.14E-03	4.01E-03	7.16E-03	1.20E-02
2.90	2.08E-05	3.42E-04	1.07E-03	3.81E-03	6.87E-03	1.17E-02
3.00	1.88E-05	3.19E-04	1.01E-03	3.62E-03	6.60E-03	1.13E-02
3.10	1.71E-05	2.99E-04	9.55E-04	3.47E-03	6.34E-03	1.10E-02
3.20	1.65E-05	2.81E-04	9.00E-04	3.31E-03	6.10E-03	1.07E-02
3.30	1.61E-05	2.64E-04	8.53E-04	3.17E-03	5.84E-03	1.04E-02
3.40	1.57E-05	2.49E-04	8.09E-04	3.04E-03	5.63E-03	1.01E-02
3.50	1.53E-05	2.35E-04	7.67E-04	2.92E-03	5.43E-03	9.81E-03
3.60	1.49E-05	2.22E-04	7.29E-04	2.80E-03	5.24E-03	9.62E-03
3.70	1.46E-05	2.11E-04	6.95E-04	2.70E-03	5.06E-03	9.35E-03
3.80	1.42E-05	2.00E-04	6.63E-04	2.59E-03	4.90E-03	9.08E-03
3.90	1.39E-05	1.90E-04	6.33E-04	2.50E-03	4.73E-03	8.91E-03
4.00	1.36E-05	1.81E-04	6.05E-04	2.42E-03	4.58E-03	8.67E-03
4.10	1.33E-05	1.72E-04	5.77E-04	2.33E-03	4.45E-03	8.43E-03
4.20	1.30E-05	1.64E-04	5.52E-04	2.25E-03	4.32E-03	8.21E-03
4.30	1.28E-05	1.57E-04	5.29E-04	2.18E-03	4.19E-03	8.06E-03
4.40	1.25E-05	1.50E-04	5.08E-04	2.10E-03	4.07E-03	7.86E-03
4.50	1.23E-05	1.43E-04	4.88E-04	2.04E-03	3.96E-03	7.66E-03
4.60	1.21E-05	1.37E-04	4.69E-04	1.98E-03	3.85E-03	7.52E-03
4.70	1.18E-05	1.31E-04	4.51E-04	1.91E-03	3.74E-03	7.34E-03
4.80	1.16E-05	1.26E-04	4.34E-04	1.86E-03	3.64E-03	7.21E-03
4.90	1.14E-05	1.21E-04	4.18E-04	1.81E-03	3.55E-03	7.04E-03
5.00	1.12E-05	1.16E-04	4.04E-04	1.76E-03	3.46E-03	6.87E-03
5.50	1.03E-05	9.65E-05	3.40E-04	1.52E-03	3.06E-03	6.20E-03
6.00	9.60E-06	8.13E-05	2.90E-04	1.35E-03	2.73E-03	5.64E-03
6.50	8.96E-06	6.94E-05	2.51E-04	1.20E-03	2.46E-03	5.19E-03
7.00	8.41E-06	6.00E-05	2.20E-04	1.07E-03	2.24E-03	4.76E-03
7.50	7.92E-06	5.24E-05	1.94E-04	9.74E-04	2.04E-03	4.39E-03
8.00	7.50E-06	4.61E-05	1.73E-04	8.82E-04	1.88E-03	4.10E-03
8.50	7.12E-06	4.09E-05	1.55E-04	8.11E-04	1.73E-03	3.83E-03
9.00	6.78E-06	3.66E-05	1.40E-04	7.42E-04	1.61E-03	3.58E-03
9.50	6.47E-06	3.29E-05	1.27E-04	6.87E-04	1.49E-03	3.37E-03
10.00	6.20E-06	2.97E-05	1.16E-04	6.37E-04	1.39E-03	3.17E-03
15.00	4.39E-06	1.34E-05	5.58E-05	3.56E-04	8.21E-04	1.97E-03
20.00	3.45E-06	7.66E-06	3.33E-05	2.35E-04	5.64E-04	1.42E-03
25.00	2.86E-06	4.95E-06	2.23E-05	1.71E-04	4.26E-04	1.10E-03

χ (Bq/m^3)						
A	B	C	D	E	F	KM
6.39E+08	2.77E+08	1.77E+07	8.03E+02	2.79E-03	2.28E-20	0.1
7.68E+08	4.10E+08	4.56E+07	1.03E+04	2.18E-01	3.64E-16	0.11
8.55E+08	5.42E+08	9.20E+07	7.47E+04	6.18E+00	1.29E-12	0.12
9.02E+08	6.41E+08	1.57E+08	3.46E+05	9.23E+01	6.91E-10	0.13
9.22E+08	7.40E+08	2.33E+08	1.20E+06	8.48E+02	1.24E-07	0.14
9.20E+08	8.18E+08	3.29E+08	3.32E+06	5.01E+03	9.50E-06	0.15
9.05E+08	8.68E+08	4.13E+08	7.47E+06	2.23E+04	3.04E-04	0.16
8.77E+08	9.08E+08	5.14E+08	1.48E+07	7.60E+04	5.97E-03	0.17
8.44E+08	9.26E+08	5.92E+08	2.64E+07	2.18E+05	9.03E-02	0.18
8.08E+08	9.40E+08	6.81E+08	4.24E+07	5.40E+05	8.31E-01	0.19
7.69E+08	9.37E+08	7.45E+08	6.34E+07	1.20E+06	5.19E+00	0.20
7.30E+08	9.33E+08	8.14E+08	9.00E+07	2.31E+06	2.63E+01	0.21
6.92E+08	9.22E+08	8.59E+08	1.21E+08	4.27E+06	1.11E+02	0.22
6.55E+08	9.06E+08	8.96E+08	1.57E+08	7.19E+06	4.05E+02	0.23
6.19E+08	8.84E+08	9.38E+08	1.96E+08	1.11E+07	1.20E+03	0.24
5.85E+08	8.61E+08	9.59E+08	2.35E+08	1.68E+07	3.42E+03	0.25
5.52E+08	8.37E+08	9.74E+08	2.85E+08	2.44E+07	8.30E+03	0.26
5.21E+08	8.11E+08	9.93E+08	3.21E+08	3.35E+07	1.86E+04	0.27
4.91E+08	7.86E+08	9.96E+08	3.74E+08	4.44E+07	3.91E+04	0.28
4.63E+08	7.60E+08	9.99E+08	4.10E+08	5.76E+07	7.63E+04	0.29
4.37E+08	7.34E+08	9.93E+08	4.61E+08	7.29E+07	1.36E+05	0.30
4.11E+08	7.08E+08	9.89E+08	4.95E+08	8.85E+07	2.40E+05	0.31
3.87E+08	6.84E+08	9.82E+08	5.28E+08	1.05E+08	4.08E+05	0.32
3.65E+08	6.59E+08	9.71E+08	5.74E+08	1.24E+08	6.38E+05	0.33
3.45E+08	6.35E+08	9.57E+08	6.03E+08	1.42E+08	9.74E+05	0.34
3.26E+08	6.13E+08	9.44E+08	6.30E+08	1.62E+08	1.49E+06	0.35
3.08E+08	5.92E+08	9.29E+08	6.58E+08	1.83E+08	2.12E+06	0.36
2.91E+08	5.71E+08	9.12E+08	6.81E+08	2.06E+08	2.98E+06	0.37
2.76E+08	5.51E+08	8.96E+08	7.03E+08	2.27E+08	4.06E+06	0.38
2.62E+08	5.31E+08	8.79E+08	7.34E+08	2.49E+08	5.47E+06	0.39
2.48E+08	5.12E+08	8.62E+08	7.51E+08	2.71E+08	7.21E+06	0.40
2.34E+08	4.94E+08	8.43E+08	7.69E+08	2.93E+08	9.29E+06	0.41
2.21E+08	4.77E+08	8.25E+08	7.82E+08	3.15E+08	1.16E+07	0.42
2.09E+08	4.60E+08	8.08E+08	7.94E+08	3.37E+08	1.46E+07	0.43
1.97E+08	4.43E+08	7.90E+08	8.07E+08	3.59E+08	1.78E+07	0.44
1.87E+08	4.28E+08	7.73E+08	8.15E+08	3.81E+08	2.18E+07	0.45
1.77E+08	4.13E+08	7.56E+08	8.23E+08	4.02E+08	2.60E+07	0.46
1.68E+08	3.99E+08	7.38E+08	8.28E+08	4.23E+08	3.10E+07	0.47
1.60E+08	3.85E+08	7.21E+08	8.35E+08	4.44E+08	3.63E+07	0.48
1.52E+08	3.72E+08	7.05E+08	8.39E+08	4.64E+08	4.22E+07	0.49
1.44E+08	3.60E+08	6.89E+08	8.43E+08	4.83E+08	4.89E+07	0.50
1.10E+08	3.06E+08	6.13E+08	8.45E+08	5.70E+08	8.90E+07	0.55
8.49E+07	2.63E+08	5.48E+08	8.26E+08	6.30E+08	1.40E+08	0.60
6.71E+07	2.27E+08	4.91E+08	7.97E+08	6.73E+08	1.96E+08	0.65
5.41E+07	1.99E+08	4.41E+08	7.65E+08	7.04E+08	2.56E+08	0.70
4.39E+07	1.75E+08	3.98E+08	7.29E+08	7.23E+08	3.17E+08	0.75
3.63E+07	1.55E+08	3.60E+08	6.92E+08	7.34E+08	3.64E+08	0.80
3.02E+07	1.39E+08	3.28E+08	6.57E+08	7.31E+08	4.08E+08	0.85
2.55E+07	1.24E+08	3.00E+08	6.21E+08	7.26E+08	4.48E+08	0.90
2.18E+07	1.13E+08	2.75E+08	5.87E+08	7.15E+08	4.86E+08	0.95
1.86E+07	1.02E+08	2.53E+08	5.55E+08	7.02E+08	5.18E+08	1.00
1.61E+07	9.27E+07	2.33E+08	5.27E+08	6.83E+08	5.38E+08	1.05
1.40E+07	8.46E+07	2.17E+08	5.00E+08	6.65E+08	5.53E+08	1.10
1.23E+07	7.76E+07	2.01E+08	4.75E+08	6.46E+08	5.67E+08	1.15
1.08E+07	7.13E+07	1.86E+08	4.52E+08	6.28E+08	5.87E+08	1.20
9.55E+06	6.58E+07	1.75E+08	4.31E+08	6.10E+08	5.95E+08	1.25
8.49E+06	6.09E+07	1.63E+08	4.11E+08	5.91E+08	6.02E+08	1.30
7.57E+06	5.69E+07	1.53E+08	3.93E+08	5.73E+08	6.07E+08	1.35
6.79E+06	5.29E+07	1.43E+08	3.75E+08	5.56E+08	6.10E+08	1.40
6.14E+06	4.94E+07	1.35E+08	3.59E+08	5.39E+08	6.07E+08	1.45
5.53E+06	4.61E+07	1.27E+08	3.44E+08	5.23E+08	6.08E+08	1.50
5.01E+06	4.32E+07	1.20E+08	3.29E+08	5.08E+08	6.07E+08	1.55
4.56E+06	4.08E+07	1.14E+08	3.19E+08	4.93E+08	6.06E+08	1.60
4.16E+06	3.84E+07	1.08E+08	3.06E+08	4.77E+08	6.03E+08	1.65
3.80E+06	3.61E+07	1.02E+08	2.94E+08	4.64E+08	5.97E+08	1.70
3.49E+06	3.41E+07	9.76E+07	2.83E+08	4.50E+08	5.93E+08	1.75
3.20E+06	3.24E+07	9.23E+07	2.72E+08	4.37E+08	5.86E+08	1.80
2.96E+06	3.05E+07	8.87E+07	2.63E+08	4.25E+08	5.82E+08	1.85
2.73E+06	2.91E+07	8.41E+07	2.53E+08	4.13E+08	5.74E+08	1.90
2.52E+06	2.77E+07	8.03E+07	2.45E+08	4.02E+08	5.69E+08	1.95
2.34E+06	2.62E+07	7.73E+07	2.36E+08	3.91E+08	5.61E+08	2.00
2.02E+06	2.38E+07	7.04E+07	2.20E+08	3.70E+08	5.46E+08	2.10
1.76E+06	2.17E+07	6.49E+07	2.08E+08	3.53E+08	5.31E+08	2.20
1.54E+06	1.99E+07	5.99E+07	1.95E+08	3.33E+08	5.15E+08	2.30
1.36E+06	1.83E+07	5.58E+07	1.84E+08	3.18E+08	5.00E+08	2.40
1.20E+06	1.69E+07	5.18E+07	1.73E+08	3.04E+08	4.86E+08	2.50
1.07E+06	1.56E+07	4.82E+07	1.65E+08	2.91E+08	4.71E+08	2.60
9.55E+05	1.45E+07	4.50E+07	1.56E+08	2.76E+08	4.57E+08	2.70
8.55E+05	1.35E+07	4.23E+07	1.48E+08	2.65E+08	4.44E+08	2.80
7.71E+05	1.26E+07	3.97E+07	1.41E+08	2.54E+08	4.32E+08	2.90
6.97E+05	1.18E+07	3.74E+07	1.34E+08	2.44E+08	4.19E+08	3.00
6.32E+05	1.11E+07	3.53E+07	1.28E+08	2.35E+08	4.07E+08	3.10
6.11E+05	1.04E+07	3.33E+07	1.22E+08	2.26E+08	3.96E+08	3.20
5.95E+05	9.78E+06	3.16E+07	1.17E+08	2.16E+08	3.85E+08	3.30
5.80E+05	9.21E+06	2.99E+07	1.12E+08	2.08E+08	3.74E+08	3.40
5.65E+05	8.70E+06	2.84E+07	1.08E+08	2.01E+08	3.63E+08	3.50
5.52E+05	8.22E+06	2.70E+07	1.04E+08	1.94E+08	3.56E+08	3.60
5.39E+05	7.81E+06	2.57E+07	9.99E+07	1.87E+08	3.46E+08	3.70
5.27E+05	7.40E+06	2.45E+07	9.59E+07	1.81E+08	3.36E+08	3.80
5.15E+05	7.03E+06	2.34E+07	9.26E+07	1.75E+08	3.30E+08	3.90
5.04E+05	6.69E+06	2.24E+07	8.94E+07	1.70E+08	3.21E+08	4.00
4.93E+05	6.37E+06	2.13E+07	8.61E+07	1.65E+08	3.12E+08	4.10
4.83E+05	6.07E+06	2.04E+07	8.33E+07	1.60E+08	3.04E+08	4.20
4.73E+05	5.80E+06	1.96E+07	8.06E+07	1.55E+08	2.98E+08	4.30
4.64E+05	5.55E+06	1.88E+07	7.79E+07	1.51E+08	2.91E+08	4.40
4.55E+05	5.30E+06	1.80E+07	7.55E+07	1.46E+08	2.83E+08	4.50
4.47E+05	5.08E+06	1.73E+07	7.32E+07	1.42E+08	2.78E+08	4.60
4.38E+05	4.86E+06	1.67E+07	7.08E+07	1.38E+08	2.72E+08	4.70
4.30E+05	4.67E+06	1.60E+07	6.88E+07	1.35E+08	2.67E+08	4.80
4.23E+05	4.48E+06	1.54E+07	6.68E+07	1.31E+08	2.60E+08	4.90
4.15E+05	4.31E+06	1.49E+07	6.49E+07	1.28E+08	2.54E+08	5.00
3.83E+05	3.57E+06	1.26E+07	5.64E+07	1.13E+08	2.30E+08	5.50
3.55E+05	3.01E+06	1.07E+07	4.99E+07	1.01E+08	2.09E+08	6.00
3.31E+05	2.57E+06	9.29E+06	4.43E+07	9.11E+07	1.92E+08	6.50
3.11E+05	2.22E+06	8.15E+06	3.97E+07	8.28E+07	1.76E+08	7.00
2.93E+05	1.94E+06	7.19E+06	3.60E+07	7.55E+07	1.63E+08	7.50
2.77E+05	1.71E+06	6.40E+06	3.26E+07	6.95E+07	1.52E+08	8.00
2.63E+05	1.51E+06	5.73E+06	3.00E+07	6.41E+07	1.42E+08	8.50
2.51E+05	1.35E+06	5.18E+06	2.74E+07	5.94E+07	1.32E+08	9.00
2.40E+05	1.22E+06	4.70E+06	2.54E+07	5.53E+07	1.25E+08	9.50
2.29E+05	1.10E+06	4.29E+06	2.36E+07	5.16E+07	1.17E+08	10.00
1.63E+05	4.97E+05	2.06E+06	1.32E+07	3.04E+07	7.30E+07	15.00
1.28E+05	2.83E+05	1.23E+06	8.70E+06	2.09E+07	5.26E+07	20.00
1.06E+05	1.83E+05	8.25E+05	6.32E+06	1.58E+07	4.07E+07	25.00

RELEASE FROM A PYROPHORIC UNIT

	INFANT	ADULT
Inhalation rate (m3/year)	1.40E+03	8.40E+03
Inhalation rate (m3/s)	4.44E-05	2.66E-04
Inhalation DCF for HTO (mSv/Bq)	5.80E-08	2.00E-08
Inhalation DCF for HT (mSv/Bq)	1.20E-11	2.40E-12
Skin absorption DCF for HTO (mSv/Bq)	5.80E-08	2.00E-08

Total dose to infant (mSv)

KM	A	B	C	D	E	F
0.1	0.008	0.004	0.000	0.000	0.000	0.000
0.11	0.010	0.005	0.001	0.000	0.000	0.000
0.12	0.011	0.007	0.001	0.000	0.000	0.000
0.13	0.012	0.008	0.002	0.000	0.000	0.000
0.14	0.012	0.010	0.003	0.000	0.000	0.000
0.15	0.012	0.011	0.004	0.000	0.000	0.000
0.16	0.012	0.011	0.005	0.000	0.000	0.000
0.17	0.011	0.012	0.007	0.000	0.000	0.000
0.18	0.011	0.012	0.008	0.000	0.000	0.000
0.19	0.010	0.012	0.009	0.001	0.000	0.000
0.20	0.010	0.012	0.010	0.001	0.000	0.000
0.21	0.009	0.012	0.010	0.001	0.000	0.000
0.22	0.009	0.012	0.011	0.002	0.000	0.000
0.23	0.008	0.012	0.012	0.002	0.000	0.000
0.24	0.008	0.011	0.012	0.003	0.000	0.000
0.25	0.008	0.011	0.012	0.003	0.000	0.000
0.26	0.007	0.011	0.013	0.004	0.000	0.000
0.27	0.007	0.010	0.013	0.004	0.000	0.000
0.28	0.006	0.010	0.013	0.005	0.001	0.000
0.29	0.006	0.010	0.013	0.005	0.001	0.000
0.30	0.006	0.009	0.013	0.006	0.001	0.000
0.31	0.005	0.009	0.013	0.006	0.001	0.000
0.32	0.005	0.009	0.013	0.007	0.001	0.000
0.33	0.005	0.008	0.013	0.007	0.002	0.000
0.34	0.004	0.008	0.012	0.008	0.002	0.000
0.35	0.004	0.008	0.012	0.008	0.002	0.000
0.36	0.004	0.008	0.012	0.008	0.002	0.000
0.37	0.004	0.007	0.012	0.009	0.003	0.000
0.38	0.004	0.007	0.012	0.009	0.003	0.000
0.39	0.003	0.007	0.011	0.009	0.003	0.000
0.40	0.003	0.007	0.011	0.010	0.003	0.000
0.41	0.003	0.006	0.011	0.010	0.004	0.000
0.42	0.003	0.006	0.011	0.010	0.004	0.000
0.43	0.003	0.006	0.010	0.010	0.004	0.000
0.44	0.003	0.006	0.010	0.010	0.005	0.000
0.45	0.002	0.006	0.010	0.011	0.005	0.000
0.46	0.002	0.005	0.010	0.011	0.005	0.000
0.47	0.002	0.005	0.009	0.011	0.005	0.000
0.48	0.002	0.005	0.009	0.011	0.006	0.000
0.49	0.002	0.005	0.009	0.011	0.006	0.001
0.50	0.002	0.005	0.009	0.011	0.006	0.001
0.55	0.001	0.004	0.008	0.011	0.007	0.001
0.60	0.001	0.003	0.007	0.011	0.008	0.002
0.65	0.001	0.003	0.006	0.010	0.009	0.003
0.70	0.001	0.003	0.006	0.010	0.009	0.003
0.75	0.001	0.002	0.005	0.009	0.009	0.004
0.80	0.000	0.002	0.005	0.009	0.009	0.005
0.85	0.000	0.002	0.004	0.008	0.009	0.005
0.90	0.000	0.002	0.004	0.008	0.009	0.006
0.95	0.000	0.001	0.004	0.008	0.009	0.006
1.00	0.000	0.001	0.003	0.007	0.009	0.007
1.05	0.000	0.001	0.003	0.007	0.009	0.007
1.10	0.000	0.001	0.003	0.006	0.009	0.007
1.15	0.000	0.001	0.003	0.006	0.008	0.007
1.20	0.000	0.001	0.002	0.006	0.008	0.008
1.25	0.000	0.001	0.002	0.006	0.008	0.008
1.30	0.000	0.001	0.002	0.005	0.008	0.008
1.35	0.000	0.001	0.002	0.005	0.007	0.008
1.40	0.000	0.001	0.002	0.005	0.007	0.008
1.45	0.000	0.001	0.002	0.005	0.007	0.008
1.50	0.000	0.001	0.002	0.004	0.007	0.008
1.55	0.000	0.001	0.002	0.004	0.007	0.008
1.60	0.000	0.001	0.001	0.004	0.006	0.008
1.65	0.000	0.000	0.001	0.004	0.006	0.008
1.70	0.000	0.000	0.001	0.004	0.006	0.008
1.75	0.000	0.000	0.001	0.004	0.006	0.008
1.80	0.000	0.000	0.001	0.004	0.006	0.008
1.85	0.000	0.000	0.001	0.003	0.005	0.007
1.90	0.000	0.000	0.001	0.003	0.005	0.007
1.95	0.000	0.000	0.001	0.003	0.005	0.007
2.00	0.000	0.000	0.001	0.003	0.005	0.007
2.10	0.000	0.000	0.001	0.003	0.005	0.007
2.20	0.000	0.000	0.001	0.003	0.005	0.007
2.30	0.000	0.000	0.001	0.003	0.004	0.007
2.40	0.000	0.000	0.001	0.002	0.004	0.006
2.50	0.000	0.000	0.001	0.002	0.004	0.006
2.60	0.000	0.000	0.001	0.002	0.004	0.006
2.70	0.000	0.000	0.001	0.002	0.004	0.006
2.80	0.000	0.000	0.001	0.002	0.003	0.006
2.90	0.000	0.000	0.001	0.002	0.003	0.006
3.00	0.000	0.000	0.000	0.002	0.003	0.005
3.10	0.000	0.000	0.000	0.002	0.003	0.005
3.20	0.000	0.000	0.000	0.002	0.003	0.005
3.30	0.000	0.000	0.000	0.002	0.003	0.005
3.40	0.000	0.000	0.000	0.001	0.003	0.005
3.50	0.000	0.000	0.000	0.001	0.003	0.005
3.60	0.000	0.000	0.000	0.001	0.002	0.005
3.70	0.000	0.000	0.000	0.001	0.002	0.004
3.80	0.000	0.000	0.000	0.001	0.002	0.004
3.90	0.000	0.000	0.000	0.001	0.002	0.004
4.00	0.000	0.000	0.000	0.001	0.002	0.004
4.10	0.000	0.000	0.000	0.001	0.002	0.004
4.20	0.000	0.000	0.000	0.001	0.002	0.004
4.30	0.000	0.000	0.000	0.001	0.002	0.004
4.40	0.000	0.000	0.000	0.001	0.002	0.004
4.50	0.000	0.000	0.000	0.001	0.002	0.004
4.60	0.000	0.000	0.000	0.001	0.002	0.004
4.70	0.000	0.000	0.000	0.001	0.002	0.003
4.80	0.000	0.000	0.000	0.001	0.002	0.003
4.90	0.000	0.000	0.000	0.001	0.002	0.003
5.00	0.000	0.000	0.000	0.001	0.002	0.003
5.50	0.000	0.000	0.000	0.001	0.001	0.003
6.00	0.000	0.000	0.000	0.001	0.001	0.003
6.50	0.000	0.000	0.000	0.001	0.001	0.002
7.00	0.000	0.000	0.000	0.001	0.001	0.002
7.50	0.000	0.000	0.000	0.000	0.001	0.002
8.00	0.000	0.000	0.000	0.000	0.001	0.002
8.50	0.000	0.000	0.000	0.000	0.001	0.002
9.00	0.000	0.000	0.000	0.000	0.001	0.002
9.50	0.000	0.000	0.000	0.000	0.001	0.002
10.00	0.000	0.000	0.000	0.000	0.001	0.002
15.00	0.000	0.000	0.000	0.000	0.000	0.001
20.00	0.000	0.000	0.000	0.000	0.000	0.001
25.00	0.000	0.000	0.000	0.000	0.000	0.001

Total dose to adult (mSv)

A	B	C	D	E	F	KM
0.017	0.007	0.000	0.000	0.000	0.000	0.1
0.020	0.011	0.001	0.000	0.000	0.000	0.11
0.023	0.014	0.002	0.000	0.000	0.000	0.12
0.024	0.017	0.004	0.000	0.000	0.000	0.13
0.025	0.020	0.006	0.000	0.000	0.000	0.14
0.025	0.022	0.009	0.000	0.000	0.000	0.15
0.024	0.023	0.011	0.000	0.000	0.000	0.16
0.023	0.024	0.014	0.000	0.000	0.000	0.17
0.022	0.025	0.016	0.001	0.000	0.000	0.18
0.022	0.025	0.018	0.001	0.000	0.000	0.19
0.020	0.025	0.020	0.002	0.000	0.000	0.20
0.019	0.025	0.022	0.002	0.000	0.000	0.21
0.018	0.025	0.023	0.003	0.000	0.000	0.22
0.017	0.024	0.024	0.004	0.000	0.000	0.23
0.017	0.024	0.025	0.005	0.000	0.000	0.24
0.016	0.023	0.026	0.006	0.000	0.000	0.25
0.015	0.022	0.026	0.008	0.001	0.000	0.26
0.014	0.022	0.026	0.009	0.001	0.000	0.27
0.013	0.021	0.027	0.010	0.001	0.000	0.28
0.012	0.020	0.027	0.011	0.002	0.000	0.29
0.012	0.020	0.026	0.012	0.002	0.000	0.30
0.011	0.019	0.026	0.013	0.002	0.000	0.31
0.010	0.018	0.026	0.014	0.003	0.000	0.32
0.010	0.018	0.026	0.015	0.003	0.000	0.33
0.009	0.017	0.025	0.016	0.004	0.000	0.34
0.009	0.016	0.025	0.017	0.004	0.000	0.35
0.008	0.016	0.025	0.018	0.005	0.000	0.36
0.008	0.015	0.024	0.018	0.005	0.000	0.37
0.007	0.015	0.024	0.019	0.006	0.000	0.38
0.007	0.014	0.023	0.020	0.007	0.000	0.39
0.007	0.014	0.023	0.020	0.007	0.000	0.40
0.006	0.013	0.022	0.020	0.008	0.000	0.41
0.006	0.013	0.022	0.021	0.008	0.000	0.42
0.006	0.012	0.022	0.021	0.009	0.000	0.43
0.005	0.012	0.021	0.021	0.010	0.000	0.44
0.005	0.011	0.021	0.022	0.010	0.001	0.45
0.005	0.011	0.020	0.022	0.011	0.001	0.46
0.004	0.011	0.020	0.022	0.011	0.001	0.47
0.004	0.010	0.019	0.022	0.012	0.001	0.48
0.004	0.010	0.019	0.022	0.012	0.001	0.49
0.004	0.010	0.018	0.022	0.013	0.001	0.50
0.003	0.008	0.016	0.023	0.015	0.002	0.55
0.002	0.007	0.015	0.022	0.017	0.004	0.60
0.002	0.006	0.013	0.021	0.018	0.005	0.65
0.001	0.005	0.012	0.020	0.019	0.007	0.70
0.001	0.005	0.011	0.019	0.019	0.008	0.75
0.001	0.004	0.010	0.018	0.020	0.010	0.80
0.001	0.004	0.009	0.017	0.019	0.011	0.85
0.001	0.003	0.008	0.017	0.019	0.012	0.90
0.001	0.003	0.007	0.016	0.019	0.013	0.95
0.000	0.003	0.007	0.015	0.019	0.014	1.00
0.000	0.002	0.006	0.014	0.018	0.014	1.05
0.000	0.002	0.006	0.013	0.018	0.015	1.10
0.000	0.002	0.005	0.013	0.017	0.015	1.15
0.000	0.002	0.005	0.012	0.017	0.016	1.20
0.000	0.002	0.005	0.011	0.016	0.016	1.25
0.000	0.002	0.004	0.011	0.016	0.016	1.30
0.000	0.002	0.004	0.010	0.015	0.016	1.35
0.000	0.001	0.004	0.010	0.015	0.016	1.40
0.000	0.001	0.004	0.010	0.014	0.016	1.45
0.000	0.001	0.003	0.009	0.014	0.016	1.50
0.000	0.001	0.003	0.009	0.014	0.016	1.55
0.000	0.001	0.003	0.008	0.013	0.016	1.60
0.000	0.001	0.003	0.008	0.013	0.016	1.65
0.000	0.001	0.003	0.008	0.012	0.016	1.70
0.000	0.001	0.003	0.008	0.012	0.016	1.75
0.000	0.001	0.002	0.007	0.012	0.016	1.80
0.000	0.001	0.002	0.007	0.011	0.015	1.85
0.000	0.001	0.002	0.007	0.011	0.015	1.90
0.000	0.001	0.002	0.007	0.011	0.015	1.95
0.000	0.001	0.002	0.006	0.010	0.015	2.00
0.000	0.001	0.002	0.006	0.010	0.015	2.10
0.000	0.001	0.002	0.006	0.009	0.014	2.20
0.000	0.001	0.002	0.005	0.009	0.014	2.30
0.000	0.000	0.001	0.005	0.008	0.013	2.40
0.000	0.000	0.001	0.005	0.008	0.013	2.50
0.000	0.000	0.001	0.004	0.008	0.013	2.60
0.000	0.000	0.001	0.004	0.007	0.012	2.70
0.000	0.000	0.001	0.004	0.007	0.012	2.80
0.000	0.000	0.001	0.004	0.007	0.011	2.90
0.000	0.000	0.001	0.004	0.007	0.011	3.00
0.000	0.000	0.001	0.003	0.006	0.011	3.10
0.000	0.000	0.001	0.003	0.006	0.011	3.20
0.000	0.000	0.001	0.003	0.006	0.010	3.30
0.000	0.000	0.001	0.003	0.006	0.010	3.40
0.000	0.000	0.001	0.003	0.005	0.010	3.50
0.000	0.000	0.001	0.003	0.005	0.009	3.60
0.000	0.000	0.001	0.003	0.005	0.009	3.70
0.000	0.000	0.001	0.003	0.005	0.009	3.80
0.000	0.000	0.001	0.002	0.005	0.009	3.90
0.000	0.000	0.001	0.002	0.005	0.009	4.00
0.000	0.000	0.001	0.002	0.004	0.008	4.10
0.000	0.000	0.001	0.002	0.004	0.008	4.20
0.000	0.000	0.001	0.002	0.004	0.008	4.30
0.000	0.000	0.001	0.002	0.004	0.008	4.40
0.000	0.000	0.000	0.002	0.004	0.008	4.50
0.000	0.000	0.000	0.002	0.004	0.007	4.60
0.000	0.000	0.000	0.002	0.004	0.007	4.70
0.000	0.000	0.000	0.002	0.004	0.007	4.80
0.000	0.000	0.000	0.002	0.003	0.007	4.90
0.000	0.000	0.000	0.002	0.003	0.007	5.00
0.000	0.000	0.000	0.002	0.003	0.006	5.50
0.000	0.000	0.000	0.001	0.003	0.006	6.00
0.000	0.000	0.000	0.001	0.002	0.005	6.50
0.000	0.000	0.000	0.001	0.002	0.005	7.00
0.000	0.000	0.000	0.001	0.002	0.004	7.50
0.000	0.000	0.000	0.001	0.002	0.004	8.00
0.000	0.000	0.000	0.001	0.002	0.004	8.50
0.000	0.000	0.000	0.001	0.002	0.004	9.00
0.000	0.000	0.000	0.001	0.001	0.003	9.50
0.000	0.000	0.000	0.001	0.001	0.003	10.00
0.000	0.000	0.000	0.000	0.001	0.002	15.00
0.000	0.000	0.000	0.000	0.001	0.001	20.00
0.000	0.000	0.000	0.000	0.000	0.001	25.00

APPENDIX I

RELEASE FROM A BULK CONTAINER

Release (curies)	25,000.0
Time of release "t" (seconds)	10.0
Wind velocity "V" (meters/second)	2.0
Effective height of release "H" (meters)	27.8
Rate of release "Q" (curies/second)	2,500.0
Percentage of release that is HTO	25.0
Percentage of release that is HT	75.0

	σ_Y					
KM	A	B	C	D	E	F
0.1	26.9	19.3	12.5	8.2	6.12	4.07
0.11	29.30	21.00	13.60	8.96	6.69	4.45
0.12	31.60	22.70	14.70	9.71	7.25	4.82
0.13	34.00	24.50	15.90	10.50	7.81	5.19
0.14	36.30	26.20	17.00	11.20	8.36	5.56
0.15	38.60	27.90	18.10	11.90	8.91	5.92
0.16	40.90	29.50	19.20	12.70	9.46	6.29
0.17	43.20	31.20	20.30	13.40	10.00	6.65
0.18	45.50	32.90	21.40	14.10	10.50	7.01
0.19	47.70	34.50	22.50	14.80	11.10	7.37
0.20	50.00	36.20	23.60	15.60	11.60	7.73
0.21	52.20	37.80	24.70	16.30	12.20	8.08
0.22	54.40	39.40	25.80	17.00	12.70	8.44
0.23	56.60	41.00	26.90	17.70	13.20	8.79
0.24	58.80	42.70	27.90	18.40	13.80	9.14
0.25	61.00	44.30	29.00	19.10	14.30	9.50
0.26	63.20	45.90	30.10	19.80	14.80	9.85
0.27	65.30	47.50	31.10	20.50	15.30	10.20
0.28	67.50	49.00	32.20	21.20	15.90	10.50
0.29	69.60	50.60	33.20	21.90	16.40	10.90
0.30	71.80	52.20	34.30	22.60	16.90	11.20
0.31	73.90	53.80	35.30	23.30	17.40	11.60
0.32	76.00	55.30	36.40	24.00	17.90	11.90
0.33	78.10	56.90	37.40	24.70	18.40	12.30
0.34	80.20	58.50	38.50	25.40	19.00	12.60
0.35	82.30	60.00	39.50	26.10	19.50	12.90
0.36	84.40	61.50	40.50	26.70	20.00	13.30
0.37	86.50	63.10	41.60	27.40	20.50	13.60
0.38	88.60	64.60	42.60	28.10	21.00	14.00
0.39	90.60	66.20	43.60	28.80	21.50	14.30
0.40	92.70	67.70	44.60	29.50	22.00	14.60
0.41	94.80	69.20	45.70	30.10	22.50	15.00
0.42	96.80	70.70	46.70	30.80	23.00	15.30
0.43	98.90	72.20	47.70	31.50	23.50	15.60
0.44	101.00	73.80	48.70	32.10	24.00	16.00
0.45	103.00	75.30	49.70	32.80	24.50	16.30
0.46	105.00	76.80	50.70	33.50	25.00	16.60
0.47	107.00	78.30	51.80	34.20	25.50	17.00
0.48	109.00	79.80	52.80	34.80	26.00	17.30
0.49	111.00	81.30	53.80	35.50	26.50	17.60
0.50	113.00	82.80	54.80	36.10	27.00	18.00
0.55	123.00	90.20	59.80	39.40	29.50	19.60
0.60	133.00	97.50	64.70	42.70	31.90	21.20
0.65	143.00	105.00	69.60	46.00	34.40	22.90
0.70	152.00	112.00	74.50	49.20	36.80	24.50
0.75	162.00	119.00	79.30	52.40	39.20	26.10
0.80	171.00	126.00	84.10	55.60	41.50	27.60
0.85	181.00	133.00	88.90	58.70	43.90	29.20
0.90	190.00	140.00	93.70	61.90	46.30	30.80
0.95	199.00	147.00	98.40	65.00	48.60	32.30
1.00	209.00	154.00	103.00	68.10	50.90	33.90
1.05	218.00	161.00	108.00	71.20	53.30	35.40
1.10	227.00	168.00	112.00	74.30	55.60	37.00
1.15	236.00	175.00	117.00	77.40	57.90	38.50
1.20	245.00	181.00	122.00	80.40	60.20	40.00
1.25	254.00	188.00	126.00	83.50	62.40	41.50
1.30	263.00	195.00	131.00	86.50	64.70	43.00
1.35	272.00	201.00	135.00	89.50	67.00	44.50
1.40	281.00	208.00	140.00	92.60	69.20	46.00
1.45	289.00	215.00	145.00	95.60	71.50	47.50
1.50	298.00	221.00	149.00	98.50	73.70	49.00
1.55	307.00	228.00	154.00	102.00	75.90	50.50
1.60	316.00	234.00	158.00	104.00	78.10	52.00
1.65	324.00	241.00	163.00	107.00	80.40	53.50
1.70	333.00	247.00	167.00	110.00	82.60	54.90
1.75	341.00	254.00	171.00	113.00	84.80	56.40
1.80	350.00	260.00	176.00	116.00	87.00	57.90
1.85	358.00	267.00	180.00	119.00	89.20	59.30
1.90	367.00	273.00	185.00	122.00	91.30	60.80
1.95	375.00	279.00	189.00	125.00	93.50	62.20
2.00	384.00	286.00	193.00	128.00	95.70	63.70
2.10	400.00	298.00	202.00	134.00	100.00	66.60
2.20	417.00	311.00	211.00	139.00	104.00	69.40
2.30	433.00	324.00	220.00	145.00	109.00	72.30
2.40	450.00	336.00	228.00	151.00	113.00	75.10
2.50	466.00	348.00	237.00	157.00	117.00	77.90
2.60	482.00	361.00	245.00	162.00	121.00	80.80
2.70	498.00	373.00	254.00	168.00	126.00	83.60
2.80	515.00	385.00	262.00	173.00	130.00	86.40
2.90	530.00	397.00	271.00	179.00	134.00	89.10
3.00	546.00	409.00	279.00	185.00	138.00	91.90
3.10	562.00	421.00	287.00	190.00	142.00	94.70
3.20	578.00	433.00	296.00	196.00	146.00	97.40
3.30	594.00	445.00	304.00	201.00	151.00	100.00
3.40	609.00	457.00	312.00	207.00	155.00	103.00
3.50	625.00	469.00	321.00	212.00	159.00	106.00
3.60	640.00	481.00	329.00	218.00	163.00	108.00
3.70	656.00	492.00	337.00	223.00	167.00	111.00
3.80	671.00	504.00	345.00	229.00	171.00	114.00
3.90	686.00	516.00	353.00	234.00	175.00	116.00
4.00	701.00	527.00	361.00	239.00	179.00	119.00
4.10	716.00	539.00	370.00	245.00	183.00	122.00
4.20	732.00	550.00	378.00	250.00	187.00	125.00
4.30	747.00	562.00	386.00	255.00	191.00	127.00
4.40	762.00	573.00	394.00	261.00	195.00	130.00
4.50	777.00	585.00	402.00	266.00	199.00	133.00
4.60	791.00	596.00	410.00	271.00	203.00	135.00
4.70	806.00	608.00	418.00	277.00	207.00	138.00
4.80	821.00	619.00	426.00	282.00	211.00	140.00
4.90	836.00	630.00	434.00	287.00	215.00	143.00
5.00	851.00	641.00	442.00	292.00	219.00	146.00
5.50	923.00	697.00	481.00	319.00	238.00	159.00
6.00	995.00	752.00	520.00	344.00	258.00	172.00
6.50	1,066.00	807.00	559.00	370.00	277.00	184.00
7.00	1,136.00	861.00	597.00	395.00	296.00	197.00
7.50	1,205.00	914.00	635.00	421.00	315.00	210.00
8.00	1,274.00	967.00	672.00	446.00	333.00	222.00
8.50	1,342.00	1,020.00	710.00	470.00	352.00	234.00
9.00	1,409.00	1,071.00	747.00	495.00	370.00	247.00
9.50	1,475.00	1,123.00	784.00	519.00	389.00	259.00
10.00	1,541.00	1,174.00	820.00	544.00	407.00	271.00
15.00	2,174.00	1,666.00	1,175.00	779.00	583.00	388.00
20.00	2,769.00	2,133.00	1,515.00	1,005.00	752.00	501.00
25.00	3,337.00	2,580.00	1,843.00	1,223.00	916.00	610.00

σ_Z						
A	B	C	D	E	F	KM
13.9	10.6	7.44	4.65	3.53	2.33	0.1
15.40	11.60	8.12	5.05	3.82	2.51	0.11
16.90	12.60	8.79	5.45	4.10	2.70	0.12
18.40	13.50	9.46	5.84	4.38	2.88	0.13
19.90	14.50	10.10	6.23	4.66	3.06	0.14
21.40	15.50	10.80	6.62	4.93	3.24	0.15
23.00	16.40	11.40	7.00	5.20	3.41	0.16
24.50	17.40	12.10	7.38	5.46	3.58	0.17
26.10	18.30	12.70	7.76	5.72	3.76	0.18
27.70	19.30	13.40	8.13	5.98	3.93	0.19
29.30	20.20	14.00	8.50	6.24	4.09	0.20
31.00	21.20	14.70	8.87	6.49	4.25	0.21
32.60	22.20	15.30	9.23	6.75	4.41	0.22
34.30	23.20	15.90	9.60	7.00	4.57	0.23
36.00	24.20	16.60	9.96	7.24	4.72	0.24
37.70	25.20	17.20	10.30	7.49	4.88	0.25
39.60	26.20	17.80	10.70	7.74	5.03	0.26
41.50	27.20	18.50	11.00	7.98	5.18	0.27
43.50	28.20	19.10	11.40	8.22	5.33	0.28
45.50	29.20	19.70	11.70	8.46	5.48	0.29
47.40	30.10	20.30	12.10	8.70	5.62	0.30
49.70	31.10	20.90	12.40	8.92	5.77	0.31
52.00	32.10	21.60	12.70	9.13	5.92	0.32
54.30	33.10	22.20	13.10	9.35	6.06	0.33
56.60	34.10	22.80	13.40	9.56	6.20	0.34
59.00	35.10	23.40	13.70	9.77	6.35	0.35
61.30	36.10	24.00	14.00	9.98	6.49	0.36
63.80	37.00	24.60	14.30	10.20	6.63	0.37
66.20	38.00	25.20	14.60	10.40	6.77	0.38
68.70	39.00	25.80	15.00	10.60	6.91	0.39
71.20	40.00	26.40	15.30	10.80	7.05	0.40
74.30	41.10	27.00	15.60	11.00	7.19	0.41
77.40	42.20	27.70	15.90	11.20	7.32	0.42
80.60	43.30	28.30	16.20	11.40	7.46	0.43
83.90	44.40	28.90	16.50	11.60	7.59	0.44
87.20	45.50	29.50	16.80	11.80	7.73	0.45
90.60	46.60	30.10	17.10	12.00	7.86	0.46
94.00	47.70	30.60	17.40	12.20	8.00	0.47
97.50	48.90	31.20	17.70	12.40	8.13	0.48
101.00	50.00	31.80	18.00	12.60	8.26	0.49
105.00	51.10	32.40	18.30	12.80	8.40	0.50
128.00	56.70	35.40	19.80	13.80	9.05	0.55
154.00	62.40	38.30	21.20	14.70	9.69	0.60
182.00	68.10	41.20	22.60	15.60	10.30	0.65
213.00	73.90	44.10	24.00	16.50	10.90	0.70
247.00	79.70	47.00	25.40	17.40	11.50	0.75
283.00	85.60	49.80	26.80	18.30	12.00	0.80
322.00	91.50	52.70	28.10	19.10	12.50	0.85
363.00	97.40	55.50	29.50	20.00	13.00	0.90
407.00	103.00	58.30	30.80	20.80	13.50	0.95
454.00	109.00	61.10	32.10	21.60	14.00	1.00
503.00	115.00	63.90	33.10	22.30	14.40	1.05
555.00	121.00	66.70	34.10	23.00	14.80	1.10
610.00	127.00	69.50	35.10	23.60	15.20	1.15
668.00	134.00	72.20	36.10	24.30	15.70	1.20
728.00	140.00	75.00	37.10	24.90	16.10	1.25
791.00	146.00	77.70	38.00	25.50	16.50	1.30
857.00	152.00	80.50	38.90	26.10	16.90	1.35
925.00	158.00	83.20	39.90	26.70	17.30	1.40
996.00	164.00	85.90	40.80	27.30	17.60	1.45
1,071.00	171.00	88.60	41.70	27.90	18.00	1.50
1,148.00	177.00	91.30	42.60	28.50	18.40	1.55
1,227.00	183.00	94.00	43.40	29.10	18.80	1.60
1,310.00	189.00	96.70	44.30	29.70	19.20	1.65
1,395.00	196.00	99.30	45.20	30.20	19.50	1.70
1,484.00	202.00	102.00	46.00	30.80	19.90	1.75
1,575.00	208.00	105.00	46.90	31.30	20.20	1.80
1,669.00	215.00	107.00	47.70	31.90	20.60	1.85
1,766.00	221.00	110.00	48.50	32.40	20.90	1.90
1,866.00	227.00	113.00	49.30	33.00	21.30	1.95
1,968.00	234.00	115.00	50.20	33.50	21.60	2.00
2,182.00	247.00	121.00	51.80	34.40	22.20	2.10
2,408.00	260.00	126.00	53.30	35.40	22.80	2.20
2,646.00	273.00	131.00	54.90	36.30	23.30	2.30
2,895.00	286.00	136.00	56.40	37.20	23.90	2.40
3,156.00	299.00	141.00	57.90	38.00	24.40	2.50
3,430.00	312.00	147.00	59.40	38.90	25.00	2.60
3,715.00	325.00	152.00	60.80	39.80	25.50	2.70
4,012.00	338.00	157.00	62.30	40.60	26.00	2.80
4,321.00	351.00	162.00	63.70	41.40	26.50	2.90
4,643.00	365.00	167.00	65.10	42.20	27.00	3.00
4,977.00	378.00	172.00	66.40	43.00	27.40	3.10
5,000.00	392.00	177.00	67.70	43.80	27.80	3.20
5,000.00	405.00	182.00	69.00	44.60	28.20	3.30
5,000.00	419.00	187.00	70.20	45.40	28.60	3.40
5,000.00	432.00	192.00	71.50	46.10	29.00	3.50
5,000.00	446.00	197.00	72.70	46.80	29.40	3.60
5,000.00	459.00	202.00	73.90	47.60	29.70	3.70
5,000.00	473.00	207.00	75.10	48.30	30.10	3.80
5,000.00	486.00	212.00	76.30	49.10	30.50	3.90
5,000.00	500.00	217.00	77.50	49.80	30.80	4.00
5,000.00	514.00	222.00	78.70	50.40	31.20	4.10
5,000.00	528.00	227.00	79.80	51.00	31.50	4.20
5,000.00	541.00	232.00	81.00	51.60	31.90	4.30
5,000.00	555.00	237.00	82.10	52.20	32.20	4.40
5,000.00	569.00	242.00	83.20	52.80	32.60	4.50
5,000.00	583.00	247.00	84.30	53.40	32.90	4.60
5,000.00	597.00	252.00	85.40	54.00	33.20	4.70
5,000.00	611.00	257.00	86.50	54.60	33.60	4.80
5,000.00	625.00	262.00	87.60	55.10	33.90	4.90
5,000.00	639.00	266.00	88.70	55.70	34.20	5.00
5,000.00	709.00	291.00	94.00	58.50	35.80	5.50
5,000.00	780.00	315.00	99.00	61.10	37.20	6.00
5,000.00	852.00	339.00	104.00	63.60	38.60	6.50
5,000.00	924.00	362.00	109.00	66.00	40.00	7.00
5,000.00	997.00	386.00	113.00	68.40	41.20	7.50
5,000.00	1,070.00	410.00	118.00	70.60	42.30	8.00
5,000.00	1,144.00	433.00	122.00	72.80	43.40	8.50
5,000.00	1,218.00	456.00	127.00	75.00	44.40	9.00
5,000.00	1,292.00	479.00	131.00	77.00	45.40	9.50
5,000.00	1,367.00	502.00	135.00	79.10	46.40	10.00
5,000.00	2,133.00	728.00	170.00	95.60	54.90	15.00
5,000.00	2,924.00	947.00	200.00	109.00	60.30	20.00
5,000.00	3,735.00	1,161.00	227.00	119.00	64.90	25.00

RELEASE FROM A BULK CONTAINER

	χ (Curies/m³)					
KM	A	B	C	D	E	F
0.1	1.44E-01	6.24E-02	3.98E-03	1.81E-07	6.27E-13	5.13E-30
0.11	1.73E-01	9.24E-02	1.03E-02	2.31E-06	4.92E-11	8.20E-26
0.12	1.93E-01	1.22E-01	2.07E-02	1.68E-05	1.39E-09	2.92E-22
0.13	2.03E-01	1.44E-01	3.53E-02	7.79E-05	2.08E-08	1.56E-19
0.14	2.08E-01	1.67E-01	5.25E-02	2.71E-04	1.91E-07	2.79E-17
0.15	2.07E-01	1.84E-01	7.41E-02	7.48E-04	1.13E-06	2.14E-15
0.16	2.04E-01	1.95E-01	9.29E-02	1.68E-03	5.03E-06	6.86E-14
0.17	1.97E-01	2.05E-01	1.16E-01	3.34E-03	1.71E-05	1.35E-12
0.18	1.90E-01	2.08E-01	1.33E-01	5.94E-03	4.92E-05	2.03E-11
0.19	1.82E-01	2.12E-01	1.53E-01	9.56E-03	1.22E-04	1.87E-10
0.20	1.73E-01	2.11E-01	1.68E-01	1.43E-02	2.69E-04	1.17E-09
0.21	1.64E-01	2.10E-01	1.83E-01	2.03E-02	5.21E-04	5.93E-09
0.22	1.56E-01	2.08E-01	1.93E-01	2.72E-02	9.62E-04	2.51E-08
0.23	1.48E-01	2.04E-01	2.02E-01	3.54E-02	1.62E-03	9.13E-08
0.24	1.40E-01	1.99E-01	2.11E-01	4.42E-02	2.50E-03	2.70E-07
0.25	1.32E-01	1.94E-01	2.16E-01	5.30E-02	3.79E-03	7.70E-07
0.26	1.24E-01	1.88E-01	2.19E-01	6.43E-02	5.49E-03	1.87E-06
0.27	1.17E-01	1.83E-01	2.24E-01	7.24E-02	7.55E-03	4.19E-06
0.28	1.10E-01	1.77E-01	2.24E-01	8.42E-02	1.00E-02	8.80E-06
0.29	1.04E-01	1.71E-01	2.25E-01	9.23E-02	1.30E-02	1.72E-05
0.30	9.84E-02	1.65E-01	2.24E-01	1.04E-01	1.64E-02	3.07E-05
0.31	9.26E-02	1.59E-01	2.23E-01	1.12E-01	1.99E-02	5.41E-05
0.32	8.73E-02	1.54E-01	2.21E-01	1.19E-01	2.36E-02	9.19E-05
0.33	8.23E-02	1.48E-01	2.19E-01	1.29E-01	2.78E-02	1.44E-04
0.34	7.77E-02	1.43E-01	2.16E-01	1.36E-01	3.19E-02	2.19E-04
0.35	7.33E-02	1.38E-01	2.13E-01	1.42E-01	3.64E-02	3.35E-04
0.36	6.94E-02	1.33E-01	2.09E-01	1.48E-01	4.12E-02	4.78E-04
0.37	6.56E-02	1.29E-01	2.05E-01	1.53E-01	4.64E-02	6.71E-04
0.38	6.21E-02	1.24E-01	2.02E-01	1.58E-01	5.12E-02	9.15E-04
0.39	5.89E-02	1.20E-01	1.98E-01	1.65E-01	5.60E-02	1.23E-03
0.40	5.59E-02	1.15E-01	1.94E-01	1.69E-01	6.10E-02	1.62E-03
0.41	5.27E-02	1.11E-01	1.90E-01	1.73E-01	6.60E-02	2.09E-03
0.42	4.98E-02	1.07E-01	1.86E-01	1.76E-01	7.10E-02	2.62E-03
0.43	4.70E-02	1.04E-01	1.82E-01	1.79E-01	7.59E-02	3.30E-03
0.44	4.44E-02	9.98E-02	1.78E-01	1.82E-01	8.09E-02	4.00E-03
0.45	4.21E-02	9.64E-02	1.74E-01	1.84E-01	8.58E-02	4.91E-03
0.46	3.99E-02	9.31E-02	1.70E-01	1.85E-01	9.06E-02	5.86E-03
0.47	3.79E-02	8.99E-02	1.66E-01	1.87E-01	9.54E-02	6.98E-03
0.48	3.59E-02	8.67E-02	1.62E-01	1.88E-01	1.00E-01	8.18E-03
0.49	3.42E-02	8.39E-02	1.59E-01	1.89E-01	1.04E-01	9.50E-03
0.50	3.24E-02	8.11E-02	1.55E-01	1.90E-01	1.09E-01	1.10E-02
0.55	2.47E-02	6.90E-02	1.38E-01	1.90E-01	1.28E-01	2.00E-02
0.60	1.91E-02	5.92E-02	1.23E-01	1.86E-01	1.42E-01	3.16E-02
0.65	1.51E-02	5.12E-02	1.11E-01	1.80E-01	1.52E-01	4.42E-02
0.70	1.22E-02	4.48E-02	9.93E-02	1.72E-01	1.58E-01	5.76E-02
0.75	9.88E-03	3.95E-02	8.96E-02	1.64E-01	1.63E-01	7.14E-02
0.80	8.18E-03	3.50E-02	8.12E-02	1.56E-01	1.65E-01	8.21E-02
0.85	6.80E-03	3.12E-02	7.39E-02	1.48E-01	1.65E-01	9.19E-02
0.90	5.75E-03	2.80E-02	6.75E-02	1.40E-01	1.64E-01	1.01E-01
0.95	4.90E-03	2.53E-02	6.19E-02	1.32E-01	1.61E-01	1.09E-01
1.00	4.19E-03	2.29E-02	5.70E-02	1.25E-01	1.58E-01	1.17E-01
1.05	3.62E-03	2.09E-02	5.24E-02	1.19E-01	1.54E-01	1.21E-01
1.10	3.15E-03	1.91E-02	4.88E-02	1.13E-01	1.50E-01	1.24E-01
1.15	2.76E-03	1.75E-02	4.52E-02	1.07E-01	1.45E-01	1.28E-01
1.20	2.43E-03	1.61E-02	4.19E-02	1.02E-01	1.41E-01	1.32E-01
1.25	2.15E-03	1.48E-02	3.93E-02	9.70E-02	1.37E-01	1.34E-01
1.30	1.91E-03	1.37E-02	3.67E-02	9.26E-02	1.33E-01	1.36E-01
1.35	1.71E-03	1.28E-02	3.45E-02	8.85E-02	1.29E-01	1.37E-01
1.40	1.53E-03	1.19E-02	3.23E-02	8.45E-02	1.25E-01	1.37E-01
1.45	1.38E-03	1.11E-02	3.03E-02	8.09E-02	1.21E-01	1.37E-01
1.50	1.25E-03	1.04E-02	2.87E-02	7.76E-02	1.18E-01	1.37E-01
1.55	1.13E-03	9.74E-03	2.70E-02	7.40E-02	1.14E-01	1.37E-01
1.60	1.03E-03	9.19E-03	2.56E-02	7.18E-02	1.11E-01	1.36E-01
1.65	9.37E-04	8.64E-03	2.42E-02	6.89E-02	1.08E-01	1.36E-01
1.70	8.56E-04	8.14E-03	2.31E-02	6.62E-02	1.04E-01	1.35E-01
1.75	7.86E-04	7.68E-03	2.20E-02	6.38E-02	1.01E-01	1.34E-01
1.80	7.22E-04	7.29E-03	2.08E-02	6.14E-02	9.85E-02	1.32E-01
1.85	6.66E-04	6.87E-03	2.00E-02	5.91E-02	9.57E-02	1.31E-01
1.90	6.14E-04	6.54E-03	1.89E-02	5.71E-02	9.31E-02	1.29E-01
1.95	5.69E-04	6.24E-03	1.81E-02	5.51E-02	9.04E-02	1.28E-01
2.00	5.26E-04	5.90E-03	1.74E-02	5.31E-02	8.80E-02	1.26E-01
2.10	4.56E-04	5.37E-03	1.59E-02	4.96E-02	8.34E-02	1.23E-01
2.20	3.96E-04	4.89E-03	1.46E-02	4.69E-02	7.94E-02	1.20E-01
2.30	3.47E-04	4.48E-03	1.35E-02	4.40E-02	7.50E-02	1.16E-01
2.40	3.05E-04	4.12E-03	1.26E-02	4.14E-02	7.16E-02	1.13E-01
2.50	2.71E-04	3.81E-03	1.17E-02	3.90E-02	6.85E-02	1.09E-01
2.60	2.41E-04	3.52E-03	1.09E-02	3.71E-02	6.55E-02	1.06E-01
2.70	2.15E-04	3.27E-03	1.01E-02	3.51E-02	6.22E-02	1.03E-01
2.80	1.93E-04	3.05E-03	9.52E-03	3.34E-02	5.96E-02	1.00E-01
2.90	1.74E-04	2.85E-03	8.93E-03	3.17E-02	5.72E-02	9.72E-02
3.00	1.57E-04	2.66E-03	8.42E-03	3.02E-02	5.50E-02	9.44E-02
3.10	1.42E-04	2.49E-03	7.96E-03	2.89E-02	5.29E-02	9.16E-02
3.20	1.38E-04	2.34E-03	7.50E-03	2.76E-02	5.09E-02	8.91E-02
3.30	1.34E-04	2.20E-03	7.11E-03	2.65E-02	4.86E-02	8.68E-02
3.40	1.31E-04	2.07E-03	6.74E-03	2.53E-02	4.69E-02	8.42E-02
3.50	1.27E-04	1.96E-03	6.39E-03	2.43E-02	4.53E-02	8.18E-02
3.60	1.24E-04	1.85E-03	6.08E-03	2.33E-02	4.37E-02	8.01E-02
3.70	1.21E-04	1.76E-03	5.79E-03	2.25E-02	4.22E-02	7.79E-02
3.80	1.19E-04	1.67E-03	5.52E-03	2.16E-02	4.08E-02	7.57E-02
3.90	1.16E-04	1.58E-03	5.27E-03	2.09E-02	3.94E-02	7.42E-02
4.00	1.14E-04	1.51E-03	5.04E-03	2.01E-02	3.82E-02	7.22E-02
4.10	1.11E-04	1.43E-03	4.81E-03	1.94E-02	3.71E-02	7.03E-02
4.20	1.09E-04	1.37E-03	4.60E-03	1.88E-02	3.60E-02	6.85E-02
4.30	1.07E-04	1.31E-03	4.41E-03	1.82E-02	3.49E-02	6.72E-02
4.40	1.04E-04	1.25E-03	4.23E-03	1.75E-02	3.39E-02	6.55E-02
4.50	1.02E-04	1.19E-03	4.06E-03	1.70E-02	3.30E-02	6.38E-02
4.60	1.01E-04	1.14E-03	3.90E-03	1.65E-02	3.21E-02	6.27E-02
4.70	9.87E-05	1.09E-03	3.75E-03	1.60E-02	3.12E-02	6.12E-02
4.80	9.69E-05	1.05E-03	3.61E-03	1.55E-02	3.03E-02	6.01E-02
4.90	9.52E-05	1.01E-03	3.48E-03	1.50E-02	2.96E-02	5.86E-02
5.00	9.35E-05	9.70E-04	3.37E-03	1.46E-02	2.88E-02	5.73E-02
5.50	8.62E-05	8.05E-04	2.83E-03	1.27E-02	2.55E-02	5.17E-02
6.00	8.00E-05	6.78E-04	2.42E-03	1.12E-02	2.28E-02	4.70E-02
6.50	7.46E-05	5.78E-04	2.09E-03	9.98E-03	2.05E-02	4.32E-02
7.00	7.00E-05	5.00E-04	1.84E-03	8.95E-03	1.86E-02	3.97E-02
7.50	6.60E-05	4.36E-04	1.62E-03	8.11E-03	1.70E-02	3.66E-02
8.00	6.25E-05	3.84E-04	1.44E-03	7.35E-03	1.57E-02	3.41E-02
8.50	5.93E-05	3.41E-04	1.29E-03	6.76E-03	1.44E-02	3.19E-02
9.00	5.65E-05	3.05E-04	1.17E-03	6.18E-03	1.34E-02	2.98E-02
9.50	5.40E-05	2.74E-04	1.06E-03	5.72E-03	1.24E-02	2.81E-02
10.00	5.16E-05	2.48E-04	9.65E-04	5.30E-03	1.16E-02	2.64E-02
15.00	3.66E-05	1.12E-04	4.65E-04	2.96E-03	6.84E-03	1.64E-02
20.00	2.87E-05	6.38E-05	2.77E-04	1.96E-03	4.70E-03	1.18E-02
25.00	2.38E-05	4.13E-05	1.86E-04	1.42E-03	3.55E-03	9.17E-03

χ (Bq/m³)						
A	B	C	D	E	F	KM
5.33E+09	2.31E+09	1.47E+08	6.69E+03	2.32E-02	1.90E-19	0.1
6.40E+09	3.42E+09	3.80E+08	8.55E+04	1.82E+00	3.04E-15	0.11
7.13E+09	4.51E+09	7.67E+08	6.23E+05	5.15E+01	1.08E-11	0.12
7.52E+09	5.34E+09	1.30E+09	2.88E+06	7.69E+02	5.76E-09	0.13
7.68E+09	6.17E+09	1.94E+09	1.00E+07	7.07E+03	1.03E-06	0.14
7.66E+09	6.82E+09	2.74E+09	2.77E+07	4.17E+04	7.92E-05	0.15
7.54E+09	7.23E+09	3.44E+09	6.23E+07	1.86E+05	2.54E-03	0.16
7.31E+09	7.57E+09	4.28E+09	1.23E+08	6.33E+05	4.98E-02	0.17
7.03E+09	7.71E+09	4.93E+09	2.20E+08	1.82E+06	7.53E-01	0.18
6.73E+09	7.84E+09	5.68E+09	3.54E+08	4.50E+06	6.92E+00	0.19
6.41E+09	7.81E+09	6.20E+09	5.28E+08	9.96E+06	4.32E+01	0.20
6.09E+09	7.78E+09	6.78E+09	7.50E+08	1.93E+07	2.19E+02	0.21
5.77E+09	7.68E+09	7.16E+09	1.01E+09	3.56E+07	9.29E+02	0.22
5.46E+09	7.55E+09	7.46E+09	1.31E+09	5.99E+07	3.38E+03	0.23
5.16E+09	7.36E+09	7.82E+09	1.63E+09	9.26E+07	1.00E+04	0.24
4.88E+09	7.18E+09	7.99E+09	1.96E+09	1.40E+08	2.85E+04	0.25
4.60E+09	6.97E+09	8.12E+09	2.38E+09	2.03E+08	6.92E+04	0.26
4.34E+09	6.76E+09	8.27E+09	2.68E+09	2.79E+08	1.55E+05	0.27
4.09E+09	6.55E+09	8.30E+09	3.11E+09	3.70E+08	3.26E+05	0.28
3.86E+09	6.33E+09	8.32E+09	3.41E+09	4.80E+08	6.36E+05	0.29
3.64E+09	6.12E+09	8.28E+09	3.84E+09	6.07E+08	1.14E+06	0.30
3.43E+09	5.90E+09	8.24E+09	4.13E+09	7.38E+08	2.00E+06	0.31
3.23E+09	5.70E+09	8.18E+09	4.40E+09	8.74E+08	3.40E+06	0.32
3.05E+09	5.49E+09	8.10E+09	4.79E+09	1.03E+09	5.32E+06	0.33
2.87E+09	5.29E+09	7.98E+09	5.03E+09	1.18E+09	8.12E+06	0.34
2.71E+09	5.11E+09	7.86E+09	5.25E+09	1.35E+09	1.24E+07	0.35
2.57E+09	4.93E+09	7.74E+09	5.48E+09	1.52E+09	1.77E+07	0.36
2.43E+09	4.75E+09	7.60E+09	5.68E+09	1.72E+09	2.48E+07	0.37
2.30E+09	4.59E+09	7.46E+09	5.86E+09	1.89E+09	3.39E+07	0.38
2.18E+09	4.42E+09	7.32E+09	6.12E+09	2.07E+09	4.55E+07	0.39
2.07E+09	4.27E+09	7.18E+09	6.26E+09	2.26E+09	6.01E+07	0.40
1.95E+09	4.12E+09	7.02E+09	6.41E+09	2.44E+09	7.74E+07	0.41
1.84E+09	3.97E+09	6.88E+09	6.52E+09	2.63E+09	9.70E+07	0.42
1.74E+09	3.83E+09	6.73E+09	6.62E+09	2.81E+09	1.22E+08	0.43
1.64E+09	3.69E+09	6.59E+09	6.72E+09	2.99E+09	1.48E+08	0.44
1.56E+09	3.57E+09	6.44E+09	6.79E+09	3.17E+09	1.82E+08	0.45
1.48E+09	3.44E+09	6.30E+09	6.85E+09	3.35E+09	2.17E+08	0.46
1.40E+09	3.33E+09	6.15E+09	6.90E+09	3.53E+09	2.58E+08	0.47
1.33E+09	3.21E+09	6.01E+09	6.96E+09	3.70E+09	3.03E+08	0.48
1.26E+09	3.10E+09	5.87E+09	6.99E+09	3.87E+09	3.51E+08	0.49
1.20E+09	3.00E+09	5.74E+09	7.03E+09	4.03E+09	4.07E+08	0.50
9.13E+08	2.55E+09	5.11E+09	7.04E+09	4.75E+09	7.41E+08	0.55
7.07E+08	2.19E+09	4.57E+09	6.88E+09	5.25E+09	1.17E+09	0.60
5.59E+08	1.89E+09	4.09E+09	6.65E+09	5.61E+09	1.63E+09	0.65
4.51E+08	1.66E+09	3.67E+09	6.37E+09	5.86E+09	2.13E+09	0.70
3.66E+08	1.46E+09	3.32E+09	6.08E+09	6.02E+09	2.64E+09	0.75
3.03E+08	1.29E+09	3.00E+09	5.77E+09	6.11E+09	3.04E+09	0.80
2.52E+08	1.16E+09	2.73E+09	5.47E+09	6.09E+09	3.40E+09	0.85
2.13E+08	1.04E+09	2.50E+09	5.17E+09	6.05E+09	3.74E+09	0.90
1.81E+08	9.38E+08	2.29E+09	4.89E+09	5.96E+09	4.05E+09	0.95
1.55E+08	8.49E+08	2.11E+09	4.63E+09	5.85E+09	4.32E+09	1.00
1.34E+08	7.72E+08	1.94E+09	4.39E+09	5.69E+09	4.48E+09	1.05
1.17E+08	7.05E+08	1.81E+09	4.17E+09	5.55E+09	4.61E+09	1.10
1.02E+08	6.47E+08	1.67E+09	3.96E+09	5.38E+09	4.72E+09	1.15
8.99E+07	5.94E+08	1.55E+09	3.77E+09	5.23E+09	4.89E+09	1.20
7.96E+07	5.48E+08	1.45E+09	3.59E+09	5.08E+09	4.96E+09	1.25
7.07E+07	5.08E+08	1.36E+09	3.43E+09	4.93E+09	5.02E+09	1.30
6.31E+07	4.74E+08	1.28E+09	3.26E+09	4.77E+09	5.06E+09	1.35
5.66E+07	4.41E+08	1.20E+09	3.13E+09	4.63E+09	5.09E+09	1.40
5.11E+07	4.12E+08	1.12E+09	2.99E+09	4.49E+09	5.06E+09	1.45
4.61E+07	3.84E+08	1.06E+09	2.87E+09	4.36E+09	5.06E+09	1.50
4.18E+07	3.60E+08	1.00E+09	2.74E+09	4.23E+09	5.06E+09	1.55
3.80E+07	3.40E+08	9.49E+08	2.66E+09	4.10E+09	5.05E+09	1.60
3.47E+07	3.20E+08	8.96E+08	2.55E+09	3.98E+09	5.02E+09	1.65
3.17E+07	3.01E+08	8.54E+08	2.45E+09	3.86E+09	4.98E+09	1.70
2.91E+07	2.84E+08	8.13E+08	2.36E+09	3.75E+09	4.94E+09	1.75
2.67E+07	2.70E+08	7.69E+08	2.27E+09	3.64E+09	4.88E+09	1.80
2.46E+07	2.54E+08	7.39E+08	2.19E+09	3.54E+09	4.85E+09	1.85
2.27E+07	2.42E+08	7.01E+08	2.11E+09	3.44E+09	4.78E+09	1.90
2.10E+07	2.31E+08	6.69E+08	2.04E+09	3.35E+09	4.74E+09	1.95
1.95E+07	2.18E+08	6.44E+08	1.97E+09	3.25E+09	4.67E+09	2.00
1.69E+07	1.99E+08	5.87E+08	1.84E+09	3.09E+09	4.55E+09	2.10
1.47E+07	1.81E+08	5.40E+08	1.73E+09	2.94E+09	4.42E+09	2.20
1.28E+07	1.66E+08	4.99E+08	1.63E+09	2.78E+09	4.29E+09	2.30
1.13E+07	1.52E+08	4.65E+08	1.53E+09	2.65E+09	4.17E+09	2.40
1.00E+07	1.41E+08	4.32E+08	1.44E+09	2.53E+09	4.05E+09	2.50
8.90E+06	1.30E+08	4.02E+08	1.37E+09	2.42E+09	3.93E+09	2.60
7.96E+06	1.21E+08	3.75E+08	1.30E+09	2.30E+09	3.81E+09	2.70
7.12E+06	1.13E+08	3.52E+08	1.24E+09	2.21E+09	3.70E+09	2.80
6.43E+06	1.05E+08	3.30E+08	1.17E+09	2.12E+09	3.60E+09	2.90
5.81E+06	9.83E+07	3.12E+08	1.12E+09	2.03E+09	3.49E+09	3.00
5.26E+06	9.23E+07	2.94E+08	1.07E+09	1.96E+09	3.39E+09	3.10
5.09E+06	8.65E+07	2.78E+08	1.02E+09	1.88E+09	3.30E+09	3.20
4.96E+06	8.15E+07	2.63E+08	9.79E+08	1.80E+09	3.21E+09	3.30
4.83E+06	7.67E+07	2.50E+08	9.37E+08	1.73E+09	3.12E+09	3.40
4.71E+06	7.25E+07	2.36E+08	9.01E+08	1.67E+09	3.02E+09	3.50
4.60E+06	6.85E+07	2.25E+08	8.63E+08	1.62E+09	2.97E+09	3.60
4.49E+06	6.51E+07	2.14E+08	8.32E+08	1.56E+09	2.88E+09	3.70
4.39E+06	6.16E+07	2.04E+08	7.99E+08	1.51E+09	2.80E+09	3.80
4.29E+06	5.86E+07	1.95E+08	7.72E+08	1.46E+09	2.75E+09	3.90
4.20E+06	5.58E+07	1.86E+08	7.45E+08	1.41E+09	2.67E+09	4.00
4.11E+06	5.31E+07	1.78E+08	7.17E+08	1.37E+09	2.60E+09	4.10
4.02E+06	5.06E+07	1.70E+08	6.94E+08	1.33E+09	2.53E+09	4.20
3.94E+06	4.84E+07	1.63E+08	6.72E+08	1.29E+09	2.49E+09	4.30
3.86E+06	4.62E+07	1.57E+08	6.49E+08	1.26E+09	2.42E+09	4.40
3.79E+06	4.42E+07	1.50E+08	6.29E+08	1.22E+09	2.36E+09	4.50
3.72E+06	4.23E+07	1.44E+08	6.10E+08	1.19E+09	2.32E+09	4.60
3.65E+06	4.05E+07	1.39E+08	5.90E+08	1.15E+09	2.26E+09	4.70
3.59E+06	3.89E+07	1.34E+08	5.73E+08	1.12E+09	2.22E+09	4.80
3.52E+06	3.74E+07	1.29E+08	5.57E+08	1.09E+09	2.17E+09	4.90
3.46E+06	3.59E+07	1.25E+08	5.41E+08	1.07E+09	2.12E+09	5.00
3.19E+06	2.98E+07	1.05E+08	4.70E+08	9.44E+08	1.91E+09	5.50
2.96E+06	2.51E+07	8.95E+07	4.16E+08	8.42E+08	1.74E+09	6.00
2.76E+06	2.14E+07	7.74E+07	3.69E+08	7.60E+08	1.60E+09	6.50
2.59E+06	1.85E+07	6.79E+07	3.31E+08	6.90E+08	1.47E+09	7.00
2.44E+06	1.61E+07	5.99E+07	3.00E+08	6.29E+08	1.36E+09	7.50
2.31E+06	1.42E+07	5.33E+07	2.72E+08	5.79E+08	1.26E+09	8.00
2.19E+06	1.26E+07	4.78E+07	2.50E+08	5.34E+08	1.18E+09	8.50
2.09E+06	1.13E+07	4.31E+07	2.29E+08	4.95E+08	1.10E+09	9.00
2.00E+06	1.01E+07	3.91E+07	2.12E+08	4.60E+08	1.04E+09	9.50
1.91E+06	9.17E+06	3.57E+07	1.96E+08	4.30E+08	9.78E+08	10.00
1.35E+06	4.14E+06	1.72E+07	1.10E+08	2.53E+08	6.08E+08	15.00
1.06E+06	2.36E+06	1.03E+07	7.25E+07	1.74E+08	4.38E+08	20.00
8.82E+05	1.53E+06	6.88E+06	5.26E+07	1.31E+08	3.39E+08	25.00

RELEASE FROM A BULK CONTAINER

	INFANT	ADULT
Inhalation rate (m3/year)	1.40E+03	8.40E+03
Inhalation rate (m3/s)	4.44E-05	2.66E-04
Inhalation DCF for HTO (mSv/Bq)	5.80E-08	2.00E-08
Inhalation DCF for HT (mSv/Bq)	1.20E-11	2.40E-12
Skin absorption DCF for HTO (mSv/Bq)	5.80E-08	2.00E-08

	Total dose to infant (mSv)					
KM	A	B	C	D	E	F
0.1	0.069	0.030	0.002	0.000	0.000	0.000
0.11	0.082	0.044	0.005	0.000	0.000	0.000
0.12	0.092	0.058	0.010	0.000	0.000	0.000
0.13	0.097	0.069	0.017	0.000	0.000	0.000
0.14	0.099	0.079	0.025	0.000	0.000	0.000
0.15	0.099	0.088	0.035	0.000	0.000	0.000
0.16	0.097	0.093	0.044	0.001	0.000	0.000
0.17	0.094	0.097	0.055	0.002	0.000	0.000
0.18	0.091	0.099	0.064	0.003	0.000	0.000
0.19	0.087	0.101	0.073	0.005	0.000	0.000
0.20	0.083	0.101	0.080	0.007	0.000	0.000
0.21	0.078	0.100	0.087	0.010	0.000	0.000
0.22	0.074	0.099	0.092	0.013	0.000	0.000
0.23	0.070	0.097	0.096	0.017	0.001	0.000
0.24	0.066	0.095	0.101	0.021	0.001	0.000
0.25	0.063	0.092	0.103	0.025	0.002	0.000
0.26	0.059	0.090	0.105	0.031	0.003	0.000
0.27	0.056	0.087	0.107	0.034	0.004	0.000
0.28	0.053	0.084	0.107	0.040	0.005	0.000
0.29	0.050	0.082	0.107	0.044	0.006	0.000
0.30	0.047	0.079	0.107	0.050	0.008	0.000
0.31	0.044	0.076	0.106	0.053	0.009	0.000
0.32	0.042	0.073	0.105	0.057	0.011	0.000
0.33	0.039	0.071	0.104	0.062	0.013	0.000
0.34	0.037	0.068	0.103	0.065	0.015	0.000
0.35	0.035	0.066	0.101	0.068	0.017	0.000
0.36	0.033	0.063	0.100	0.071	0.020	0.000
0.37	0.031	0.061	0.098	0.073	0.022	0.000
0.38	0.030	0.059	0.096	0.075	0.024	0.000
0.39	0.028	0.057	0.094	0.079	0.027	0.001
0.40	0.027	0.055	0.092	0.081	0.029	0.001
0.41	0.025	0.053	0.090	0.083	0.031	0.001
0.42	0.024	0.051	0.089	0.084	0.034	0.001
0.43	0.022	0.049	0.087	0.085	0.036	0.002
0.44	0.021	0.048	0.085	0.087	0.039	0.002
0.45	0.020	0.046	0.083	0.088	0.041	0.002
0.46	0.019	0.044	0.081	0.088	0.043	0.003
0.47	0.018	0.043	0.079	0.089	0.045	0.003
0.48	0.017	0.041	0.077	0.090	0.048	0.004
0.49	0.016	0.040	0.076	0.090	0.050	0.005
0.50	0.015	0.039	0.074	0.091	0.052	0.005
0.55	0.012	0.033	0.066	0.091	0.061	0.010
0.60	0.009	0.028	0.059	0.089	0.068	0.015
0.65	0.007	0.024	0.053	0.086	0.072	0.021
0.70	0.006	0.021	0.047	0.082	0.076	0.027
0.75	0.005	0.019	0.043	0.078	0.078	0.034
0.80	0.004	0.017	0.039	0.074	0.079	0.039
0.85	0.003	0.015	0.035	0.070	0.078	0.044
0.90	0.003	0.013	0.032	0.067	0.078	0.048
0.95	0.002	0.012	0.029	0.063	0.077	0.052
1.00	0.002	0.011	0.027	0.060	0.075	0.056
1.05	0.002	0.010	0.025	0.057	0.073	0.058
1.10	0.002	0.009	0.023	0.054	0.071	0.059
1.15	0.001	0.008	0.022	0.051	0.069	0.061
1.20	0.001	0.008	0.020	0.049	0.067	0.063
1.25	0.001	0.007	0.019	0.046	0.065	0.064
1.30	0.001	0.007	0.017	0.044	0.063	0.065
1.35	0.001	0.006	0.016	0.042	0.061	0.065
1.40	0.001	0.006	0.015	0.040	0.060	0.066
1.45	0.001	0.005	0.014	0.039	0.058	0.065
1.50	0.001	0.005	0.014	0.037	0.056	0.065
1.55	0.001	0.005	0.013	0.035	0.054	0.065
1.60	0.000	0.004	0.012	0.034	0.053	0.065
1.65	0.000	0.004	0.012	0.033	0.051	0.065
1.70	0.000	0.004	0.011	0.032	0.050	0.064
1.75	0.000	0.004	0.010	0.030	0.048	0.064
1.80	0.000	0.003	0.010	0.029	0.047	0.063
1.85	0.000	0.003	0.010	0.028	0.046	0.062
1.90	0.000	0.003	0.009	0.027	0.044	0.062
1.95	0.000	0.003	0.009	0.026	0.043	0.061
2.00	0.000	0.003	0.008	0.025	0.042	0.060
2.10	0.000	0.003	0.008	0.024	0.040	0.059
2.20	0.000	0.002	0.007	0.022	0.038	0.057
2.30	0.000	0.002	0.006	0.021	0.036	0.055
2.40	0.000	0.002	0.006	0.020	0.034	0.054
2.50	0.000	0.002	0.006	0.019	0.033	0.052
2.60	0.000	0.002	0.005	0.018	0.031	0.051
2.70	0.000	0.002	0.005	0.017	0.030	0.049
2.80	0.000	0.001	0.005	0.016	0.028	0.048
2.90	0.000	0.001	0.004	0.015	0.027	0.046
3.00	0.000	0.001	0.004	0.014	0.026	0.045
3.10	0.000	0.001	0.004	0.014	0.025	0.044
3.20	0.000	0.001	0.004	0.013	0.024	0.042
3.30	0.000	0.001	0.003	0.013	0.023	0.041
3.40	0.000	0.001	0.003	0.012	0.022	0.040
3.50	0.000	0.001	0.003	0.012	0.022	0.039
3.60	0.000	0.001	0.003	0.011	0.021	0.038
3.70	0.000	0.001	0.003	0.011	0.020	0.037
3.80	0.000	0.001	0.003	0.010	0.019	0.036
3.90	0.000	0.001	0.003	0.010	0.019	0.035
4.00	0.000	0.001	0.002	0.010	0.018	0.034
4.10	0.000	0.001	0.002	0.009	0.018	0.033
4.20	0.000	0.001	0.002	0.009	0.017	0.033
4.30	0.000	0.001	0.002	0.009	0.017	0.032
4.40	0.000	0.001	0.002	0.008	0.016	0.031
4.50	0.000	0.001	0.002	0.008	0.016	0.030
4.60	0.000	0.001	0.002	0.008	0.015	0.030
4.70	0.000	0.001	0.002	0.008	0.015	0.029
4.80	0.000	0.001	0.002	0.007	0.014	0.029
4.90	0.000	0.000	0.002	0.007	0.014	0.028
5.00	0.000	0.000	0.002	0.007	0.014	0.027
5.50	0.000	0.000	0.001	0.006	0.012	0.025
6.00	0.000	0.000	0.001	0.005	0.011	0.022
6.50	0.000	0.000	0.001	0.005	0.010	0.021
7.00	0.000	0.000	0.001	0.004	0.009	0.019
7.50	0.000	0.000	0.001	0.004	0.008	0.017
8.00	0.000	0.000	0.001	0.004	0.007	0.016
8.50	0.000	0.000	0.001	0.003	0.007	0.015
9.00	0.000	0.000	0.001	0.003	0.006	0.014
9.50	0.000	0.000	0.001	0.003	0.006	0.013
10.00	0.000	0.000	0.000	0.003	0.006	0.013
15.00	0.000	0.000	0.000	0.001	0.003	0.008
20.00	0.000	0.000	0.000	0.001	0.002	0.006
25.00	0.000	0.000	0.000	0.001	0.002	0.004

Total dose to adult (mSv)						
A	B	C	D	E	F	KM
0.142	0.062	0.004	0.000	0.000	0.000	0.1
0.170	0.091	0.010	0.000	0.000	0.000	0.11
0.190	0.120	0.020	0.000	0.000	0.000	0.12
0.200	0.142	0.035	0.000	0.000	0.000	0.13
0.205	0.164	0.052	0.000	0.000	0.000	0.14
0.204	0.182	0.073	0.001	0.000	0.000	0.15
0.201	0.193	0.092	0.002	0.000	0.000	0.16
0.195	0.202	0.114	0.003	0.000	0.000	0.17
0.187	0.205	0.131	0.006	0.000	0.000	0.18
0.179	0.209	0.151	0.009	0.000	0.000	0.19
0.171	0.208	0.165	0.014	0.000	0.000	0.20
0.162	0.207	0.181	0.020	0.001	0.000	0.21
0.154	0.205	0.191	0.027	0.001	0.000	0.22
0.145	0.201	0.199	0.035	0.002	0.000	0.23
0.138	0.196	0.208	0.044	0.002	0.000	0.24
0.130	0.191	0.213	0.052	0.004	0.000	0.25
0.122	0.186	0.216	0.063	0.005	0.000	0.26
0.116	0.180	0.220	0.071	0.007	0.000	0.27
0.109	0.175	0.221	0.083	0.010	0.000	0.28
0.103	0.169	0.222	0.091	0.013	0.000	0.29
0.097	0.163	0.221	0.102	0.016	0.000	0.30
0.091	0.157	0.219	0.110	0.020	0.000	0.31
0.086	0.152	0.218	0.117	0.023	0.000	0.32
0.081	0.146	0.216	0.128	0.027	0.000	0.33
0.077	0.141	0.212	0.134	0.031	0.000	0.34
0.072	0.136	0.210	0.140	0.036	0.000	0.35
0.068	0.131	0.206	0.146	0.041	0.000	0.36
0.065	0.127	0.202	0.151	0.046	0.001	0.37
0.061	0.122	0.199	0.156	0.050	0.001	0.38
0.058	0.118	0.195	0.163	0.055	0.001	0.39
0.055	0.114	0.191	0.167	0.060	0.002	0.40
0.052	0.110	0.187	0.171	0.065	0.002	0.41
0.049	0.106	0.183	0.174	0.070	0.003	0.42
0.046	0.102	0.179	0.176	0.075	0.003	0.43
0.044	0.098	0.175	0.179	0.080	0.004	0.44
0.042	0.095	0.172	0.181	0.085	0.005	0.45
0.039	0.092	0.168	0.183	0.089	0.006	0.46
0.037	0.089	0.164	0.184	0.094	0.007	0.47
0.035	0.086	0.160	0.185	0.099	0.008	0.48
0.034	0.083	0.156	0.186	0.103	0.009	0.49
0.032	0.080	0.153	0.187	0.107	0.011	0.50
0.024	0.068	0.136	0.188	0.127	0.020	0.55
0.019	0.058	0.122	0.183	0.140	0.031	0.60
0.015	0.050	0.109	0.177	0.149	0.044	0.65
0.012	0.044	0.098	0.170	0.156	0.057	0.70
0.010	0.039	0.088	0.162	0.160	0.070	0.75
0.008	0.034	0.080	0.154	0.163	0.081	0.80
0.007	0.031	0.073	0.146	0.162	0.091	0.85
0.006	0.028	0.067	0.138	0.161	0.100	0.90
0.005	0.025	0.061	0.130	0.159	0.108	0.95
0.004	0.023	0.056	0.123	0.156	0.115	1.00
0.004	0.021	0.052	0.117	0.152	0.119	1.05
0.003	0.019	0.048	0.111	0.148	0.123	1.10
0.003	0.017	0.045	0.105	0.143	0.126	1.15
0.002	0.016	0.041	0.100	0.139	0.130	1.20
0.002	0.015	0.039	0.096	0.135	0.132	1.25
0.002	0.014	0.036	0.091	0.131	0.134	1.30
0.002	0.013	0.034	0.087	0.127	0.135	1.35
0.002	0.012	0.032	0.083	0.123	0.136	1.40
0.001	0.011	0.030	0.080	0.120	0.135	1.45
0.001	0.010	0.028	0.076	0.116	0.135	1.50
0.001	0.010	0.027	0.073	0.113	0.135	1.55
0.001	0.009	0.025	0.071	0.109	0.134	1.60
0.001	0.009	0.024	0.068	0.106	0.134	1.65
0.001	0.008	0.023	0.065	0.103	0.133	1.70
0.001	0.008	0.022	0.063	0.100	0.132	1.75
0.001	0.007	0.020	0.060	0.097	0.130	1.80
0.001	0.007	0.020	0.058	0.094	0.129	1.85
0.001	0.006	0.019	0.056	0.092	0.127	1.90
0.001	0.006	0.018	0.054	0.089	0.126	1.95
0.001	0.006	0.017	0.052	0.087	0.125	2.00
0.000	0.005	0.016	0.049	0.082	0.121	2.10
0.000	0.005	0.014	0.046	0.078	0.118	2.20
0.000	0.004	0.013	0.043	0.074	0.114	2.30
0.000	0.004	0.012	0.041	0.071	0.111	2.40
0.000	0.004	0.012	0.038	0.068	0.108	2.50
0.000	0.003	0.011	0.037	0.065	0.105	2.60
0.000	0.003	0.010	0.035	0.061	0.102	2.70
0.000	0.003	0.009	0.033	0.059	0.099	2.80
0.000	0.003	0.009	0.031	0.056	0.096	2.90
0.000	0.003	0.008	0.030	0.054	0.093	3.00
0.000	0.002	0.008	0.028	0.052	0.090	3.10
0.000	0.002	0.007	0.027	0.050	0.088	3.20
0.000	0.002	0.007	0.026	0.048	0.086	3.30
0.000	0.002	0.007	0.025	0.046	0.083	3.40
0.000	0.002	0.006	0.024	0.045	0.081	3.50
0.000	0.002	0.006	0.023	0.043	0.079	3.60
0.000	0.002	0.006	0.022	0.042	0.077	3.70
0.000	0.002	0.005	0.021	0.040	0.075	3.80
0.000	0.002	0.005	0.021	0.039	0.073	3.90
0.000	0.001	0.005	0.020	0.038	0.071	4.00
0.000	0.001	0.005	0.019	0.037	0.069	4.10
0.000	0.001	0.005	0.019	0.035	0.067	4.20
0.000	0.001	0.004	0.018	0.034	0.066	4.30
0.000	0.001	0.004	0.017	0.033	0.065	4.40
0.000	0.001	0.004	0.017	0.032	0.063	4.50
0.000	0.001	0.004	0.016	0.032	0.062	4.60
0.000	0.001	0.004	0.016	0.031	0.060	4.70
0.000	0.001	0.004	0.015	0.030	0.059	4.80
0.000	0.001	0.003	0.015	0.029	0.058	4.90
0.000	0.001	0.003	0.014	0.028	0.056	5.00
0.000	0.001	0.003	0.013	0.025	0.051	5.50
0.000	0.001	0.002	0.011	0.022	0.046	6.00
0.000	0.001	0.002	0.010	0.020	0.043	6.50
0.000	0.000	0.002	0.009	0.018	0.039	7.00
0.000	0.000	0.002	0.008	0.017	0.036	7.50
0.000	0.000	0.001	0.007	0.015	0.034	8.00
0.000	0.000	0.001	0.007	0.014	0.031	8.50
0.000	0.000	0.001	0.006	0.013	0.029	9.00
0.000	0.000	0.001	0.006	0.012	0.028	9.50
0.000	0.000	0.001	0.005	0.011	0.026	10.00
0.000	0.000	0.000	0.003	0.007	0.016	15.00
0.000	0.000	0.000	0.002	0.005	0.012	20.00
0.000	0.000	0.000	0.001	0.004	0.009	25.00

APPENDIX J

RELEASE FROM A TORNADO

Release (curies)	97,297.0
Time of release "t" (seconds)	10.0
Wind velocity "V" (meters/second)	55.5
Effective height of release "H" (meters)	1.0
Rate of release "Q" (curies/second)	9,729.7
Percentage of release that is HTO	25.0
Percentage of release that is HT	75.0

	σ_Y	σ_Z	
KM	A	A	KM
0.1	26.9	13.9	0.1
0.11	29.30	15.40	0.11
0.12	31.60	16.90	0.12
0.13	34.00	18.40	0.13
0.14	36.30	19.90	0.14
0.15	38.60	21.40	0.15
0.16	40.90	23.00	0.16
0.17	43.20	24.50	0.17
0.18	45.50	26.10	0.18
0.19	47.70	27.70	0.19
0.20	50.00	29.30	0.20
0.21	52.20	31.00	0.21
0.22	54.40	32.60	0.22
0.23	56.60	34.30	0.23
0.24	58.80	36.00	0.24
0.25	61.00	37.70	0.25
0.26	63.20	39.60	0.26
0.27	65.30	41.50	0.27
0.28	67.50	43.50	0.28
0.29	69.60	45.50	0.29
0.30	71.80	47.40	0.30
0.31	73.90	49.70	0.31
0.32	76.00	52.00	0.32
0.33	78.10	54.30	0.33
0.34	80.20	56.60	0.34
0.35	82.30	59.00	0.35
0.36	84.40	61.30	0.36
0.37	86.50	63.80	0.37
0.38	88.60	66.20	0.38
0.39	90.60	68.70	0.39
0.40	92.70	71.20	0.40
0.41	94.80	74.30	0.41
0.42	96.80	77.40	0.42
0.43	98.90	80.60	0.43
0.44	101.00	83.90	0.44
0.45	103.00	87.20	0.45
0.46	105.00	90.60	0.46
0.47	107.00	94.00	0.47
0.48	109.00	97.50	0.48
0.49	111.00	101.00	0.49
0.50	113.00	105.00	0.50
0.55	123.00	128.00	0.55
0.60	133.00	154.00	0.60
0.65	143.00	182.00	0.65
0.70	152.00	213.00	0.70
0.75	162.00	247.00	0.75
0.80	171.00	283.00	0.80
0.85	181.00	322.00	0.85
0.90	190.00	363.00	0.90
0.95	199.00	407.00	0.95
1.00	209.00	454.00	1.00
1.05	218.00	503.00	1.05
1.10	227.00	555.00	1.10
1.15	236.00	610.00	1.15
1.20	245.00	668.00	1.20
1.25	254.00	728.00	1.25
1.30	263.00	791.00	1.30
1.35	272.00	857.00	1.35
1.40	281.00	925.00	1.40
1.45	289.00	996.00	1.45
1.50	298.00	1,071.00	1.50
1.55	307.00	1,148.00	1.55
1.60	316.00	1,227.00	1.60
1.65	324.00	1,310.00	1.65
1.70	333.00	1,395.00	1.70
1.75	341.00	1,484.00	1.75
1.80	350.00	1,575.00	1.80
1.85	358.00	1,669.00	1.85
1.90	367.00	1,766.00	1.90
1.95	375.00	1,866.00	1.95
2.00	384.00	1,968.00	2.00
2.10	400.00	2,182.00	2.10
2.20	417.00	2,408.00	2.20
2.30	433.00	2,646.00	2.30
2.40	450.00	2,895.00	2.40
2.50	466.00	3,156.00	2.50
2.60	482.00	3,430.00	2.60
2.70	498.00	3,715.00	2.70
2.80	515.00	4,012.00	2.80
2.90	530.00	4,321.00	2.90
3.00	546.00	4,643.00	3.00
3.10	562.00	4,977.00	3.10
3.20	578.00	5,000.00	3.20
3.30	594.00	5,000.00	3.30
3.40	609.00	5,000.00	3.40
3.50	625.00	5,000.00	3.50
3.60	640.00	5,000.00	3.60
3.70	656.00	5,000.00	3.70
3.80	671.00	5,000.00	3.80
3.90	686.00	5,000.00	3.90
4.00	701.00	5,000.00	4.00
4.10	716.00	5,000.00	4.10
4.20	732.00	5,000.00	4.20
4.30	747.00	5,000.00	4.30
4.40	762.00	5,000.00	4.40
4.50	777.00	5,000.00	4.50
4.60	791.00	5,000.00	4.60
4.70	806.00	5,000.00	4.70
4.80	821.00	5,000.00	4.80
4.90	836.00	5,000.00	4.90
5.00	851.00	5,000.00	5.00
5.50	923.00	5,000.00	5.50
6.00	995.00	5,000.00	6.00
6.50	1,066.00	5,000.00	6.50
7.00	1,136.00	5,000.00	7.00
7.50	1,205.00	5,000.00	7.50
8.00	1,274.00	5,000.00	8.00
8.50	1,342.00	5,000.00	8.50
9.00	1,409.00	5,000.00	9.00
9.50	1,475.00	5,000.00	9.50
10.00	1,541.00	5,000.00	10.00
15.00	2,174.00	5,000.00	15.00
20.00	2,769.00	5,000.00	20.00
25.00	3,337.00	5,000.00	25.00

RELEASE FROM A TORNADO

KM	χ (Curies/m³) A
0.1	1.49E-01
0.11	1.23E-01
0.12	1.04E-01
0.13	8.91E-02
0.14	7.72E-02
0.15	6.75E-02
0.16	5.93E-02
0.17	5.27E-02
0.18	4.70E-02
0.19	4.22E-02
0.20	3.81E-02
0.21	3.45E-02
0.22	3.15E-02
0.23	2.87E-02
0.24	2.64E-02
0.25	2.43E-02
0.26	2.23E-02
0.27	2.06E-02
0.28	1.90E-02
0.29	1.76E-02
0.30	1.64E-02
0.31	1.52E-02
0.32	1.41E-02
0.33	1.32E-02
0.34	1.23E-02
0.35	1.15E-02
0.36	1.08E-02
0.37	1.01E-02
0.38	9.51E-03
0.39	8.96E-03
0.40	8.45E-03
0.41	7.92E-03
0.42	7.45E-03
0.43	7.00E-03
0.44	6.58E-03
0.45	6.21E-03
0.46	5.87E-03
0.47	5.55E-03
0.48	5.25E-03
0.49	4.98E-03
0.50	4.70E-03
0.55	3.54E-03
0.60	2.72E-03
0.65	2.14E-03
0.70	1.72E-03
0.75	1.39E-03
0.80	1.15E-03
0.85	9.57E-04
0.90	8.09E-04
0.95	6.89E-04
1.00	5.88E-04
1.05	5.09E-04
1.10	4.43E-04
1.15	3.88E-04
1.20	3.41E-04
1.25	3.02E-04
1.30	2.68E-04
1.35	2.39E-04
1.40	2.15E-04
1.45	1.94E-04
1.50	1.75E-04
1.55	1.58E-04
1.60	1.44E-04
1.65	1.31E-04
1.70	1.20E-04
1.75	1.10E-04
1.80	1.01E-04
1.85	9.34E-05
1.90	8.61E-05
1.95	7.97E-05
2.00	7.38E-05
2.10	6.39E-05
2.20	5.56E-05
2.30	4.87E-05
2.40	4.28E-05
2.50	3.79E-05
2.60	3.38E-05
2.70	3.02E-05
2.80	2.70E-05
2.90	2.44E-05
3.00	2.20E-05
3.10	2.00E-05
3.20	1.93E-05
3.30	1.88E-05
3.40	1.83E-05
3.50	1.79E-05
3.60	1.74E-05
3.70	1.70E-05
3.80	1.66E-05
3.90	1.63E-05
4.00	1.59E-05
4.10	1.56E-05
4.20	1.52E-05
4.30	1.49E-05
4.40	1.46E-05
4.50	1.44E-05
4.60	1.41E-05
4.70	1.38E-05
4.80	1.36E-05
4.90	1.33E-05
5.00	1.31E-05
5.50	1.21E-05
6.00	1.12E-05
6.50	1.05E-05
7.00	9.82E-06
7.50	9.26E-06
8.00	8.76E-06
8.50	8.32E-06
9.00	7.92E-06
9.50	7.57E-06
10.00	7.24E-06
15.00	5.13E-06
20.00	4.03E-06
25.00	3.34E-06

χ (Bq/m³) A	KM
5.51E+09	0.1
4.57E+09	0.11
3.86E+09	0.12
3.30E+09	0.13
2.85E+09	0.14
2.50E+09	0.15
2.19E+09	0.16
1.95E+09	0.17
1.74E+09	0.18
1.56E+09	0.19
1.41E+09	0.20
1.28E+09	0.21
1.16E+09	0.22
1.06E+09	0.23
9.75E+08	0.24
8.98E+08	0.25
8.25E+08	0.26
7.62E+08	0.27
7.03E+08	0.28
6.52E+08	0.29
6.07E+08	0.30
5.62E+08	0.31
5.22E+08	0.32
4.87E+08	0.33
4.55E+08	0.34
4.25E+08	0.35
3.99E+08	0.36
3.74E+08	0.37
3.52E+08	0.38
3.32E+08	0.39
3.13E+08	0.40
2.93E+08	0.41
2.76E+08	0.42
2.59E+08	0.43
2.44E+08	0.44
2.30E+08	0.45
2.17E+08	0.46
2.05E+08	0.47
1.94E+08	0.48
1.84E+08	0.49
1.74E+08	0.50
1.31E+08	0.55
1.01E+08	0.60
7.93E+07	0.65
6.38E+07	0.70
5.16E+07	0.75
4.27E+07	0.80
3.54E+07	0.85
2.99E+07	0.90
2.55E+07	0.95
2.18E+07	1.00
1.88E+07	1.05
1.64E+07	1.10
1.43E+07	1.15
1.26E+07	1.20
1.12E+07	1.25
9.92E+06	1.30
8.86E+06	1.35
7.94E+06	1.40
7.17E+06	1.45
6.47E+06	1.50
5.86E+06	1.55
5.33E+06	1.60
4.86E+06	1.65
4.44E+06	1.70
4.08E+06	1.75
3.75E+06	1.80
3.46E+06	1.85
3.19E+06	1.90
2.95E+06	1.95
2.73E+06	2.00
2.37E+06	2.10
2.06E+06	2.20
1.80E+06	2.30
1.58E+06	2.40
1.40E+06	2.50
1.25E+06	2.60
1.12E+06	2.70
9.99E+05	2.80
9.02E+05	2.90
8.14E+05	3.00
7.38E+05	3.10
7.14E+05	3.20
6.95E+05	3.30
6.78E+05	3.40
6.61E+05	3.50
6.45E+05	3.60
6.29E+05	3.70
6.15E+05	3.80
6.02E+05	3.90
5.89E+05	4.00
5.77E+05	4.10
5.64E+05	4.20
5.53E+05	4.30
5.42E+05	4.40
5.31E+05	4.50
5.22E+05	4.60
5.12E+05	4.70
5.03E+05	4.80
4.94E+05	4.90
4.85E+05	5.00
4.47E+05	5.50
4.15E+05	6.00
3.87E+05	6.50
3.64E+05	7.00
3.43E+05	7.50
3.24E+05	8.00
3.08E+05	8.50
2.93E+05	9.00
2.80E+05	9.50
2.68E+05	10.00
1.90E+05	15.00
1.49E+05	20.00
1.24E+05	25.00

RELEASE FROM A TORNADO

	INFANT	ADULT
Inhalation rate (m3/year)	1.40E+03	8.40E+03
Inhalation rate (m3/s)	4.44E-05	2.66E-04
Inhalation DCF for HTO (mSv/Bq)	5.80E-08	2.00E-08
Inhalation DCF for HT (mSv/Bq)	1.20E-11	2.40E-12
Skin absorption DCF for HTO (mSv/Bq)	5.80E-08	2.00E-08

	Total dose to infant (mSv)
KM	A
0.1	0.071
0.11	0.059
0.12	0.050
0.13	0.042
0.14	0.037
0.15	0.032
0.16	0.028
0.17	0.025
0.18	0.022
0.19	0.020
0.20	0.018
0.21	0.016
0.22	0.015
0.23	0.014
0.24	0.013
0.25	0.012
0.26	0.011
0.27	0.010
0.28	0.009
0.29	0.008
0.30	0.008
0.31	0.007
0.32	0.007
0.33	0.006
0.34	0.006
0.35	0.005
0.36	0.005
0.37	0.005
0.38	0.005
0.39	0.004
0.40	0.004
0.41	0.004
0.42	0.004
0.43	0.003
0.44	0.003
0.45	0.003
0.46	0.003
0.47	0.003
0.48	0.003
0.49	0.002
0.50	0.002
0.55	0.002
0.60	0.001
0.65	0.001
0.70	0.001
0.75	0.001
0.80	0.001
0.85	0.000
0.90	0.000
0.95	0.000
1.00	0.000
1.05	0.000
1.10	0.000
1.15	0.000
1.20	0.000
1.25	0.000
1.30	0.000
1.35	0.000
1.40	0.000
1.45	0.000
1.50	0.000
1.55	0.000
1.60	0.000
1.65	0.000
1.70	0.000
1.75	0.000
1.80	0.000
1.85	0.000
1.90	0.000
1.95	0.000
2.00	0.000
2.10	0.000
2.20	0.000
2.30	0.000
2.40	0.000
2.50	0.000
2.60	0.000
2.70	0.000
2.80	0.000
2.90	0.000
3.00	0.000
3.10	0.000
3.20	0.000
3.30	0.000
3.40	0.000
3.50	0.000
3.60	0.000
3.70	0.000
3.80	0.000
3.90	0.000
4.00	0.000
4.10	0.000
4.20	0.000
4.30	0.000
4.40	0.000
4.50	0.000
4.60	0.000
4.70	0.000
4.80	0.000
4.90	0.000
5.00	0.000
5.50	0.000
6.00	0.000
6.50	0.000
7.00	0.000
7.50	0.000
8.00	0.000
8.50	0.000
9.00	0.000
9.50	0.000
10.00	0.000
15.00	0.000
20.00	0.000
25.00	0.000

Total dose to adult (mSv)	
A	KM
0.147	0.1
0.122	0.11
0.103	0.12
0.088	0.13
0.076	0.14
0.067	0.15
0.058	0.16
0.052	0.17
0.046	0.18
0.042	0.19
0.038	0.20
0.034	0.21
0.031	0.22
0.028	0.23
0.026	0.24
0.024	0.25
0.022	0.26
0.020	0.27
0.019	0.28
0.017	0.29
0.016	0.30
0.015	0.31
0.014	0.32
0.013	0.33
0.012	0.34
0.011	0.35
0.011	0.36
0.010	0.37
0.009	0.38
0.009	0.39
0.008	0.40
0.008	0.41
0.007	0.42
0.007	0.43
0.006	0.44
0.006	0.45
0.006	0.46
0.005	0.47
0.005	0.48
0.005	0.49
0.005	0.50
0.003	0.55
0.003	0.60
0.002	0.65
0.002	0.70
0.001	0.75
0.001	0.80
0.001	0.85
0.001	0.90
0.001	0.95
0.001	1.00
0.001	1.05
0.000	1.10
0.000	1.15
0.000	1.20
0.000	1.25
0.000	1.30
0.000	1.35
0.000	1.40
0.000	1.45
0.000	1.50
0.000	1.55
0.000	1.60
0.000	1.65
0.000	1.70
0.000	1.75
0.000	1.80
0.000	1.85
0.000	1.90
0.000	1.95
0.000	2.00
0.000	2.10
0.000	2.20
0.000	2.30
0.000	2.40
0.000	2.50
0.000	2.60
0.000	2.70
0.000	2.80
0.000	2.90
0.000	3.00
0.000	3.10
0.000	3.20
0.000	3.30
0.000	3.40
0.000	3.50
0.000	3.60
0.000	3.70
0.000	3.80
0.000	3.90
0.000	4.00
0.000	4.10
0.000	4.20
0.000	4.30
0.000	4.40
0.000	4.50
0.000	4.60
0.000	4.70
0.000	4.80
0.000	4.90
0.000	5.00
0.000	5.50
0.000	6.00
0.000	6.50
0.000	7.00
0.000	7.50
0.000	8.00
0.000	8.50
0.000	9.00
0.000	9.50
0.000	10.00
0.000	15.00
0.000	20.00
0.000	25.00

APPENDIX K

RELEASE FROM A ROGUE VEHICLE

Release (curies)	16,025.0
Time of release "t" (seconds)	10.0
Wind velocity "V" (meters/second)	2.0
Effective height of release "H" (meters)	27.8
Rate of release "Q" (curies/second)	1,602.5
Percentage of release that is HTO	25.0
Percentage of release that is HT	75.0

	σ_y					
KM	A	B	C	D	E	F
0.1	26.9	19.3	12.5	8.2	6.12	4.07
0.11	29.30	21.00	13.60	8.96	6.69	4.45
0.12	31.60	22.70	14.70	9.71	7.25	4.82
0.13	34.00	24.50	15.90	10.50	7.81	5.19
0.14	36.30	26.20	17.00	11.20	8.36	5.56
0.15	38.60	27.90	18.10	11.90	8.91	5.92
0.16	40.90	29.50	19.20	12.70	9.46	6.29
0.17	43.20	31.20	20.30	13.40	10.00	6.65
0.18	45.50	32.90	21.40	14.10	10.50	7.01
0.19	47.70	34.50	22.50	14.80	11.10	7.37
0.20	50.00	36.20	23.60	15.60	11.60	7.73
0.21	52.20	37.80	24.70	16.30	12.20	8.08
0.22	54.40	39.40	25.80	17.00	12.70	8.44
0.23	56.60	41.00	26.90	17.70	13.20	8.79
0.24	58.80	42.70	27.90	18.40	13.80	9.14
0.25	61.00	44.30	29.00	19.10	14.30	9.50
0.26	63.20	45.90	30.10	19.80	14.80	9.85
0.27	65.30	47.50	31.10	20.50	15.30	10.20
0.28	67.50	49.00	32.20	21.20	15.90	10.50
0.29	69.60	50.60	33.20	21.90	16.40	10.90
0.30	71.80	52.20	34.30	22.60	16.90	11.20
0.31	73.90	53.80	35.30	23.30	17.40	11.60
0.32	76.00	55.30	36.40	24.00	17.90	11.90
0.33	78.10	56.90	37.40	24.70	18.40	12.30
0.34	80.20	58.50	38.50	25.40	19.00	12.60
0.35	82.30	60.00	39.50	26.10	19.50	12.90
0.36	84.40	61.50	40.50	26.70	20.00	13.30
0.37	86.50	63.10	41.60	27.40	20.50	13.60
0.38	88.60	64.60	42.60	28.10	21.00	14.00
0.39	90.60	66.20	43.60	28.80	21.50	14.30
0.40	92.70	67.70	44.60	29.50	22.00	14.60
0.41	94.80	69.20	45.70	30.10	22.50	15.00
0.42	96.80	70.70	46.70	30.80	23.00	15.30
0.43	98.90	72.20	47.70	31.50	23.50	15.60
0.44	101.00	73.80	48.70	32.10	24.00	16.00
0.45	103.00	75.30	49.70	32.80	24.50	16.30
0.46	105.00	76.80	50.70	33.50	25.00	16.60
0.47	107.00	78.30	51.80	34.20	25.50	17.00
0.48	109.00	79.80	52.80	34.80	26.00	17.30
0.49	111.00	81.30	53.80	35.50	26.50	17.60
0.50	113.00	82.80	54.80	36.10	27.00	18.00
0.55	123.00	90.20	59.80	39.40	29.50	19.60
0.60	133.00	97.50	64.70	42.70	31.90	21.20
0.65	143.00	105.00	69.60	46.00	34.40	22.90
0.70	152.00	112.00	74.50	49.20	36.80	24.50
0.75	162.00	119.00	79.30	52.40	39.20	26.10
0.80	171.00	126.00	84.10	55.60	41.50	27.60
0.85	181.00	133.00	88.90	58.70	43.90	29.20
0.90	190.00	140.00	93.70	61.90	46.30	30.80
0.95	199.00	147.00	98.40	65.00	48.60	32.30
1.00	209.00	154.00	103.00	68.10	50.90	33.90
1.05	218.00	161.00	108.00	71.20	53.30	35.40
1.10	227.00	168.00	112.00	74.30	55.60	37.00
1.15	236.00	175.00	117.00	77.40	57.90	38.50
1.20	245.00	181.00	122.00	80.40	60.20	40.00
1.25	254.00	188.00	126.00	83.50	62.40	41.50
1.30	263.00	195.00	131.00	86.50	64.70	43.00
1.35	272.00	201.00	135.00	89.50	67.00	44.50
1.40	281.00	208.00	140.00	92.60	69.20	46.00
1.45	289.00	215.00	145.00	95.60	71.50	47.50
1.50	298.00	221.00	149.00	98.50	73.70	49.00
1.55	307.00	228.00	154.00	102.00	75.90	50.50
1.60	316.00	234.00	158.00	104.00	78.10	52.00
1.65	324.00	241.00	163.00	107.00	80.40	53.50
1.70	333.00	247.00	167.00	110.00	82.60	54.90
1.75	341.00	254.00	171.00	113.00	84.80	56.40
1.80	350.00	260.00	176.00	116.00	87.00	57.90
1.85	358.00	267.00	180.00	119.00	89.20	59.30
1.90	367.00	273.00	185.00	122.00	91.30	60.80
1.95	375.00	279.00	189.00	125.00	93.50	62.20
2.00	384.00	286.00	193.00	128.00	95.70	63.70
2.10	400.00	298.00	202.00	134.00	100.00	66.60
2.20	417.00	311.00	211.00	139.00	104.00	69.40
2.30	433.00	324.00	220.00	145.00	109.00	72.30
2.40	450.00	336.00	228.00	151.00	113.00	75.10
2.50	466.00	348.00	237.00	157.00	117.00	77.90
2.60	482.00	361.00	245.00	162.00	121.00	80.80
2.70	498.00	373.00	254.00	168.00	126.00	83.60
2.80	515.00	385.00	262.00	173.00	130.00	86.40
2.90	530.00	397.00	271.00	179.00	134.00	89.10
3.00	546.00	409.00	279.00	185.00	138.00	91.90
3.10	562.00	421.00	287.00	190.00	142.00	94.70
3.20	578.00	433.00	296.00	196.00	146.00	97.40
3.30	594.00	445.00	304.00	201.00	151.00	100.00
3.40	609.00	457.00	312.00	207.00	155.00	103.00
3.50	625.00	469.00	321.00	212.00	159.00	106.00
3.60	640.00	481.00	329.00	218.00	163.00	108.00
3.70	656.00	492.00	337.00	223.00	167.00	111.00
3.80	671.00	504.00	345.00	229.00	171.00	114.00
3.90	686.00	516.00	353.00	234.00	175.00	116.00
4.00	701.00	527.00	361.00	239.00	179.00	119.00
4.10	716.00	539.00	370.00	245.00	183.00	122.00
4.20	732.00	550.00	378.00	250.00	187.00	125.00
4.30	747.00	562.00	386.00	255.00	191.00	127.00
4.40	762.00	573.00	394.00	261.00	195.00	130.00
4.50	777.00	585.00	402.00	266.00	199.00	133.00
4.60	791.00	596.00	410.00	271.00	203.00	135.00
4.70	806.00	608.00	418.00	277.00	207.00	138.00
4.80	821.00	619.00	426.00	282.00	211.00	140.00
4.90	836.00	630.00	434.00	287.00	215.00	143.00
5.00	851.00	641.00	442.00	292.00	219.00	146.00
5.50	923.00	697.00	481.00	319.00	238.00	159.00
6.00	995.00	752.00	520.00	344.00	258.00	172.00
6.50	1,066.00	807.00	559.00	370.00	277.00	184.00
7.00	1,136.00	861.00	597.00	395.00	296.00	197.00
7.50	1,205.00	914.00	635.00	421.00	315.00	210.00
8.00	1,274.00	967.00	672.00	446.00	333.00	222.00
8.50	1,342.00	1,020.00	710.00	470.00	352.00	234.00
9.00	1,409.00	1,071.00	747.00	495.00	370.00	247.00
9.50	1,475.00	1,123.00	784.00	519.00	389.00	259.00
10.00	1,541.00	1,174.00	820.00	544.00	407.00	271.00
15.00	2,174.00	1,666.00	1,175.00	779.00	583.00	388.00
20.00	2,769.00	2,133.00	1,515.00	1,005.00	752.00	501.00
25.00	3,337.00	2,580.00	1,843.00	1,223.00	916.00	610.00

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A	B	C	D	E	F	KM
13.9	10.6	7.44	4.65	3.53	2.33	0.1
15.40	11.60	8.12	5.05	3.82	2.51	0.11
16.90	12.60	8.79	5.45	4.10	2.70	0.12
18.40	13.50	9.46	5.84	4.38	2.88	0.13
19.90	14.50	10.10	6.23	4.66	3.06	0.14
21.40	15.50	10.80	6.62	4.93	3.24	0.15
23.00	16.40	11.40	7.00	5.20	3.41	0.16
24.50	17.40	12.10	7.38	5.46	3.58	0.17
26.10	18.30	12.70	7.76	5.72	3.76	0.18
27.70	19.30	13.40	8.13	5.98	3.93	0.19
29.30	20.20	14.00	8.50	6.24	4.09	0.20
31.00	21.20	14.70	8.87	6.49	4.25	0.21
32.60	22.20	15.30	9.23	6.75	4.41	0.22
34.30	23.20	15.90	9.60	7.00	4.57	0.23
36.00	24.20	16.60	9.96	7.24	4.72	0.24
37.70	25.20	17.20	10.30	7.49	4.88	0.25
39.60	26.20	17.80	10.70	7.74	5.03	0.26
41.50	27.20	18.50	11.00	7.98	5.18	0.27
43.50	28.20	19.10	11.40	8.22	5.33	0.28
45.50	29.20	19.70	11.70	8.46	5.48	0.29
47.40	30.10	20.30	12.10	8.70	5.62	0.30
49.70	31.10	20.90	12.40	8.92	5.77	0.31
52.00	32.10	21.60	12.70	9.13	5.92	0.32
54.30	33.10	22.20	13.10	9.35	6.06	0.33
56.60	34.10	22.80	13.40	9.56	6.20	0.34
59.00	35.10	23.40	13.70	9.77	6.35	0.35
61.30	36.10	24.00	14.00	9.98	6.49	0.36
63.80	37.00	24.60	14.30	10.20	6.63	0.37
66.20	38.00	25.20	14.60	10.40	6.77	0.38
68.70	39.00	25.80	15.00	10.60	6.91	0.39
71.20	40.00	26.40	15.30	10.80	7.05	0.40
74.30	41.10	27.00	15.60	11.00	7.19	0.41
77.40	42.20	27.70	15.90	11.20	7.32	0.42
80.60	43.30	28.30	16.20	11.40	7.46	0.43
83.90	44.40	28.90	16.50	11.60	7.59	0.44
87.20	45.50	29.50	16.80	11.80	7.73	0.45
90.60	46.60	30.10	17.10	12.00	7.86	0.46
94.00	47.70	30.60	17.40	12.20	8.00	0.47
97.50	48.90	31.20	17.70	12.40	8.13	0.48
101.00	50.00	31.80	18.00	12.60	8.26	0.49
105.00	51.10	32.40	18.30	12.80	8.40	0.50
128.00	56.70	35.40	19.80	13.80	9.05	0.55
154.00	62.40	38.30	21.20	14.70	9.69	0.60
182.00	68.10	41.20	22.60	15.60	10.30	0.65
213.00	73.90	44.10	24.00	16.50	10.90	0.70
247.00	79.70	47.00	25.40	17.40	11.50	0.75
283.00	85.60	49.90	26.80	18.30	12.00	0.80
322.00	91.50	52.70	28.10	19.10	12.50	0.85
363.00	97.40	55.50	29.50	20.00	13.00	0.90
407.00	103.00	58.30	30.80	20.80	13.50	0.95
454.00	109.00	61.10	32.10	21.60	14.00	1.00
503.00	115.00	63.90	33.10	22.30	14.40	1.05
555.00	121.00	66.70	34.10	23.00	14.80	1.10
610.00	127.00	69.50	35.10	23.60	15.20	1.15
668.00	134.00	72.20	36.10	24.30	15.70	1.20
728.00	140.00	75.00	37.10	24.90	16.10	1.25
791.00	146.00	77.70	38.00	25.50	16.50	1.30
857.00	152.00	80.50	38.90	26.10	16.90	1.35
925.00	158.00	83.20	39.90	26.70	17.30	1.40
996.00	164.00	85.90	40.80	27.30	17.60	1.45
1,071.00	171.00	88.60	41.70	27.90	18.00	1.50
1,148.00	177.00	91.30	42.60	28.50	18.40	1.55
1,227.00	183.00	94.00	43.40	29.10	18.80	1.60
1,310.00	189.00	96.70	44.30	29.70	19.20	1.65
1,395.00	196.00	99.30	45.20	30.20	19.50	1.70
1,484.00	202.00	102.00	46.00	30.80	19.90	1.75
1,575.00	208.00	105.00	46.90	31.30	20.20	1.80
1,669.00	215.00	107.00	47.70	31.90	20.60	1.85
1,766.00	221.00	110.00	48.50	32.40	20.90	1.90
1,866.00	227.00	113.00	49.30	33.00	21.30	1.95
1,968.00	234.00	115.00	50.20	33.50	21.60	2.00
2,182.00	247.00	121.00	51.80	34.40	22.20	2.10
2,408.00	260.00	126.00	53.30	35.40	22.80	2.20
2,646.00	273.00	131.00	54.90	36.30	23.30	2.30
2,895.00	286.00	136.00	56.40	37.20	23.90	2.40
3,156.00	299.00	141.00	57.90	38.00	24.40	2.50
3,430.00	312.00	147.00	59.40	38.90	25.00	2.60
3,715.00	325.00	152.00	60.80	39.80	25.50	2.70
4,012.00	338.00	157.00	62.30	40.60	26.00	2.80
4,321.00	351.00	162.00	63.70	41.40	26.50	2.90
4,643.00	365.00	167.00	65.10	42.20	27.00	3.00
4,977.00	378.00	172.00	66.40	43.00	27.40	3.10
5,000.00	392.00	177.00	67.70	43.80	27.80	3.20
5,000.00	405.00	182.00	69.00	44.60	28.20	3.30
5,000.00	419.00	187.00	70.20	45.40	28.60	3.40
5,000.00	432.00	192.00	71.50	46.10	29.00	3.50
5,000.00	446.00	197.00	72.70	46.90	29.40	3.60
5,000.00	459.00	202.00	73.90	47.60	29.70	3.70
5,000.00	473.00	207.00	75.10	48.30	30.10	3.80
5,000.00	486.00	212.00	76.30	49.10	30.50	3.90
5,000.00	500.00	217.00	77.50	49.80	30.80	4.00
5,000.00	514.00	222.00	78.70	50.40	31.20	4.10
5,000.00	528.00	227.00	79.80	51.00	31.50	4.20
5,000.00	541.00	232.00	81.00	51.60	31.80	4.30
5,000.00	555.00	237.00	82.10	52.20	32.20	4.40
5,000.00	569.00	242.00	83.20	52.80	32.60	4.50
5,000.00	583.00	247.00	84.30	53.40	32.90	4.60
5,000.00	597.00	252.00	85.40	54.00	33.20	4.70
5,000.00	611.00	257.00	86.50	54.60	33.60	4.80
5,000.00	625.00	262.00	87.60	55.10	33.90	4.90
5,000.00	639.00	266.00	88.70	55.70	34.20	5.00
5,000.00	709.00	291.00	94.00	58.50	35.80	5.50
5,000.00	780.00	315.00	99.00	61.10	37.20	6.00
5,000.00	852.00	339.00	104.00	63.60	38.60	6.50
5,000.00	924.00	362.00	109.00	66.00	40.00	7.00
5,000.00	997.00	386.00	113.00	68.40	41.20	7.50
5,000.00	1,070.00	410.00	118.00	70.60	42.30	8.00
5,000.00	1,144.00	433.00	122.00	72.80	43.40	8.50
5,000.00	1,218.00	456.00	127.00	75.00	44.40	9.00
5,000.00	1,292.00	479.00	131.00	77.00	45.40	9.50
5,000.00	1,367.00	502.00	135.00	79.10	46.40	10.00
5,000.00	2,133.00	728.00	170.00	95.60	54.90	15.00
5,000.00	2,924.00	947.00	200.00	109.00	60.30	20.00
5,000.00	3,735.00	1,161.00	227.00	119.00	64.90	25.00

RELEASE FROM A ROGUE VEHICLE

	χ (Curies/m^3)					
KM	A	B	C	D	E	F
0.1	9.23E-02	4.00E-02	2.55E-03	1.16E-07	4.02E-13	3.29E-30
0.11	1.11E-01	5.93E-02	6.58E-03	1.48E-06	3.15E-11	5.26E-26
0.12	1.23E-01	7.82E-02	1.33E-02	1.08E-05	8.92E-10	1.87E-22
0.13	1.30E-01	9.25E-02	2.26E-02	4.99E-05	1.33E-08	9.98E-20
0.14	1.33E-01	1.07E-01	3.36E-02	1.73E-04	1.22E-07	1.79E-17
0.15	1.33E-01	1.18E-01	4.75E-02	4.80E-04	7.23E-07	1.37E-15
0.16	1.31E-01	1.25E-01	5.96E-02	1.08E-03	3.22E-06	4.39E-14
0.17	1.27E-01	1.31E-01	7.41E-02	2.14E-03	1.10E-05	8.62E-13
0.18	1.22E-01	1.34E-01	8.55E-02	3.81E-03	3.15E-05	1.30E-11
0.19	1.17E-01	1.36E-01	9.83E-02	6.13E-03	7.79E-05	1.20E-10
0.20	1.11E-01	1.35E-01	1.07E-01	9.15E-03	1.73E-04	7.49E-10
0.21	1.05E-01	1.35E-01	1.17E-01	1.30E-02	3.34E-04	3.80E-09
0.22	1.00E-01	1.33E-01	1.24E-01	1.74E-02	6.17E-04	1.61E-08
0.23	9.46E-02	1.31E-01	1.29E-01	2.27E-02	1.04E-03	5.85E-08
0.24	8.94E-02	1.28E-01	1.35E-01	2.83E-02	1.60E-03	1.73E-07
0.25	8.45E-02	1.24E-01	1.38E-01	3.40E-02	2.43E-03	4.94E-07
0.26	7.97E-02	1.21E-01	1.41E-01	4.12E-02	3.52E-03	1.20E-06
0.27	7.52E-02	1.17E-01	1.43E-01	4.64E-02	4.84E-03	2.69E-06
0.28	7.08E-02	1.14E-01	1.44E-01	5.40E-02	6.41E-03	5.64E-06
0.29	6.68E-02	1.10E-01	1.44E-01	5.92E-02	8.31E-03	1.10E-05
0.30	6.31E-02	1.06E-01	1.43E-01	6.66E-02	1.05E-02	1.97E-05
0.31	5.94E-02	1.02E-01	1.43E-01	7.15E-02	1.28E-02	3.47E-05
0.32	5.59E-02	9.87E-02	1.42E-01	7.62E-02	1.51E-02	5.89E-05
0.33	5.28E-02	9.52E-02	1.40E-01	8.29E-02	1.78E-02	9.21E-05
0.34	4.98E-02	9.17E-02	1.38E-01	8.71E-02	2.05E-02	1.41E-04
0.35	4.70E-02	8.85E-02	1.36E-01	9.10E-02	2.34E-02	2.14E-04
0.36	4.45E-02	8.54E-02	1.34E-01	9.50E-02	2.64E-02	3.06E-04
0.37	4.20E-02	8.24E-02	1.32E-01	9.84E-02	2.97E-02	4.30E-04
0.38	3.98E-02	7.95E-02	1.29E-01	1.01E-01	3.28E-02	5.87E-04
0.39	3.78E-02	7.66E-02	1.27E-01	1.06E-01	3.59E-02	7.89E-04
0.40	3.58E-02	7.40E-02	1.24E-01	1.08E-01	3.91E-02	1.04E-03
0.41	3.38E-02	7.13E-02	1.22E-01	1.11E-01	4.23E-02	1.34E-03
0.42	3.19E-02	6.88E-02	1.19E-01	1.13E-01	4.55E-02	1.68E-03
0.43	3.01E-02	6.64E-02	1.17E-01	1.15E-01	4.87E-02	2.11E-03
0.44	2.85E-02	6.40E-02	1.14E-01	1.16E-01	5.19E-02	2.57E-03
0.45	2.70E-02	6.18E-02	1.12E-01	1.18E-01	5.50E-02	3.15E-03
0.46	2.56E-02	5.96E-02	1.09E-01	1.19E-01	5.81E-02	3.76E-03
0.47	2.43E-02	5.76E-02	1.06E-01	1.20E-01	6.11E-02	4.48E-03
0.48	2.30E-02	5.56E-02	1.04E-01	1.21E-01	6.41E-02	5.24E-03
0.49	2.19E-02	5.38E-02	1.02E-01	1.21E-01	6.70E-02	6.09E-03
0.50	2.08E-02	5.20E-02	9.94E-02	1.22E-01	6.98E-02	7.06E-03
0.55	1.58E-02	4.42E-02	8.85E-02	1.22E-01	8.24E-02	1.28E-02
0.60	1.23E-02	3.80E-02	7.91E-02	1.19E-01	9.10E-02	2.03E-02
0.65	9.69E-03	3.28E-02	7.08E-02	1.15E-01	9.71E-02	2.83E-02
0.70	7.81E-03	2.87E-02	6.36E-02	1.10E-01	1.02E-01	3.69E-02
0.75	6.33E-03	2.53E-02	5.74E-02	1.05E-01	1.04E-01	4.57E-02
0.80	5.24E-03	2.24E-02	5.20E-02	9.99E-02	1.06E-01	5.26E-02
0.85	4.36E-03	2.00E-02	4.74E-02	9.48E-02	1.05E-01	5.89E-02
0.90	3.69E-03	1.80E-02	4.33E-02	8.96E-02	1.05E-01	6.47E-02
0.95	3.14E-03	1.62E-02	3.97E-02	8.48E-02	1.03E-01	7.02E-02
1.00	2.68E-03	1.47E-02	3.65E-02	8.02E-02	1.01E-01	7.48E-02
1.05	2.32E-03	1.34E-02	3.36E-02	7.61E-02	9.87E-02	7.76E-02
1.10	2.02E-03	1.22E-02	3.13E-02	7.22E-02	9.61E-02	7.98E-02
1.15	1.77E-03	1.12E-02	2.90E-02	6.86E-02	9.33E-02	8.18E-02
1.20	1.56E-03	1.03E-02	2.69E-02	6.53E-02	9.06E-02	8.47E-02
1.25	1.38E-03	9.50E-03	2.52E-02	6.22E-02	8.80E-02	8.60E-02
1.30	1.23E-03	8.80E-03	2.35E-02	5.94E-02	8.53E-02	8.69E-02
1.35	1.09E-03	8.21E-03	2.21E-02	5.67E-02	8.27E-02	8.77E-02
1.40	9.81E-04	7.64E-03	2.07E-02	5.42E-02	8.03E-02	8.81E-02
1.45	8.86E-04	7.13E-03	1.94E-02	5.18E-02	7.78E-02	8.76E-02
1.50	7.99E-04	6.66E-03	1.84E-02	4.97E-02	7.55E-02	8.77E-02
1.55	7.23E-04	6.24E-03	1.73E-02	4.74E-02	7.33E-02	8.77E-02
1.60	6.58E-04	5.89E-03	1.64E-02	4.60E-02	7.11E-02	8.74E-02
1.65	6.01E-04	5.54E-03	1.55E-02	4.42E-02	6.89E-02	8.70E-02
1.70	5.49E-04	5.22E-03	1.48E-02	4.25E-02	6.69E-02	8.62E-02
1.75	5.04E-04	4.92E-03	1.41E-02	4.09E-02	6.50E-02	8.56E-02
1.80	4.63E-04	4.67E-03	1.33E-02	3.93E-02	6.31E-02	8.46E-02
1.85	4.27E-04	4.41E-03	1.28E-02	3.79E-02	6.13E-02	8.40E-02
1.90	3.93E-04	4.19E-03	1.21E-02	3.66E-02	5.97E-02	8.29E-02
1.95	3.64E-04	4.00E-03	1.16E-02	3.53E-02	5.80E-02	8.21E-02
2.00	3.37E-04	3.78E-03	1.12E-02	3.40E-02	5.64E-02	8.10E-02
2.10	2.92E-04	3.44E-03	1.02E-02	3.18E-02	5.35E-02	7.88E-02
2.20	2.54E-04	3.14E-03	9.36E-03	3.00E-02	5.09E-02	7.66E-02
2.30	2.23E-04	2.87E-03	8.65E-03	2.82E-02	4.81E-02	7.43E-02
2.40	1.96E-04	2.64E-03	8.06E-03	2.65E-02	4.59E-02	7.22E-02
2.50	1.73E-04	2.44E-03	7.49E-03	2.50E-02	4.39E-02	7.01E-02
2.60	1.54E-04	2.26E-03	6.96E-03	2.38E-02	4.20E-02	6.80E-02
2.70	1.38E-04	2.10E-03	6.50E-03	2.25E-02	3.98E-02	6.60E-02
2.80	1.23E-04	1.95E-03	6.10E-03	2.14E-02	3.82E-02	6.41E-02
2.90	1.11E-04	1.82E-03	5.72E-03	2.03E-02	3.67E-02	6.23E-02
3.00	1.01E-04	1.70E-03	5.40E-03	1.93E-02	3.53E-02	6.05E-02
3.10	9.12E-05	1.60E-03	5.10E-03	1.85E-02	3.39E-02	5.87E-02
3.20	8.82E-05	1.50E-03	4.81E-03	1.77E-02	3.26E-02	5.71E-02
3.30	8.59E-05	1.41E-03	4.56E-03	1.70E-02	3.12E-02	5.56E-02
3.40	8.38E-05	1.33E-03	4.32E-03	1.62E-02	3.00E-02	5.40E-02
3.50	8.16E-05	1.26E-03	4.10E-03	1.56E-02	2.90E-02	5.24E-02
3.60	7.97E-05	1.19E-03	3.90E-03	1.50E-02	2.80E-02	5.14E-02
3.70	7.78E-05	1.13E-03	3.71E-03	1.44E-02	2.71E-02	4.99E-02
3.80	7.60E-05	1.07E-03	3.54E-03	1.38E-02	2.62E-02	4.85E-02
3.90	7.44E-05	1.02E-03	3.38E-03	1.34E-02	2.53E-02	4.76E-02
4.00	7.28E-05	9.66E-04	3.23E-03	1.29E-02	2.45E-02	4.63E-02
4.10	7.12E-05	9.19E-04	3.08E-03	1.24E-02	2.38E-02	4.51E-02
4.20	6.97E-05	8.77E-04	2.95E-03	1.20E-02	2.31E-02	4.39E-02
4.30	6.83E-05	8.38E-04	2.83E-03	1.16E-02	2.24E-02	4.31E-02
4.40	6.69E-05	8.01E-04	2.71E-03	1.12E-02	2.17E-02	4.20E-02
4.50	6.56E-05	7.65E-04	2.60E-03	1.09E-02	2.11E-02	4.09E-02
4.60	6.45E-05	7.33E-04	2.50E-03	1.06E-02	2.05E-02	4.02E-02
4.70	6.33E-05	7.02E-04	2.41E-03	1.02E-02	2.00E-02	3.92E-02
4.80	6.21E-05	6.74E-04	2.32E-03	9.93E-03	1.94E-02	3.85E-02
4.90	6.10E-05	6.47E-04	2.23E-03	9.65E-03	1.90E-02	3.76E-02
5.00	5.99E-05	6.22E-04	2.16E-03	9.38E-03	1.85E-02	3.67E-02
5.50	5.53E-05	5.16E-04	1.81E-03	8.14E-03	1.64E-02	3.31E-02
6.00	5.13E-05	4.35E-04	1.55E-03	7.20E-03	1.46E-02	3.01E-02
6.50	4.79E-05	3.71E-04	1.34E-03	6.40E-03	1.32E-02	2.77E-02
7.00	4.49E-05	3.20E-04	1.18E-03	5.73E-03	1.19E-02	2.54E-02
7.50	4.23E-05	2.80E-04	1.04E-03	5.20E-03	1.09E-02	2.35E-02
8.00	4.00E-05	2.46E-04	9.24E-04	4.71E-03	1.00E-02	2.19E-02
8.50	3.80E-05	2.19E-04	8.28E-04	4.33E-03	9.25E-03	2.05E-02
9.00	3.62E-05	1.95E-04	7.47E-04	3.96E-03	8.58E-03	1.91E-02
9.50	3.46E-05	1.76E-04	6.78E-04	3.67E-03	7.98E-03	1.80E-02
10.00	3.31E-05	1.59E-04	6.19E-04	3.40E-03	7.45E-03	1.70E-02
15.00	2.35E-05	7.18E-05	2.98E-04	1.90E-03	4.39E-03	1.05E-02
20.00	1.84E-05	4.09E-05	1.78E-04	1.26E-03	3.01E-03	7.59E-03
25.00	1.53E-05	2.65E-05	1.19E-04	9.12E-04	2.28E-03	5.88E-03

χ (Bq/m^3)						
A	B	C	D	E	F	KM
3.42E+09	1.48E+09	9.43E+07	4.29E+03	1.49E-02	1.22E-19	0.1
4.10E+09	2.19E+09	2.43E+08	5.48E+04	1.17E+00	1.95E-15	0.11
4.57E+09	2.89E+09	4.91E+08	3.99E+05	3.30E+01	6.92E-12	0.12
4.82E+09	3.42E+09	8.36E+08	1.85E+06	4.93E+02	3.69E-09	0.13
4.92E+09	3.95E+09	1.24E+09	6.42E+06	4.53E+03	6.63E-07	0.14
4.91E+09	4.37E+09	1.76E+09	1.77E+07	2.67E+04	5.07E-05	0.15
4.83E+09	4.64E+09	2.20E+09	3.99E+07	1.19E+05	1.63E-03	0.16
4.68E+09	4.85E+09	2.74E+09	7.91E+07	4.06E+05	3.19E-02	0.17
4.51E+09	4.94E+09	3.16E+09	1.41E+08	1.17E+06	4.82E-01	0.18
4.32E+09	5.02E+09	3.64E+09	2.27E+08	2.88E+06	4.44E+00	0.19
4.11E+09	5.01E+09	3.98E+09	3.38E+08	6.39E+06	2.77E+01	0.20
3.90E+09	4.98E+09	4.35E+09	4.80E+08	1.24E+07	1.41E+02	0.21
3.70E+09	4.93E+09	4.59E+09	6.45E+08	2.28E+07	5.96E+02	0.22
3.50E+09	4.84E+09	4.78E+09	8.39E+08	3.84E+07	2.16E+03	0.23
3.31E+09	4.72E+09	5.01E+09	1.05E+09	5.94E+07	6.41E+03	0.24
3.13E+09	4.60E+09	5.12E+09	1.26E+09	8.99E+07	1.83E+04	0.25
2.95E+09	4.47E+09	5.20E+09	1.52E+09	1.30E+08	4.43E+04	0.26
2.78E+09	4.33E+09	5.30E+09	1.72E+09	1.79E+08	9.94E+04	0.27
2.62E+09	4.20E+09	5.32E+09	2.00E+09	2.37E+08	2.09E+05	0.28
2.47E+09	4.06E+09	5.33E+09	2.19E+09	3.07E+08	4.08E+05	0.29
2.33E+09	3.92E+09	5.31E+09	2.46E+09	3.89E+08	7.29E+05	0.30
2.20E+09	3.78E+09	5.28E+09	2.65E+09	4.73E+08	1.28E+06	0.31
2.07E+09	3.65E+09	5.24E+09	2.82E+09	5.60E+08	2.18E+06	0.32
1.95E+09	3.52E+09	5.19E+09	3.07E+09	6.60E+08	3.41E+06	0.33
1.84E+09	3.39E+09	5.11E+09	3.22E+09	7.57E+08	5.20E+06	0.34
1.74E+09	3.27E+09	5.04E+09	3.37E+09	8.64E+08	7.93E+06	0.35
1.65E+09	3.16E+09	4.96E+09	3.52E+09	9.77E+08	1.13E+07	0.36
1.56E+09	3.05E+09	4.87E+09	3.64E+09	1.10E+09	1.59E+07	0.37
1.47E+09	2.94E+09	4.78E+09	3.75E+09	1.21E+09	2.17E+07	0.38
1.40E+09	2.84E+09	4.69E+09	3.92E+09	1.33E+09	2.92E+07	0.39
1.32E+09	2.74E+09	4.60E+09	4.01E+09	1.45E+09	3.85E+07	0.40
1.25E+09	2.64E+09	4.50E+09	4.11E+09	1.56E+09	4.96E+07	0.41
1.18E+09	2.55E+09	4.41E+09	4.18E+09	1.68E+09	6.22E+07	0.42
1.12E+09	2.46E+09	4.31E+09	4.24E+09	1.80E+09	7.82E+07	0.43
1.05E+09	2.37E+09	4.22E+09	4.31E+09	1.92E+09	9.49E+07	0.44
9.99E+08	2.29E+09	4.13E+09	4.36E+09	2.03E+09	1.16E+08	0.45
9.46E+08	2.21E+09	4.04E+09	4.39E+09	2.15E+09	1.39E+08	0.46
8.98E+08	2.13E+09	3.94E+09	4.43E+09	2.26E+09	1.66E+08	0.47
8.53E+08	2.06E+09	3.85E+09	4.46E+09	2.37E+09	1.94E+08	0.48
8.10E+08	1.99E+09	3.76E+09	4.48E+09	2.48E+09	2.25E+08	0.49
7.68E+08	1.92E+09	3.68E+09	4.51E+09	2.58E+09	2.61E+08	0.50
5.85E+08	1.64E+09	3.27E+09	4.51E+09	3.05E+09	4.75E+08	0.55
4.53E+08	1.40E+09	2.93E+09	4.41E+09	3.37E+09	7.50E+08	0.60
3.58E+08	1.21E+09	2.62E+09	4.26E+09	3.59E+09	1.05E+09	0.65
2.89E+08	1.06E+09	2.35E+09	4.09E+09	3.76E+09	1.37E+09	0.70
2.34E+08	9.36E+08	2.13E+09	3.90E+09	3.86E+09	1.69E+09	0.75
1.94E+08	8.30E+08	1.93E+09	3.70E+09	3.92E+09	1.95E+09	0.80
1.61E+08	7.40E+08	1.75E+09	3.51E+09	3.90E+09	2.18E+09	0.85
1.36E+08	6.64E+08	1.60E+09	3.31E+09	3.88E+09	2.40E+09	0.90
1.16E+08	6.01E+08	1.47E+09	3.14E+09	3.82E+09	2.60E+09	0.95
9.93E+07	5.44E+08	1.35E+09	2.97E+09	3.75E+09	2.77E+09	1.00
8.59E+07	4.95E+08	1.24E+09	2.81E+09	3.65E+09	2.87E+09	1.05
7.48E+07	4.52E+08	1.16E+09	2.67E+09	3.55E+09	2.95E+09	1.10
6.55E+07	4.15E+08	1.07E+09	2.54E+09	3.45E+09	3.03E+09	1.15
5.76E+07	3.81E+08	9.95E+08	2.42E+09	3.35E+09	3.13E+09	1.20
5.10E+07	3.52E+08	9.32E+08	2.30E+09	3.26E+09	3.18E+09	1.25
4.53E+07	3.26E+08	8.70E+08	2.20E+09	3.16E+09	3.22E+09	1.30
4.05E+07	3.04E+08	8.18E+08	2.10E+09	3.06E+09	3.24E+09	1.35
3.63E+07	2.83E+08	7.66E+08	2.00E+09	2.97E+09	3.26E+09	1.40
3.28E+07	2.64E+08	7.19E+08	1.92E+09	2.88E+09	3.24E+09	1.45
2.96E+07	2.46E+08	6.80E+08	1.84E+09	2.79E+09	3.25E+09	1.50
2.68E+07	2.31E+08	6.41E+08	1.76E+09	2.71E+09	3.24E+09	1.55
2.43E+07	2.18E+08	6.08E+08	1.70E+09	2.63E+09	3.23E+09	1.60
2.22E+07	2.05E+08	5.74E+08	1.64E+09	2.55E+09	3.22E+09	1.65
2.03E+07	1.93E+08	5.47E+08	1.57E+09	2.48E+09	3.19E+09	1.70
1.86E+07	1.82E+08	5.21E+08	1.51E+09	2.40E+09	3.17E+09	1.75
1.71E+07	1.73E+08	4.93E+08	1.46E+09	2.34E+09	3.13E+09	1.80
1.58E+07	1.63E+08	4.74E+08	1.40E+09	2.27E+09	3.11E+09	1.85
1.46E+07	1.55E+08	4.49E+08	1.35E+09	2.21E+09	3.07E+09	1.90
1.35E+07	1.48E+08	4.29E+08	1.31E+09	2.14E+09	3.04E+09	1.95
1.25E+07	1.40E+08	4.13E+08	1.26E+09	2.08E+09	3.00E+09	2.00
1.08E+07	1.27E+08	3.76E+08	1.18E+09	1.98E+09	2.91E+09	2.10
9.40E+06	1.16E+08	3.46E+08	1.11E+09	1.88E+09	2.84E+09	2.20
8.24E+06	1.06E+08	3.20E+08	1.04E+09	1.78E+09	2.75E+09	2.30
7.24E+06	9.77E+07	2.98E+08	9.81E+08	1.70E+09	2.67E+09	2.40
6.42E+06	9.03E+07	2.77E+08	9.25E+08	1.62E+09	2.59E+09	2.50
5.71E+06	8.35E+07	2.57E+08	8.79E+08	1.55E+09	2.52E+09	2.60
5.10E+06	7.76E+07	2.40E+08	8.32E+08	1.47E+09	2.44E+09	2.70
4.57E+06	7.23E+07	2.26E+08	7.93E+08	1.41E+09	2.37E+09	2.80
4.12E+06	6.75E+07	2.12E+08	7.52E+08	1.36E+09	2.31E+09	2.90
3.72E+06	6.30E+07	2.00E+08	7.15E+08	1.30E+09	2.24E+09	3.00
3.37E+06	5.91E+07	1.89E+08	6.85E+08	1.25E+09	2.17E+09	3.10
3.27E+06	5.55E+07	1.78E+08	6.54E+08	1.21E+09	2.11E+09	3.20
3.18E+06	5.22E+07	1.69E+08	6.27E+08	1.15E+09	2.06E+09	3.30
3.10E+06	4.92E+07	1.60E+08	6.00E+08	1.11E+09	2.00E+09	3.40
3.02E+06	4.65E+07	1.52E+08	5.77E+08	1.07E+09	1.94E+09	3.50
2.95E+06	4.39E+07	1.44E+08	5.53E+08	1.04E+09	1.90E+09	3.60
2.88E+06	4.17E+07	1.37E+08	5.34E+08	1.00E+09	1.85E+09	3.70
2.81E+06	3.95E+07	1.31E+08	5.12E+08	9.68E+08	1.80E+09	3.80
2.75E+06	3.76E+07	1.25E+08	4.95E+08	9.36E+08	1.76E+09	3.90
2.69E+06	3.58E+07	1.19E+08	4.78E+08	9.06E+08	1.71E+09	4.00
2.64E+06	3.40E+07	1.14E+08	4.60E+08	8.79E+08	1.67E+09	4.10
2.58E+06	3.25E+07	1.09E+08	4.45E+08	8.53E+08	1.62E+09	4.20
2.53E+06	3.10E+07	1.05E+08	4.31E+08	8.28E+08	1.59E+09	4.30
2.48E+06	2.96E+07	1.00E+08	4.16E+08	8.05E+08	1.55E+09	4.40
2.43E+06	2.83E+07	9.64E+07	4.03E+08	7.82E+08	1.51E+09	4.50
2.39E+06	2.71E+07	9.26E+07	3.91E+08	7.60E+08	1.49E+09	4.60
2.34E+06	2.60E+07	8.90E+07	3.78E+08	7.39E+08	1.45E+09	4.70
2.30E+06	2.49E+07	8.57E+07	3.67E+08	7.20E+08	1.42E+09	4.80
2.26E+06	2.39E+07	8.25E+07	3.57E+08	7.01E+08	1.39E+09	4.90
2.22E+06	2.30E+07	7.98E+07	3.47E+08	6.83E+08	1.36E+09	5.00
2.04E+06	1.91E+07	6.71E+07	3.01E+08	6.05E+08	1.23E+09	5.50
1.90E+06	1.61E+07	5.74E+07	2.66E+08	5.40E+08	1.12E+09	6.00
1.77E+06	1.37E+07	4.96E+07	2.37E+08	4.87E+08	1.03E+09	6.50
1.66E+06	1.19E+07	4.35E+07	2.12E+08	4.42E+08	9.41E+08	7.00
1.57E+06	1.04E+07	3.84E+07	1.92E+08	4.03E+08	8.69E+08	7.50
1.48E+06	9.12E+06	3.42E+07	1.74E+08	3.71E+08	8.10E+08	8.00
1.41E+06	8.08E+06	3.06E+07	1.60E+08	3.42E+08	7.57E+08	8.50
1.34E+06	7.23E+06	2.77E+07	1.47E+08	3.17E+08	7.07E+08	9.00
1.28E+06	6.50E+06	2.51E+07	1.36E+08	2.95E+08	6.65E+08	9.50
1.22E+06	5.88E+06	2.29E+07	1.26E+08	2.76E+08	6.27E+08	10.00
8.68E+05	2.66E+06	1.10E+07	7.03E+07	1.62E+08	3.90E+08	15.00
6.82E+05	1.51E+06	6.57E+06	4.65E+07	1.11E+08	2.81E+08	20.00
5.66E+05	9.79E+05	4.41E+06	3.37E+07	8.42E+07	2.17E+08	25.00

RELEASE FROM A ROGUE VEHICLE

	INFANT	ADULT
Inhalation rate (m3/year)	1.40E+03	8.40E+03
Inhalation rate (m3/s)	4.44E-05	2.66E-04
Inhalation DCF for HTO (mSv/Bq)	5.80E-08	2.00E-08
Inhalation DCF for HT (mSv/Bq)	1.20E-11	2.40E-12
Skin absorption DCF for HTO (mSv/Bq)	5.80E-08	2.00E-08

	Total dose to infant (mSv)					
KM	A	B	C	D	E	F
0.1	0.044	0.019	0.001	0.000	0.000	0.000
0.11	0.053	0.028	0.003	0.000	0.000	0.000
0.12	0.059	0.037	0.006	0.000	0.000	0.000
0.13	0.062	0.044	0.011	0.000	0.000	0.000
0.14	0.063	0.051	0.016	0.000	0.000	0.000
0.15	0.063	0.056	0.023	0.000	0.000	0.000
0.16	0.062	0.060	0.028	0.001	0.000	0.000
0.17	0.060	0.062	0.035	0.001	0.000	0.000
0.18	0.058	0.064	0.041	0.002	0.000	0.000
0.19	0.056	0.065	0.047	0.003	0.000	0.000
0.20	0.053	0.064	0.051	0.004	0.000	0.000
0.21	0.050	0.064	0.056	0.006	0.000	0.000
0.22	0.048	0.063	0.059	0.008	0.000	0.000
0.23	0.045	0.062	0.062	0.011	0.000	0.000
0.24	0.043	0.061	0.065	0.013	0.001	0.000
0.25	0.040	0.059	0.066	0.016	0.001	0.000
0.26	0.038	0.058	0.067	0.020	0.002	0.000
0.27	0.036	0.056	0.068	0.022	0.002	0.000
0.28	0.034	0.054	0.069	0.026	0.003	0.000
0.29	0.032	0.052	0.069	0.028	0.004	0.000
0.30	0.030	0.050	0.068	0.032	0.005	0.000
0.31	0.028	0.049	0.068	0.034	0.006	0.000
0.32	0.027	0.047	0.068	0.036	0.007	0.000
0.33	0.025	0.045	0.067	0.040	0.008	0.000
0.34	0.024	0.044	0.066	0.042	0.010	0.000
0.35	0.022	0.042	0.065	0.043	0.011	0.000
0.36	0.021	0.041	0.064	0.045	0.013	0.000
0.37	0.020	0.039	0.063	0.047	0.014	0.000
0.38	0.019	0.038	0.062	0.048	0.016	0.000
0.39	0.018	0.037	0.060	0.051	0.017	0.000
0.40	0.017	0.035	0.059	0.052	0.019	0.000
0.41	0.016	0.034	0.058	0.053	0.020	0.001
0.42	0.015	0.033	0.057	0.054	0.022	0.001
0.43	0.014	0.032	0.056	0.055	0.023	0.001
0.44	0.014	0.030	0.054	0.055	0.025	0.001
0.45	0.013	0.029	0.053	0.056	0.026	0.001
0.46	0.012	0.028	0.052	0.057	0.028	0.002
0.47	0.012	0.027	0.051	0.057	0.029	0.002
0.48	0.011	0.026	0.050	0.057	0.031	0.002
0.49	0.010	0.026	0.048	0.058	0.032	0.003
0.50	0.010	0.025	0.047	0.058	0.033	0.003
0.55	0.008	0.021	0.042	0.058	0.039	0.006
0.60	0.006	0.018	0.038	0.057	0.043	0.010
0.65	0.005	0.016	0.034	0.055	0.046	0.013
0.70	0.004	0.014	0.030	0.053	0.048	0.018
0.75	0.003	0.012	0.027	0.050	0.050	0.022
0.80	0.002	0.011	0.025	0.048	0.050	0.025
0.85	0.002	0.010	0.023	0.045	0.050	0.028
0.90	0.002	0.009	0.021	0.043	0.050	0.031
0.95	0.001	0.008	0.019	0.040	0.049	0.033
1.00	0.001	0.007	0.017	0.038	0.048	0.036
1.05	0.001	0.006	0.016	0.036	0.047	0.037
1.10	0.001	0.006	0.015	0.034	0.046	0.038
1.15	0.001	0.005	0.014	0.033	0.044	0.039
1.20	0.001	0.005	0.013	0.031	0.043	0.040
1.25	0.001	0.005	0.012	0.030	0.042	0.041
1.30	0.001	0.004	0.011	0.028	0.041	0.041
1.35	0.001	0.004	0.011	0.027	0.039	0.042
1.40	0.000	0.004	0.010	0.026	0.038	0.042
1.45	0.000	0.003	0.009	0.025	0.037	0.042
1.50	0.000	0.003	0.009	0.024	0.036	0.042
1.55	0.000	0.003	0.008	0.023	0.035	0.042
1.60	0.000	0.003	0.008	0.022	0.034	0.042
1.65	0.000	0.003	0.007	0.021	0.033	0.041
1.70	0.000	0.002	0.007	0.020	0.032	0.041
1.75	0.000	0.002	0.007	0.019	0.031	0.041
1.80	0.000	0.002	0.006	0.019	0.030	0.040
1.85	0.000	0.002	0.006	0.018	0.029	0.040
1.90	0.000	0.002	0.006	0.017	0.028	0.039
1.95	0.000	0.002	0.006	0.017	0.028	0.039
2.00	0.000	0.002	0.005	0.016	0.027	0.039
2.10	0.000	0.002	0.005	0.015	0.025	0.038
2.20	0.000	0.001	0.004	0.014	0.024	0.037
2.30	0.000	0.001	0.004	0.013	0.023	0.035
2.40	0.000	0.001	0.004	0.013	0.022	0.034
2.50	0.000	0.001	0.004	0.012	0.021	0.033
2.60	0.000	0.001	0.003	0.011	0.020	0.032
2.70	0.000	0.001	0.003	0.011	0.019	0.031
2.80	0.000	0.001	0.003	0.010	0.018	0.031
2.90	0.000	0.001	0.003	0.010	0.017	0.030
3.00	0.000	0.001	0.003	0.009	0.017	0.029
3.10	0.000	0.001	0.002	0.009	0.016	0.028
3.20	0.000	0.001	0.002	0.008	0.016	0.027
3.30	0.000	0.001	0.002	0.008	0.015	0.027
3.40	0.000	0.001	0.002	0.008	0.014	0.026
3.50	0.000	0.001	0.002	0.007	0.014	0.025
3.60	0.000	0.001	0.002	0.007	0.013	0.024
3.70	0.000	0.001	0.002	0.007	0.013	0.024
3.80	0.000	0.001	0.002	0.007	0.012	0.023
3.90	0.000	0.000	0.002	0.006	0.012	0.023
4.00	0.000	0.000	0.002	0.006	0.012	0.022
4.10	0.000	0.000	0.001	0.006	0.011	0.021
4.20	0.000	0.000	0.001	0.006	0.011	0.021
4.30	0.000	0.000	0.001	0.006	0.011	0.021
4.40	0.000	0.000	0.001	0.005	0.010	0.020
4.50	0.000	0.000	0.001	0.005	0.010	0.019
4.60	0.000	0.000	0.001	0.005	0.010	0.019
4.70	0.000	0.000	0.001	0.005	0.010	0.019
4.80	0.000	0.000	0.001	0.005	0.009	0.018
4.90	0.000	0.000	0.001	0.005	0.009	0.018
5.00	0.000	0.000	0.001	0.004	0.009	0.017
5.50	0.000	0.000	0.001	0.004	0.008	0.016
6.00	0.000	0.000	0.001	0.003	0.007	0.014
6.50	0.000	0.000	0.001	0.003	0.006	0.013
7.00	0.000	0.000	0.001	0.003	0.006	0.012
7.50	0.000	0.000	0.000	0.002	0.005	0.011
8.00	0.000	0.000	0.000	0.002	0.005	0.010
8.50	0.000	0.000	0.000	0.002	0.004	0.010
9.00	0.000	0.000	0.000	0.002	0.004	0.009
9.50	0.000	0.000	0.000	0.002	0.004	0.009
10.00	0.000	0.000	0.000	0.002	0.004	0.008
15.00	0.000	0.000	0.000	0.001	0.002	0.005
20.00	0.000	0.000	0.000	0.001	0.001	0.004
25.00	0.000	0.000	0.000	0.000	0.001	0.003

Total dose to adult (mSv)						
A	B	C	D	E	F	KM
0.091	0.039	0.003	0.000	0.000	0.000	0.1
0.109	0.058	0.006	0.000	0.000	0.000	0.11
0.122	0.077	0.013	0.000	0.000	0.000	0.12
0.128	0.091	0.022	0.000	0.000	0.000	0.13
0.131	0.105	0.033	0.000	0.000	0.000	0.14
0.131	0.116	0.047	0.000	0.000	0.000	0.15
0.129	0.124	0.059	0.001	0.000	0.000	0.16
0.125	0.129	0.073	0.002	0.000	0.000	0.17
0.120	0.132	0.084	0.004	0.000	0.000	0.18
0.115	0.134	0.097	0.006	0.000	0.000	0.19
0.109	0.133	0.106	0.009	0.000	0.000	0.20
0.104	0.133	0.116	0.013	0.000	0.000	0.21
0.098	0.131	0.122	0.017	0.001	0.000	0.22
0.093	0.129	0.127	0.022	0.001	0.000	0.23
0.088	0.126	0.134	0.028	0.002	0.000	0.24
0.083	0.123	0.137	0.033	0.002	0.000	0.25
0.079	0.119	0.139	0.041	0.003	0.000	0.26
0.074	0.115	0.141	0.046	0.005	0.000	0.27
0.070	0.112	0.142	0.053	0.006	0.000	0.28
0.066	0.108	0.142	0.058	0.008	0.000	0.29
0.062	0.104	0.141	0.066	0.010	0.000	0.30
0.059	0.101	0.141	0.070	0.013	0.000	0.31
0.055	0.097	0.140	0.075	0.015	0.000	0.32
0.052	0.094	0.138	0.082	0.018	0.000	0.33
0.049	0.090	0.136	0.086	0.020	0.000	0.34
0.046	0.087	0.134	0.090	0.023	0.000	0.35
0.044	0.084	0.132	0.094	0.026	0.000	0.36
0.041	0.081	0.130	0.097	0.029	0.000	0.37
0.039	0.078	0.127	0.100	0.032	0.001	0.38
0.037	0.076	0.125	0.104	0.035	0.001	0.39
0.035	0.073	0.123	0.107	0.039	0.001	0.40
0.033	0.070	0.120	0.109	0.042	0.001	0.41
0.031	0.068	0.117	0.111	0.045	0.002	0.42
0.030	0.065	0.115	0.113	0.048	0.002	0.43
0.028	0.063	0.112	0.115	0.051	0.003	0.44
0.027	0.061	0.110	0.116	0.054	0.003	0.45
0.025	0.059	0.108	0.117	0.057	0.004	0.46
0.024	0.057	0.105	0.118	0.060	0.004	0.47
0.023	0.055	0.103	0.119	0.063	0.005	0.48
0.022	0.053	0.100	0.119	0.066	0.006	0.49
0.020	0.051	0.098	0.120	0.069	0.007	0.50
0.016	0.044	0.087	0.120	0.081	0.013	0.55
0.012	0.037	0.078	0.118	0.090	0.020	0.60
0.010	0.032	0.070	0.113	0.096	0.028	0.65
0.008	0.028	0.063	0.109	0.100	0.036	0.70
0.006	0.025	0.057	0.104	0.103	0.045	0.75
0.005	0.022	0.051	0.099	0.104	0.052	0.80
0.004	0.020	0.047	0.093	0.104	0.058	0.85
0.004	0.018	0.043	0.088	0.103	0.064	0.90
0.003	0.016	0.039	0.084	0.102	0.069	0.95
0.003	0.014	0.036	0.079	0.100	0.074	1.00
0.002	0.013	0.033	0.075	0.097	0.077	1.05
0.002	0.012	0.031	0.071	0.095	0.079	1.10
0.002	0.011	0.029	0.068	0.092	0.081	1.15
0.002	0.010	0.027	0.064	0.089	0.083	1.20
0.001	0.009	0.025	0.061	0.087	0.085	1.25
0.001	0.009	0.023	0.059	0.084	0.086	1.30
0.001	0.008	0.022	0.056	0.082	0.086	1.35
0.001	0.008	0.020	0.053	0.079	0.087	1.40
0.001	0.007	0.019	0.051	0.077	0.086	1.45
0.001	0.007	0.018	0.049	0.074	0.086	1.50
0.001	0.006	0.017	0.047	0.072	0.086	1.55
0.001	0.006	0.016	0.045	0.070	0.086	1.60
0.001	0.005	0.015	0.044	0.068	0.086	1.65
0.001	0.005	0.015	0.042	0.066	0.085	1.70
0.000	0.005	0.014	0.040	0.064	0.084	1.75
0.000	0.005	0.013	0.039	0.062	0.083	1.80
0.000	0.004	0.013	0.037	0.060	0.083	1.85
0.000	0.004	0.012	0.036	0.059	0.082	1.90
0.000	0.004	0.011	0.035	0.057	0.081	1.95
0.000	0.004	0.011	0.034	0.056	0.080	2.00
0.000	0.003	0.010	0.031	0.053	0.078	2.10
0.000	0.003	0.009	0.030	0.050	0.076	2.20
0.000	0.003	0.009	0.028	0.047	0.073	2.30
0.000	0.003	0.008	0.026	0.045	0.071	2.40
0.000	0.002	0.007	0.025	0.043	0.069	2.50
0.000	0.002	0.007	0.023	0.041	0.067	2.60
0.000	0.002	0.006	0.022	0.039	0.065	2.70
0.000	0.002	0.006	0.021	0.038	0.063	2.80
0.000	0.002	0.006	0.020	0.036	0.061	2.90
0.000	0.002	0.005	0.019	0.035	0.060	3.00
0.000	0.002	0.005	0.018	0.033	0.058	3.10
0.000	0.001	0.005	0.017	0.032	0.056	3.20
0.000	0.001	0.004	0.017	0.031	0.055	3.30
0.000	0.001	0.004	0.016	0.030	0.053	3.40
0.000	0.001	0.004	0.015	0.029	0.052	3.50
0.000	0.001	0.004	0.015	0.028	0.051	3.60
0.000	0.001	0.004	0.014	0.027	0.049	3.70
0.000	0.001	0.003	0.014	0.026	0.048	3.80
0.000	0.001	0.003	0.013	0.025	0.047	3.90
0.000	0.001	0.003	0.013	0.024	0.046	4.00
0.000	0.001	0.003	0.012	0.023	0.044	4.10
0.000	0.001	0.003	0.012	0.023	0.043	4.20
0.000	0.001	0.003	0.011	0.022	0.042	4.30
0.000	0.001	0.003	0.011	0.021	0.041	4.40
0.000	0.001	0.003	0.011	0.021	0.040	4.50
0.000	0.001	0.002	0.010	0.020	0.040	4.60
0.000	0.001	0.002	0.010	0.020	0.039	4.70
0.000	0.001	0.002	0.010	0.019	0.038	4.80
0.000	0.001	0.002	0.010	0.019	0.037	4.90
0.000	0.001	0.002	0.009	0.018	0.036	5.00
0.000	0.001	0.002	0.008	0.016	0.033	5.50
0.000	0.000	0.002	0.007	0.014	0.030	6.00
0.000	0.000	0.001	0.006	0.013	0.027	6.50
0.000	0.000	0.001	0.006	0.012	0.025	7.00
0.000	0.000	0.001	0.005	0.011	0.023	7.50
0.000	0.000	0.001	0.005	0.010	0.022	8.00
0.000	0.000	0.001	0.004	0.009	0.020	8.50
0.000	0.000	0.001	0.004	0.008	0.019	9.00
0.000	0.000	0.001	0.004	0.008	0.018	9.50
0.000	0.000	0.001	0.003	0.007	0.017	10.00
0.000	0.000	0.000	0.002	0.004	0.010	15.00
0.000	0.000	0.000	0.001	0.003	0.007	20.00
0.000	0.000	0.000	0.001	0.002	0.006	25.00

APPENDIX L

RELEASE FROM A SMALL FIRE

Release (curies)	219.0
Time of release "t" (seconds)	300.0
Volume of room (meters^3)	522.0
Rate of release "Q" (curies/second)	0.7
Percentage of release that is HTO	25.0
Percentage of release that is HT	75.0

χ (Curies/m^3)
4.20E-01

χ (Bq/m^3)
1.55E+10

	ADULT
Inhalation rate (m3/year)	8.40E+03
Inhalation rate (m3/s)	2.66E-04
Inhalation DCF for HTO (mSv/Bq)	2.00E-08
Inhalation DCF for HT (mSv/Bq)	2.40E-12
Skin absorption DCF for HTO (mSv/Bq)	2.00E-08

Total dose to adult (mSv)
12.406

APPENDIX M

RELEASE FROM A HANDLING INCIDENT

Release (curies)	233.0
Time of release "t" (seconds)	120.0
Volume of room (meters^3)	522.0
Rate of release "Q" (curies/second)	1.9
Percentage of release that is HTO	25.0
Percentage of release that is HT	75.0

χ (Curies/m^3)
4.46E-01

χ (Bq/m^3)
1.65E+10

	ADULT
Inhalation rate (m3/year)	8.40E+03
Inhalation rate (m3/s)	2.66E-04
Inhalation DCF for HTO (mSv/Bq)	2.00E-08
Inhalation DCF for HT (mSv/Bq)	2.40E-12
Skin absorption DCF for HTO (mSv/Bq)	2.00E-08

Total dose to adult (mSv)
5.280

APPENDIX N

RELEASE FROM A PACKING INCIDENT

Release (curies)	200.0
Time of release "t" (seconds)	120.0
Volume of room (meters^3)	586.0
Rate of release "Q" (curies/second)	1.7
Percentage of release that is HTO	25.0
Percentage of release that is HT	75.0

χ (Curies/m^3)
3.41E-01

χ (Bq/m^3)
1.26E+10

	ADULT
Inhalation rate (m3/year)	8.40E+03
Inhalation rate (m3/s)	2.66E-04
Inhalation DCF for HTO (mSv/Bq)	2.00E-08
Inhalation DCF for HT (mSv/Bq)	2.40E-12
Skin absorption DCF for HTO (mSv/Bq)	2.00E-08

Total dose to adult (mSv)
4.037