Project: Container Surveillance and Storage Capability (CSSC) Project	**Calculation Number:** S-CLC-K-00237	**Project Number:** SR07.KN53477W.030.EM07BWSAA
Title: Accident Analysis for the 3013 Container Surveillance and Storage Capability Project (U)	**Functional Classification:** N/A **Discipline:** Safety	Sheet 1 of 73
Calc Level [X] Type 1 [X] Type 2	**Type 1 Calc Status** [x] Preliminary [ ] Confirmed	
Computer Program No. Excel 2003	**Version/Release No.** 11.8105.8107 SP2	

Purpose and Objective:

To determine the unmitigated and mitigated consequences for all CSSC accidents.

Summary of Conclusion:

The consequences of all CSSC accidents have been determined and are summarized in Table 2. With mitigation, these consequences are all well below evaluation guidelines.

	Revisions
Rev No.	Revision Description
A	Original Issue

Sign Off (signatures of previous revision on file)

Rev. No.	Originators (Print) Sign/Date	Verification/Checking Method	Verifier/Checker (Print) Sign/Date	Manager (Print) Sign/Date
A	D. K. Allison 8-7-07	Individual Review of changes per this revision	S. Chow 8/7/07 SC 8/7/07	S. Lonchar 8/9/07
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RECORD OF REVISION

Project: Container Surveillance and Storage Capability (CSSC) Project	**Calculation No:** S-CLC-K-00237
Title: Accident Analysis for the 3013 Container Surveillance and Storage Capability Project (U)	

Originator: D. K. Allison	**Date:**	**Checker:** S. Chow	**Date:**	**Rev. No:**
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REV. NO.	PAGES REPLACED	PAGES ADDED	PAGES DELETED	PAGES REVISED	DESCRIPTION OF REVISIONS
A	None	All	None	None	Original Issue

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Reviewer(s):

Name (Print Or Type)	Signature	Date
S. Chow	Stanley Chow	8/7/~~06~~ 07 SC 8/9/07

CIRCLE ONE

1.	Are the Subject and/or Purpose clearly stated?	Yes	No	
2.	Are the required Input Data and their references and sources provided and are they consistent with the Calc-note purpose?	Yes	No	
3.	Are the Assumptions clearly identified, valid, and consistent with the Calc-note purpose?	Yes	No	
4.	Is the Analytical Method or Approach Used clearly identified?	Yes	No	
5.	Are all pages consecutively numbered and identified by the Calc-note number?	Yes	No	
6.	Is/are the version(s) of the computer program(s) used identified and QA'd adequately?	Yes	No	N/A
7.	Are input listings for all computer programs documented in this Calc-note, and are they V&Vd and appropriate for the intended use?	Yes	No	N/A
8.	Are the Results and Conclusions clearly stated?	Yes	No	
9.	Are all OUTPUT documents included (or if not part of the calculation, clearly referenced in the Results section?) grammatically correct, clear and consistent with the main Calc-note text?	Yes	No	N/A
10.	Are the results, methods, input, and assumptions compatible with the stated purpose?	Yes	No	

If No to Any of the Above, List Sheet Number (S) With Justification and Obtain Manager's Signature Below:

_____

Manager's Signature

REVIEWER'S NOTES (use additional pages as necessary)

Review method used: Alternate calculation ____ ; Attached?: Y__ N__

Approximated Originator's steps: ✓

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2 OPEN ITEMS

Reference 1 is preliminary.

3 INTRODUCTION

This Engineering Calculation (EC) addresses accidents for the Container Surveillance and Storage Capability (CSSC) project in K-Area. Accidents identified in Reference 1 as requiring Accident Analysis are shown below:

Event Category	Bounding Events
E-1: Fires	PA-1, PA-3, RS-2, GB-1, OF-2, COM-3
E-2: Explosions	GB-4, GB-4a, GB-4b, COM-40, COM-41, COM-42
E-3: Loss of Confinement	RS-4, GB-8, GB-10, COM-X2, COM-X3, COM-18, COM-39
E-4: Direct Exposure*	COM-X5, COM-20
E-5: Criticality	GB-17a, COM-25, COM-26
E-6: External	COM-27a and COM 27b
E-7: Natural Phenomena	COM-28a, COM-28c, COM-28e, COM-28f

* These are non-radiological events.

4 INPUT DATA AND ASSUMPTIONS

The following input and assumptions have not been included in a separate input and assumptions EC. The Design Authority (DA) signature on the front page of this EC indicates that these input and assumptions are appropriate where applicable to facility operations/capabilities.

Input Data

Parameter	Value	Units	Reference
Onsite Dose Factor (95% met, 3 cm surface roughness, 3 min)	1.88E+01	rem/g Pu	2
Onsite Dose Factor (95% met, 3 cm surface roughness, 8 hr)	5.38E+00	rem/g Pu	2
Offsite Dose Factor (95% met, 3 cm surface roughness, 3 min)	1.43E-02	rem/g Pu	2
Offsite Dose Factor (95% met, 3 cm surface roughness, 8 hr)	3.95E-03	rem/g Pu	2
ARF*RF for waste in fire	5E-04	N/A	3, 4

Parameter	Value	Units	Reference
(contained)			
ARF*RF for waste in fire (uncontained)	1E-02	N/A	3, 4
ARF*RF for impact on HEPA	5E-04	N/A	4
ARF*RF for impact on solid waste	1E-03*0.1 = 1E-04	N/A	3, 4
ARF*RF for unconfined powder in fire	6E-03*0.01 = 6E-05	N/A	4
ARF*RF for HEPA filter material in fire	1E-04	N/A	4
ARF*RF for powder/contamination external to explosion	5E-03*0.3 = 1.5E-03	N/A	4
ARF*RF for spilling powder (< 3 m)	6E-04	N/A	4
ARR*RF for resuspension of powder when shielded from wind	4E-06	1/hr	4
ARR*RF for resuspension of powder when not shielded from wind	4E-05	1/hr	4
Duration for resuspension	8	hr	5
Fraction of inventory ejected from drum in overpressure event	33	%	3
Empty 3013 inner can internal volume	2074.53	cc	19
Convenience can material volume	104.01	cc	19
Density of Pu oxide	11.46	kg/l	6
Isotopic composition (powder, waste, holdup)	Am-241 1.714 Pu-238 0.1002 Pu-239 76.08 Pu-240 20.62 Pu-241 1.815 Pu-242 1.385	Wt %	7
Specific activity	Am-241 3.44 Pu-238 17.1 Pu-239 0.0621 Pu-240 0.227 Pu-241 103 Pu-242 0.00393	Ci/g	16
Dose potential normalized to Pu-238 per gram	Am-241 1.837E-01 Pu-238 1.000E+00 Pu-239 3.947E-03 Pu-240 1.443E-02 Pu-241 1.178E-01 Pu-242 2.398E-04	N/A	7
Heat generation rate	Pu-238 3.26E-02 Am-241 3.28E-02 Pu-241 3.20E-05 Pu-240 3.06E-02 Pu-239 3.02E-02	W/Ci	8

Parameter	Value	Units	Reference
	Pu-242 2.90E-02		
Composition of check standards (SR 1979 and LL 1979)	Pu-238 0.011 Pu-239 93.73 Pu-240 5.861 Pu-241 0.37 Pu-242 0.027 Am-241 0.32893	%	7
Composition of calibration, i.e., PUEU, standards (SRPSTDPUEU1, SRPSTDPUEU2, SRPSTDPUEU3, SRPSTDPUEU4, SRPSTDPUEU5, SRPSTDPUEU6, and SRPSTDPUEU7)	Pu-238 0.0144 Pu-239 93.778 Pu-240 5.8618 Pu-241 0.2798 Pu-242 0.0658 Am-241 0.248742	%	7
Event PA-1 MAR	4.4	kg Pu	1
Event PA-3 MAR	2.4 22 500 1 150 3.7 0.5	kg Pu (waste drum) kg Pu (3013) g Pu (check standard) kg Pu (waste drum) g Pu (samples) kg Pu (cal standard) g Pu (waste bag)	1
Event RS-2 MAR	8448	kg Pu (3013)	1
Event GB-1 MAR	4.4 600	kg Pu (3013) g Pu (holdup)	1
Event OF-2 MAR	4.4 600	kg Pu (3013) g Pu (holdup)	1
Event COM-3 MAR	8.43E+06 2.4 22 600 500 1 150 3.7 0.5	g Pu (3013) kg Pu (waste drum) kg Pu (3013) g Pu holdup g Pu (check standard) kg Pu (waste drum) g Pu (samples) kg Pu (cal standard) g Pu (waste bag)	1
Event GB-4 MAR	4.4	kg Pu (3013)	1
Event GB-4a MAR	4.4 600	kg Pu (3013) g Pu (holdup)	1
Event GB-4b MAR	4.4 600	kg Pu (3013) g Pu (holdup)	1
Event COM-40 MAR	395	g Pu (waste drum)	1
Event COM-41 MAR	150	g Pu (samples)	1
Event COM-42 MAR	4.4	kg Pu (3013)	1
Event RS-4 MAR	528	kg Pu (3013)	1
Event GB-8 MAR	4.4 600	kg Pu (3013) g Pu (holdup)	1
Event GB-10 MAR	4.4 600	kg Pu (3013) kg Pu (holdup)	1
Event COM-X2 MAR	4.4	kg Pu (3013)	1

Parameter	Value	Units	Reference
Event COM-X3 MAR	8.8	kg Pu (3013)	1
Event COM-18 MAR	4.4	kg Pu (3013)	1
Event COM-39 MAR	4.4	kg Pu (3013)	1
Event GB-17a MAR	4.4 600	kg Pu (3013) g Pu (holdup)	1
Event COM-25 MAR	22	kg Pu (3013)	1
Event COM-26 MAR	22	kg Pu (3013)	1
Event COM-27a MAR	8.45E+06 2.4 600 500 1 150 3.7 0.5	g Pu (3013) kg Pu (waste drum) g Pu holdup g Pu (check standard) kg Pu (waste drum) g Pu (samples) kg Pu (cal standard) g Pu (waste bag)	1
Event COM-27b MAR (HEPA and ductwork MAR's are from Assumptions 11 and 18)	1 1 5	kg Pu (HEPA holdup) kg Pu (duct holdup) kg Pu (GB inventory)	1
Event COM-28a MAR (HEPA and ductwork MAR's are from Assumptions 11 and 18)	1 1 5	kg Pu (HEPA holdup) kg Pu (duct holdup) kg Pu (GB inventory)	1
Event COM-28c MAR (HEPA and ductwork MAR's are from Assumptions 11 and 18)	1 1 5	kg Pu (HEPA holdup) kg Pu (duct holdup) kg Pu (GB inventory)	1
Event COM-28e MAR	8.45E+06 2.4 600 500 1 150 3.7 0.5 1000 1000	g Pu (3013) kg Pu (waste drum) g Pu holdup g Pu (check standard) kg Pu (waste drum) g Pu (samples) kg Pu (cal standard) g Pu (waste bag) g Pu (HEPA) g Pu (holdup)	1
Event COM-28f MAR	8.45E+06 2.4 600 500 1 150 3.7 0.5 1000 1000	g Pu (3013) kg Pu (waste drum) g Pu holdup g Pu (check standard) kg Pu (waste drum) g Pu (samples) kg Pu (cal standard) g Pu (waste bag) g Pu (HEPA) g Pu (holdup)	1
Molar volume at STP	22.4	l/mole	9
Molecular weight H_2	2	g/mole	9
Molecular weight O	16	g/mole	9
Mass of standard SR 1979	400.42	g Pu	10
Mass of standard LL 1979	400.41	g Pu	10
Mass of standard SRPSTDPUEU1	0.1	g Pu	10
Mass of standard SRPSTDPUEU2	43.60	g Pu	10

Parameter	Value	Units	Reference
Mass of standard SRPSTDPUEU3	87.10	g Pu	10
Mass of standard SRPSTDPUEU4	174.50	g Pu	10
Mass of standard SRPSTDPUEU5	348.60	g Pu	10
Mass of standard SRPSTDPUEU6	1308.10	g Pu	10
Mass of standard SRPSTDPUEU7	1746.80	g Pu	10
Hydrogen generation rate	14	cm^3/hr/W	17

Assumptions

Assumption 1: The fraction of a TRU waste drum's inventory ejected when the drum is ruptured by a fire is 33%,

Basis for this assumption: This value is recommended in Reference 3 for drums involved in a pool fire. The fire is assumed conservatively to be capable of rapid heat up of the drum such that gases cannot escape through the drum's hydrogen vent fast enough to prevent pressurization.

Sensitivity to this assumption: The calculated consequences are driven by the fraction of the MAR that becomes unconfined during the event. The fraction defined in this assumption is specified in Reference 3 to be in an unconfined state for subsequent releases. A higher fraction becoming unconfined would lead to higher calculated doses.

Additional Text: None.

Assumption 2: The only standards to be used in CSSC are the following:

Check Standards: SR 1979, LL 1979

Calibration Standards: SRPSTDPUEU1, SRPSTDPUEU2, SRPSTDPUEU3, SRPSTDPUEU4, SRPSTDPUEU5, SRPSTDPUEU6, SRPSTDPUEU7

Basis for this assumption: This is consistent with facility operations.

Sensitivity to this assumption: Depending on composition, other standards may lead to higher or lower calculated consequences for events involving standards.

Additional Text: These standards are described in Reference 10.

Assumption 3: The evaluation temperature for calculating the pressure in a 3013 container is 340 K.

Basis for this assumption: This temperature corresponds to 152 deg F. The atmosphere within the container will be heated by the decay of the Pu oxide contained therein. The temperature assumed here is judged to be a reasonably bounding temperature.

Sensitivity to this assumption: The pressure calculated in Appendix B of this EC is sensitive to this assumption, at least in relation to the loading temperature; however, the results of this EC are not very sensitive to the pressure calculated in Appendix B.

Additional Text: None.

Assumption 4: The temperature at which the 3013 containers in CSSC were loaded with fill gas was 300 K.

Basis for this assumption: These containers were loaded in a typical room temperature situation. The assumed temperature is judged to be reasonable.

Sensitivity to this assumption: The pressure calculated in Appendix B is sensitive to the ratio of this temperature and the evaluation temperature in Assumption 3. However, the results of this EC are not sensitive to this assumption.

Additional Text: None.

Assumption 5: The pressure at which the 3013 containers in CSSC were loaded with fill gas is 14.7 psia.

Basis for this assumption: These containers were not pressurized in the process of loading with fill gas.

Sensitivity to this assumption: The pressure calculated in Appendix B would increase if the initial pressure were greater than one atmosphere. However, the results of this EC are not very sensitive to this assumption.

Additional Text: None.

Assumption 6: All 3013 containers are packaged according to the 3013 standard (Reference 9), i.e., the maximum inventory of a container is 4.4 kg Pu (5 kg Pu oxide) and the maximum moisture content is 0.5 wt %.

Basis for this assumption: This is consistent with facility operations. Adherence to the 3013 standard has been verified (through the material receipt program) prior to shipment to CSSC.

Sensitivity to this assumption: The results of this calculation may be very sensitive to this assumption, depending on the nature and magnitude of the variance.

Additional Text: None.

Assumption 7: The failure pressure of all sample vials and standards is 1000 psig.

Basis for this assumption: Reference 10 provides information about the check and calibration standards. The check standards are described as a paint can/produce can combination. These standards are judged to fail at a pressure far lower than 1000 psig. The calibration standards are described as a crimp sealed convenience can within two welded cans. According to Reference 11, the sample vials have a lid 0.125 inches thick and walls 0.157 inches thick.

Sensitivity to this assumption: Sample vials may hold 150 g of Pu. Except for event COM-41, events involving vials also involve other materials such that the contribution from the vials is relatively small. The results of this EC are, therefore, not very sensitive to this assumption.

Additional Text: None.

Assumption 8: Hydrogen, oxygen, and helium are the only gases generated within the 3013 container.

Basis for this assumption: Hydrogen and oxygen are generated by mechanisms discussed in Reference 9. Helium is generated by the alpha decay of the Pu isotopes present in the 3013.

Sensitivity to this assumption: The pressure calculated in Appendix B would increase if significant quantities of additional gases were generated.

Additional Text: None.

Assumption 9: Oxygen generated within a 3013 container is scavenged by the Pu Oxide (or other material) present in the container.

Basis for this assumption: In the development of equation 12 of Reference 9, it is assumed implicitly that any oxygen generated by this mechanism is removed from the atmosphere by adsorption onto surfaces.

Sensitivity to this assumption: The conclusions of this calculation may change if oxygen were considered to be present in the vapor space of the container. The pressure calculated in Appendix B may be significantly higher.

Additional Text: None.

Assumption 10: The only items occupying space within the inner 3013 container are the convenience can and Pu oxide.

Basis for this assumption: No other items are expected or have been identified.

Sensitivity to this assumption: The presence of items occupying significant space within the container would increase the pressure calculated in Appendix B. Unless the space occupied were large relative to the space occupied by the Pu oxide, the effect of these items on the results of this EC would not be large.

Additional Text: None.

Assumption 11: The inventory present as holdup in the CSSC ventilation exhaust system is 1 kg.

Basis for this assumption: This is judged to be a reasonably bounding value based on the operation/design of the facility. This system is protected by the HEPA filters in the glovebox exhaust stream. Significant contamination will not be present on this system unless a major accident has occurred. In the case of a major accident, the loading on the HEPA filters will be evaluated. A significant inventory present on the filters may indicate a significant inventory present throughout the system and further investigation will be undertaken.

Sensitivity to this assumption: The holdup residing in the ventilation system contributes to the consequences for several events ranging from facility wide events to events only involving the filter/fan pad and ductwork leading from the facility to the filters. The consequences of facility wide events are not sensitive to the holdup residing in the ventilation system because it is a small contributor to the over-all consequences. The consequences of events involving only the HEPA filters and ductwork may be sensitive to this assumption.

Additional Text: None.

Assumption 12: Resuspension of powder following a high-pressure pressurized release of that powder is ignored for the purpose of calculating consequences.

Basis for this assumption: The ARF*RF for a pressurized release is almost two orders of magnitude higher than that for resuspension. Furthermore, much of the powder residing in a 3013 undergoing rapid depressurization is expected to remain in the 3013 and to be shielded from the ventilation flow causing resuspension.

Sensitivity to this assumption: The results of this calculation are not sensitive to this assumption.

Additional Text: None.

Assumption 13: All material residing in a waste drum is combustible.

Basis for this assumption: This is a conservative assumption based on the airborne release fractions discussed in Reference 3.

Sensitivity to this assumption: If material residing in the drum were non-combustible, the calculated consequences would decrease for events involving drums.

Additional Text: None.

Assumption 14: None of the radiological inventory present in a waste drum is loose oxide powder.

Basis for this assumption: This is consistent with the treatment recommended in Reference 3. It is non-conservative but consistent with facility operations. Procedures are in place to preclude the introduction of loose powder into the waste drum.

Sensitivity to this assumption: The presence of loose powder would increase the consequences from events in which a high pressure failure of drums is anticipated. This failure mode occurs only in unmitigated scenarios. Mitigated scenarios, which credit the fire suppression system, involve seal failure of the drums. The presence of loose powder would not affect the consequences for mitigated scenarios.

Additional Text: None.

Assumption 15: The leakpath factor is one for all unmitigated scenarios and for mitigated scenarios not crediting HEPA filtration.

Basis for this assumption: This is a bounding assumption.

Sensitivity to this assumption: A leakpath factor less than one means that less material exits the building. Calculated consequences decrease when less material exits the building.

Additional Text: None.

Assumption 16: The material at risk for criticality events is that residing in 3013 containers.

Basis for this assumption: Criticalities may involve other containers but 3013 containers pressurized by a criticality lead to bounding unmitigated consequences. Criticality events have not been modeled other than to postulate a pressurized release of material.

Sensitivity to this assumption: Because all criticality events are prevented, the results of this EC are not sensitive to this assumption.

Additional Text: None.

Assumption 17: Unmitigated releases from a pressurized CPD occur at 1000 psig.

Basis for this assumption: This is judged to be conservative. The CPD is not designed to be absolutely leak tight.

Sensitivity to this assumption: The consequences of this EC are not sensitive to this assumption.

Additional Text: None.

Assumption 18: The inventory loaded on the CSSC HEPA filters is 1 kg.

Basis for this assumption: This is judged to be a reasonably bounding value based on the operation/operation of the facility. These filters are protected by the HEPA filters in the glovebox exhaust stream. Significant contamination will be present on the HEPA filters unless a major accident has occurred. In that case, the state of the HEPA filters will be evaluated and they will be replaced if excessive contamination is found to be present.

Sensitivity to this assumption: The consequences of events involving these filters exclusively is proportional to the inventory on the filters. The contribution from these filters to the consequences of events involving large segments of the facility is sometimes large for mitigated scenarios. The consequences for these events may be sensitive to this assumption.

Additional Text: None.

Assumption 19: The leakpath factor of the CSSC HEPA filters is at most 0.03%.

Basis for this assumption: These filters meet the performance requirements given in Reference 18 which states that "Aerosol penetration for any HEPA filter shall not exceed 0.03% (0.0003) at 0.3 micrometer diameter particles.".

Sensitivity to this assumption: The consequences of events crediting the filters as a mitigator are proportional to the HEPA leakpath factor. The results, therefore, are very sensitive to this assumption.

Additional Text: None.

5 ANALYTICAL METHODS AND COMPUTATIONS

The methodology for calculating the source term is taken from Reference 4:

$$ST = MAR \times DR \times ARF \times RF \times LPF \quad (1)$$

where ST = Source Term (Curies or grams)
MAR = Material at Risk (Curies or grams)
DR = Damage Ratio
ARF = Airborne Release Fraction (or Airborne Release Rate x Time for continuous release)
RF = Respirable Fraction
LPF = Leak Path Factor

The dose from the source term for a particular release mechanism (i.e., impact, resuspension, fire) is given by:

$$D_{ij} = ST \times TEDE_{ii} \quad (2)$$

where D_{ij} = Dose for i^{th} receptor and j^{th} release duration
$TEDE_{ij}$ = TEDE for the ith receptor and j^{th} release duration

In general, ARF's and RF's are taken from Reference 4. The LPF is assumed to be one. TEDE's, or dose factors, are taken from Reference 2.

Equations 1 and 2 are used in Appendix E to calculate unmitigated consequences for all CSSC accident scenarios. Mitigated scenarios are evaluated in the main body of this EC based on the spreadsheet developed in Appendix E.

Scenarios

In general, the scenarios described below involve two phases. In the initial phase, a short term, often energetic release occurs. This release may be the result of an explosion or fire. In the second phase, long-term resuspension results from wind suspending material (powder, contamination) for a period of time after the initial event. In the following, this resuspension phase is not discussed but it is a contributor to the consequences resulting from all non-pressurized releases. It has been ignored for pressurized releases (see Assumption 12).

Fires

The six fire events analyzed in this EC are listed below. These six do not include fires resulting from aircraft crash or natural phenomena events.

Event	Description
PA-1	Isolated fire in packaging area (not in glovebox or NDA room)
PA-3	Fire involving entire packaging area inventory (excluding glovebox and NDA room)
RS-2	Fire involving entire 3013 Storage Room inventory
GB-1	Glovebox fire
OF-2	Fan/filter pad fire
COM-3	External or internal fire propagates to involve entire CSSC inventory

The bounding fire event is COM-3. It is a fire initiated in any part of the KAC building (including CSSC) that propagates to engulf the entire CSSC inventory. It involves material in the processing rooms as well as material in the 3013 Storage Room. The fire is sufficiently intense to cause the pressurization and rupture of all containers present in the facility. Additional releases result from holdup in ductwork in gloveboxes. The next worst event is RS-2 which is a fire confined to the 3013 Storage Room. The consequences from these events are dominated by pressurized releases from 3013 containers residing in the 3013 Storage Room. These releases are very large and require preventive controls. Because RS-2 requires the same controls required by COM-3, COM-3 is taken as a bounding event and specific controls developed for this event. These controls mitigate event RS-2 as well.

Event PA-3, a fire involving the packaging area, bounds PA-1. PA-3 begins as an isolated fire and grows to involve multiple fuel packages. PA-3 may be mitigated by the 3013 container and the fire suppression system. The container is robust enough to prevent a release while the fire is

small enough that the fire suppression system has not been triggered. Strictly speaking, PA-1, the isolated fire, may be mitigated entirely by the 3013. However, this event must rely on the fire suppression system to prevent the isolated fire from becoming a room fire, i.e., event PA-3.

Event GB-1 is the bounding glovebox fire event. It is a pressurized release from a 3013 residing in the glovebox and a non-pressurized release from glovebox holdup material. The depressurization of the 3013 container creates a pressure wave which causes a release from the holdup material. This event is a unique bounding event.

Event OF-2 is a fire involving the fan/filter pad external to the CSSC processing areas. This fire disables the CSSC ventilation system and causes an air reversal in a glovebox. The material at risk is the contamination on the HEPA filters, material present as holdup in the ductwork of the ventilation system, and material in the glovebox including that in an open 3013 and holdup. This event is a unique bounding event.

Explosions

Six explosion events are addressed in this EC.

Event	Description
GB-4	Deflagration within CPD or CPD piping
GB-4a	Deflagration of CPD enclosure
GB-4b	Deflagration during can cutting
COM-40	Waste drum deflagration
COM-41	Sample gas vial deflagration
COM-42	Deflagration in standard, 3013, or inner 3013

GB-4 is a deflagration of a 3013 prior to, or during, puncturing in the CPD. Based on the discussion presented in Reference 14 (see p. 19 and 20 of that reference), the bounding pressurized release is not an explosion but the rupture of a container after the maximum buildup of pressure over its storage lifetime. Based on the calculation provided in Appendix B of the present EC, this pressure is taken to be 400 psig.

GB-4b is a deflagration of a 3013 prior to, or during, can cutting. The bounding pressure is the same as that for GB-4 (400 psig). Because this event does not occur within the CPD or other enclosure, holdup material residing in the glovebox (600 g total) will experience the pressure wave resulting from the depressurizing 3013. The contribution of holdup to the overall dose is small.

GB-4a is a deflagration involving hydrogen that has leaked from a 3013 into the CPD enclosure. The consequences of this event are bounded by those of GB-4b. However, unique controls associated with the CPD must be credited for this event and it is considered a unique event.

COM-40 is a deflagration involving a TRU waste drum as a result of hydrogen buildup in the drum. The drum is assumed to contain 395 g of Pu as contamination on the contents of the drum. This inventory is the maximum allowed in a large CSSC TRU waste drum. Because the contents of the drum are combustible, they are assumed to ignite as a result of the deflagration. The consequences of such an event are judged to be identical to those associated with a pressurized release resulting from a pool fire (see Appendix A).

COM-41 is a sample vial deflagration. The vial may contain 150 g of Pu as oxide. (It is more likely that this 150 g will reside in multiple vials; for conservatism, it is assumed here to be in a single vial.) The vial may contain a contaminated gas sample instead of an oxide sample. The consequences from a deflagration involving a gas sample are bounded by those from the oxide sample. Hydrogen is assumed to be generated within the vial as a result of the radiolysis of moisture attached to the oxide.

COM-42 is a deflagration within a 3013 container, a check standard, a calibration standard, or an inner 3013. This event may be initiated by a mechanical impact such as a drop and is bounded by the MAR and release from a 3013 container.

Each of the previously described deflagrations involve a unique container and entail unique controls; therefore, each is considered to be a bounding event.

Loss of Confinement Events

A total of seven loss of confinement events were identified in Reference 1.

Event	Description
RS-4	Collapse of 3013 Storage Room storage rack
GB-8	3013 failure within a glovebox
GB-10	Glovebox overpressurization
COM-X2	Dropped 3013/inner container/shipping package/sample vial/standard
COM-X3	Concrete impact on 3013/inner container/shipping package or TRU/LL waste
COM-18	Firearm discharge
COM-39	Leakage from non-pressurized inner container

RS-4 is the collapse of a storage rack in the 3013 Storage Room causing a loss of confinement from 120 3013 containers. The containers are assumed to be pressurized by gases evolved during storage.

GB-8 is the failure of a pressurized 3013 within a glovebox. Depressurization of the 3013 affects holdup material residing in the glovebox.

GB-10 is a glove box overpressurization event caused, for example, by a malfunctioning ventilation system. The material at risk is the inventory of a single 3013 (assumed to be open) and glovebox holdup.

COM-X2 is the pressurized release of material from a dropped container. The container may be any of the following: 3013, 3013 inner container, shipping package, sample vial, or standard.

COM-X3 is the pressurized release of material from two 3013 containers, 3013 inner containers, or a shipping packages as a result of the impact of spalled concrete or another dropped object on the containers. It may also involve an impact to TRU or LL waste; however, releases from waste are bounded by those from powder in the previously mentioned containers.

COM-18 is the impact of a bullet from the discharge of a firearm in the vicinity of a 3013. The container is assumed to be pressurized at the time of impact.

COM-39 is a spill of powder from an inner 3013 container prior to leak testing. The release is a non-pressurized release.

As with the deflagration events, loss of confinement events require unique controls; therefore, each is a bounding event.

Direct Exposure Events

There are two direct exposure events.

Event	Description
COM-X5	Inadvertent FM-200 discharge
COM-20	Process gas discharge

These events are non-radiological events. Each requires a unique control and is carried forward as a bounding event. COM-X5 involves the discharge of a fire suppression agent that if inhaled in sufficient quantity may cause heart arrhythmia and possibly death. COM-20 involves the release of process gas, e.g., P-10, CO_2, argon, helium, in sufficient quantities to cause asphyxiation.

Criticality Events

Three criticality events have been identified.

Event	Description
GB-17a	Criticality in glovebox
COM-25	Criticality in process area (inadvertent assembly)
COM-26	Criticality in process area (moderation/reflection)

GB-17a is a criticality in a process glovebox. This event involves the maximum inventory residing in the glovebox, i.e., a maximally loaded 3013 and holdup material.

COM-25 and COM-26 are criticalities involving multiple containers in a process area. No more than five 3013 containers may be located outside the 3013 Storage Room at one time and these five are assumed to be the MAR for this event. The consequences of criticalities involving other containers are bounded by those of a criticality involving 3013 containers.

All three criticality events are carried forward as bounding events.

External Events

Two external events are analyzed.

Event	Description
COM-27a	Aircraft crash into process area
COM-27b	Aircraft crash into fan/filter pad

COM-27a is the crash of a small aircraft into the building that houses CSSC. A full facility fire is assumed to follow the impact. The entire CSSC inventory is involved.

COM-27b is the crash of a small aircraft into the fan filter building. The initial impact affects inventory residing on the HEPA filters and held up in the ventilation system ductwork. The event is assumed to disable the ventilation system affecting an additional 5 kg of Pu (4.4 kg from an open 3013 and 0.6 kg holdup) residing in a glovebox.

Because these events involve impacts to different buildings, each event is considered to be a bounding event.

Natural Phenomena

Four natural phenomena events were identified in Reference 1.

Event	Description
COM-28a	High wind/tornado
COM-28c	Snow/ice/freezing temperature
COM-28e	Earthquake induced criticality
COM-28f	Earthquake induced fire

COM-28a is a high wind/tornado event that disables the ventilation system by damaging the fan/filter pad. Consequences result from HEPA filters and/or ductwork holdup being dislodged and falling or airborne objects striking filters or the ducts in which the holdup resides. Additional consequences result from powder in a glovebox assumed to undergo an air reversal.

COM-28c is a snow/ice/freezing temperature event that disables the ventilation system. The consequences from this event result only from a glovebox air reversal resulting from the loss of the ventilation system. The initiating event is judged not to cause a release from the HEPA filters or holdup in ventilation ductwork.

COM-28e is a seismic event that collapses the CSSC project area structure and damages the fan and/or filter on the fan/filter pad. A criticality event is assumed to result from the rearrangement of the 3013 containers located in the 3013 Storage Room. The criticality results in a pressurized release from all 3013 containers. An additional release results from the agitation of holdup material located in the glovebox and ventilation ductwork and from the HEPA filters which are assumed to be dislodged and drop.

COM-28f is a seismically induced fire. This event is assumed to cause a pressurized release from all containers that may be pressurized. Additional airborne releases result from agitation and the presence in the fire of HEPA filter and other holdup material.

These events are analyzed as bounding events.

Unmitigated Consequences

The unmitigated consequences are calculated in Appendix E and summarized in Table 1. From those calculations, it is apparent that pressurized releases are the greatest contributors to consequences; therefore, mitigating systems should concentrate on preventing/reducing these contributions.

Mitigated Consequences

Mitigated consequences for all events are calculated in Figure 1. Unmitigated consequences from Appendix E are included in the figure for comparison. The following sections discuss the mitigation of each event by event type. Events involving the 3013 Storage Room require credit be given for various controls (including the design of the storage racks and combustible controls) to mitigate offsite consequences. Events not involving the 3013 Storage Room do not require the mitigation of offsite consequences. Most, however, require mitigation for onsite consequences. Mitigators required for onsite receptors have been used to reduce the offsite consequences for events in which onsite mitigation is required. Mitigators required for facility workers in the vicinity of an event, but not for the 100 m onsite or offsite receptors, are not listed in Figure 1. These are, however, discussed in the following text.

Fires

PA-1

A release from a single 3013 container involved in an isolated fire in the process area is prevented by the 3013 container and the fire suppression system. This system extinguishes the fire before it can heat (and pressurize) the container to the point of failure. The container can withstand extremely high pressures at room temperature. At high temperatures, like those associated with a non-suppressed fire, the container may weaken and fail from internal pressure. The suppression system is capable of extinguishing fires involving a certain amount of combustibles (transient and fixed) or less. Therefore, crediting the fire suppression system requires crediting administrative controls to limit the amount of combustibles present in areas near 3013 containers. The mitigated consequences of this event are zero to all receptors.

PA-3

This event involves material in various containers within the packaging area. As in event PA-1, the combination of the 3013 container, the fire suppressions system, and combustible loading controls are credited with preventing the fire from heating up 3013 containers such that a pressurized release occurs. Samples and calibration and check standards are not credited in this way; pressurized releases from these containers are assumed to occur even in the mitigated scenario. The fire suppression system (in conjunction with combustible controls) is credited with preventing a pressurized release from waste drums. These drums, however, may undergo seal failure in a fire eventually extinguished by the suppression system. Releases from waste present in plastic bags are not mitigated by the suppression system. All releases from the building during this event are mitigated by the CSSC ventilation system which includes HEPA filtration. The mitigated consequences to the 100 m onsite receptor are 0.34 rem. The consequences to personnel in the room at the time the event begins are mitigated by evacuation. It is judged that such personnel will receive doses comparable to that calculated for the 100 m receptor. The consequences to the offsite receptor are 0.26 mrem.

RS-2

This event results in the pressurized release of inventory from 3013 containers residing in the 3013 Storage Room. Combustibles are strictly controlled in this room by design and by administrative controls. Fires that might challenge a 3013 are prevented; therefore, the mitigated consequences from this event are zero to all receptors.

GB-1

The glovebox may contain one 3013 (open or closed) in addition to inventory present as holdup. Because the room fire suppression system may not be capable of extinguishing a fire in the glove box and because it is desired not to credit the glovebox fire suppression system, a pressurized release from the 3013 container occurs in the mitigated scenario. The pressure wave from the depressurizing 3013 is assumed to affect material present as holdup. Airborne releases from both of these sources are mitigated by the facility ventilation system which provides HEPA filtration. The mitigated consequences are 0.54 mrem to the offsite receptor and 0.71 rem to the 100 m onsite receptor. The glovebox confinement and exhaust ventilation system are credited with providing enough time for workers in the vicinity to evacuate.

OF-2

This event is prevented by combustible controls for the fan/filter pad outside the CSSC facility. Because the fire does not occur, the ventilation system is not disabled and the postulated air reversal does not occur. The mitigated consequences for this event are zero to all receptors.

COM-3

This fire involves the 3013 Storage Room and other process areas. A fire initiated outside CSSC (i.e., in the KAC) is prevented from propagating into CSSC by the external fire-rated walls. A fire initiated within CSSC is mitigated as follows. Releases from 3013 containers located in the 3013 Storage Room are prevented by various controls including the design of the racks and limits on combustibles in the room. It is assumed that five 3013 containers are present in process areas including the glovebox. A pressurized release from 3013 containers is prevented in a process room by the room fire suppression system, room combustible loading limits, and the 3013 container which must be robust enough to prevent a release before the suppression system can extinguish the fire. One of the five containers may be located in a glovebox. For the reasons given in the previous discussion regarding event GB-1, the bounding glovebox fire, this container is assumed to undergo a pressurized release in the mitigated scenario. The rupturing of this container produces a pressure wave assumed to cause an airborne release from holdup in the glovebox. Additional releases result from material in waste drums. By limiting the severity of the fire, the suppression system prevents a pressurized release from these drums; however, a release still occurs via seal failure. Waste in bags results in a similar release. Calibration and check standards as well as sample containers cannot withstand the fire. They are assumed to fail at the 3013 container failure pressure (as in the unmitigated scenario). The building ventilation system including HEPA filtration is credited with mitigating releases to all receptors external to the building. Personnel within the building are assumed to evacuate before a significant release can

occur. The mitigated consequences for this event are 0.80 mrem to the offsite receptor and 1.1 rem to the 100 m receptor.

Explosions

GB-4

This event is a deflagration of a 3013 while inside the CPD. As mentioned in Appendix E, the bounding 3013 release pressure does not correspond to a deflagration but to the maximum pressure that may buildup during normal storage. Because the 3013 resides in the CPD, holdup material present in the glovebox will not experience the pressure wave caused by the rupturing container. For receptors outside the building, the only system available to mitigate this event is the ventilation system including HEPA filtration. Crediting filtration, the offsite dose is 0.28 mrem and the onsite dose, 0.37 rem. Personnel in the vicinity of the explosion are protected from the pressure wave by the CPD and from the initial burst of airborne contamination by the glovebox confinement system. The glovebox exhaust ventilation system provide protection from contamination remaining in the glovebox atmosphere after the initial burst. These items are judged to give personnel sufficient time for evacuation before significant uptake occurs.

GB-4a

A deflagration within the CPD but not in the 3013 container is judged not to result in an appreciable release crediting the presence of the 3013 with shielding the powder contained therein from the pressure wave resulting from the deflagration. A deflagration in the CPD originating in a punctured 3013 may result in a release; however, this release is bounded by that associated with event GB-4. Powder originating in the 3013 must first be expelled into the CPD before being released into the glovebox proper. This reduces the effective release pressure. Furthermore, the presence of the CPD will shield holdup material present in the glovebox from any pressure wave. Finally, any release from the building resulting from this event is mitigated by the filtered ventilation system. The offsite consequences for this event are 0.28 mrem. The onsite consequences are 0.37 rem. Personnel within the vicinity of the glovebox, i.e., within the room, are protected from the pressure wave by the CPD. The confinement function of the glovebox and its exhaust ventilation system are credited with giving personnel sufficient time to evacuate.

GB-4b

This event is a deflagration in the glovebox during can cutting. The can cutter does not shield holdup material present in the glovebox in the same way the CPD does. Therefore, holdup contributes to the source term. The consequences are mitigated by the ventilation system which includes HEPA filtration. Crediting filtration, the offsite dose is 0.29 mrem and the onsite dose, 0.38 rem. Workers in the vicinity of the glovebox are protected by the confinement function of the glovebox and the glovebox ventilation exhaust system. As shown previously, the maximum pressure at which a 3013 may undergo rapid depressurization is 400 psig. This pressure will not significantly pressurize the glovebox. Because the event is not a detonation, shrapnel is not produced such that it might threaten the glovebox window.

COM-40

All TRU waste drums used in CSSC are required to be vented. Therefore, a deflagration within the drum is prevented. The consequences from this event are zero to all receptors.

COM-41

Based on Reference 21 the sample vial will withstand an internal deflagration; therefore, crediting the design of the vial makes the calculated consequences for this event zero to all receptors.

COM-42

This event may involve a 3013 container, a check standard, a calibration standard, or an inner 3013 that has not been leak checked. The 3013 container has been drop tested at heights of interest for this event; therefore, a release is not considered credible. A non-leak checked inner 3013 has not been drop tested but has been recently loaded. As shown in Appendix B of this EC, a period of time is required for significant pressure to buildup in the 3013 after loading. These containers are processed immediately; therefore, a pressurized release is not considered credible. Check and calibration standards also have not been drop tested. However, the ISSC program ensures that standards do not undergo significant pressurization. Some initiators for this event (i.e., impact and drop) may lead to spill releases (see event COM-39). Because this event is defined as a deflagration, however, the mitigated consequences from this event are zero to all receptors.

Loss of Confinement Events

RS-4

This event is prevented by the design of the 3013 container storage racks and the building structural integrity program. The former addresses various low energy initiators such as a cart impact. The latter addresses the impact of structural components which are so large that the storage rack cannot be effectively designed against their impact. The mitigated consequences from this event are zero for all receptors.

GB-8

This event is identical to event GB-4 if it is recognized that a deflagration is bounded by a pressurized release at the bounding storage pressure as discussed with respect to event GB-4. Because it occurs within the CPD, glovebox holdup is not affected. The release is mitigated by the ventilation system which includes HEPA filtration. The offsite and onsite consequences are 0.37 rem and 0.28 mrem, respectively. As in event GB-4, the CPD, the glovebox confinement function, and the glovebox ventilation exhaust mitigate the release to personnel in the vicinity of the glovebox.

GB-10

This event is mitigated by the room ventilation system including HEPA filtration, at least with respect to receptors external to the building, i.e., the offsite and 100 m receptors. The consequences to these receptors are 1.9E-06 rem and 2.6E-03 rem, respectively. The confinement function of the glovebox and various safety functions associated with the glovebox ventilation system give personnel in the immediate vicinity time to evacuate before they incur significant uptake of radioactive material.

COM-X2

Shipping packages and 3013 containers have been drop tested; therefore, these containers may be credited with preventing a release from this event. Inner 3013 containers that have not been leak checked have not been tested. As discussed in event COM-42 (and shown in Appendix B), inner 3013 containers are not expected to have sufficient time to buildup appreciable pressure prior to processing. Standards have not been dropped tested; per the ISSC program, however, they are not pressurized. Sample vials are strong enough to withstand a deflagration. They are judged to be strong enough to withstand a drop event (possibly leading to a deflagration) without losing confinement. Ruling out pressurized releases reduces this event to a spill/leakage event identical to event COM-39. It involves the contents of a maximally loaded 3013 container. This MAR bounds that of all containers. The mitigated consequences are 1.3E-05 rem offsite and 17 mrem to the 100 m onsite receptor. The consequences to the facility worker in the vicinity of the event are judged to be small given controls on the handling of these containers.

COM-X3

This event involves impacts to two containers (3013 containers, standards, drums, samples, 3013 inner containers). Containers are not designed against the impact of large objects; therefore, they must be prevented. The structural integrity program is credited with preventing impacts from structural components. Operating procedures are credited with preventing impacts from objects, such as gas cylinders, routinely handled within the facility. The container is credited with precluding releases from non-preventable impacts involving small objects. The consequences to all receptors from this event are zero.

COM-18

This event is prevented by controls implemented by the Safeguards and Security Program which prevent the accidental discharge of a firearm in the vicinity of a container. The consequences from this event, therefore, are zero to all receptors.

COM-39

This event is conservatively modeled assuming the entire inventory of the inner container is spilled. Even with this conservatism, the consequences to the offsite and 100 m receptors are very small. Crediting the CSSC ventilation system with HEPA filtration reduces the consequences to 1.3E-05 rem offsite and 17 mrem onsite. The consequences to a worker in the immediate vicinity of the spill are judged to be negligible as well given controls on the handling of such containers.

Direct Exposure Events

COM-X5

This event is prevented by the design of the FM-200 system. The system is composed of one train. The discharge of a single FM-200 train with the capacity inherent in the design will not cause the release of sufficient agent to cause overexposure. The consequences to all receptors from this event are zero.

COM-20

The size of the room in which process gases reside is large enough to preclude the accumulation of dangerous concentrations. Controls on the operation and design of the glovebox CO2 system prevent the accumulation of dangerous concentrations when personnel are present. The consequences to all receptors from this event are zero.

Criticality Events

GB-17a

This event, like all criticality events, is prevented by criticality controls. The consequences to all receptors from this event are zero.

COM-25

This event is prevented by criticality controls. The consequences are zero to all receptors.

COM-26

As with the previous events, this event is prevented by criticality controls and the consequences to all receptors are zero.

External Events

COM-27a

This event involves all CSSC inventory except that external to the building proper, i.e., the inventory residing on the building HEPA filters and the ductwork leading to the filters. While the building is not credited with preventing releases as a result of this event, it is credited with preventing damage to mitigative systems. As with other events affecting the 3013 Storage Room inventory, the design of the storage racks and 3013 containers, combustible controls, and operational controls are credited with preventing a release from this material. All 3013 containers located in process areas are prevented from undergoing a pressurized release by the CSSC fire suppression system in combination with the robustness of the 3013 container. To arrive at bounding mitigated consequences for this event, one maximally loaded 3013 is assumed to reside

in the glovebox. This 3013 is assumed to undergo a pressurized release because the glovebox fire suppression system is not capable of preventing such a release. Check standards, calibration standards, and sample containers are also assumed to fail at 1000 psig. The fire suppression system is assumed to control the fire before it becomes sufficiently intense to cause waste drums to pressurize prior to failure. These containers are assumed to undergo seal failure. The small release associated with waste in bags remains as in the unmitigated scenario. All releases from the building are mitigated by the CSSC ventilation system which carries airborne material through HEPA filters before exiting the building. The mitigated consequences to the offsite receptor are 0.79 mrem. The mitigated consequences to the onsite receptor are 1.0 rem. Because the fire requires time to develop, CSSC facility workers will have sufficient time to evacuate prior to an airborne release. The emergency preparedness program is credited with ensuring that these workers are capable of evacuating.

COM-27b

The external fan and filters are not designed to withstand the impact of an aircraft. The aircraft, furthermore, carries its own combustibles in the form of its fuel and, therefore, an ensuing fire cannot be prevented by limiting combustibles around the fan/filter pad. The initial impact will disable the CSSC ventilation system thus causing an air reversal in the glovebox. Because mitigators are not available to reduce the consequences to the offsite and onsite 100 m receptors, the mitigated consequences to these receptors are identical to the unmitigated consequences, i.e., 26 rem to the onsite receptor and 20 mrem to the offsite receptor. The consequences to a worker in the vicinity of the glovebox are mitigated by the confinement function of the glovebox which provides this receptor sufficient time to evacuate before he receives a significant dose.

Natural Phenomena

COM-28a

The CSSC building (excluding the fans and filters on the fan/filter pad and associated ductwork) is designed to withstand tornado winds and missiles. The CSSC ventilation system is equipped with a tornado damper and interlocks thus preventing air reversals from occurring as a result of the impact of a tornado on the fan/filter pad and associated ductwork. Inventory residing on the HEPA filters and in ductwork leading to the HEPA filters is assumed to be affected by tornado winds and/or missiles. The mitigated consequences associated with these items are the same as the unmitigated consequences; controls are not available to mitigate these releases. The mitigated consequences to the offsite and 100 m onsite receptors are 11 mrem and 15 rem, respectively. The consequences to personnel within the CSSC facility building will be much lower because of the protection afforded by the building structure.

COM-28c

This event is mitigated by the design of the fan, filters, and ductwork outside the KAC building. These components are design to withstand snow, ice, and freezing temperatures without a negative effect on the CSSC ventilation system; therefore, conditions leading to a release, such

as a flow reversal, do not occur. The mitigated consequences to all receptors from this event are zero.

COM-28e

The criticality program is credited with preventing a criticality following an earthquake. The building is qualified to withstand the initiating event as are the storage room racks (which prevent containers stored therein from falling to the floor); therefore, 3013 containers residing in the storage room do not undergo a pressurized release during this scenario. As shown in Reference 20, a criticality involving five oxide containers (the maximum number allowed at one time in all process areas combined) or one metal container (again, the maximum number allowed at one time in all process areas combined) is not possible. (The reference actually excludes a criticality involving eleven oxide containers plus standards or two metal containers plus standards.) To maximize the calculated consequences, it is assumed that the contents of one maximally loaded 3013 are in the glovebox, out of the container. This material is subject to shaking by the earthquake. Check and calibration standards are assumed not to undergo a release. Pressurization is precluded for these items by the ISSC program and a loss of confinement event involving them is precluded by the building structure and controls preventing impact by falling objects, e.g., overhead equipment. Loaded 3013 containers not in the storage room are likewise protected from the impact of falling objects and will not undergo a release. Sample containers, are assumed to undergo pressurized releases. Waste drums and bags are assumed to undergo a non-pressurized release. The loading on HEPA filters results in a release as a result of shaking. The filters (and ventilation system), however, continue to provide filtration for releases occurring within the facility. The mitigated consequences to the offsite receptor are 11 mrem. The mitigated consequences to the 100 m onsite receptor are 15 rem. The emergency preparedness program is credited with reducing the consequences to CSSC facility personnel.

COM-28f

Based on the survivability of the building and storage racks, 3013 containers residing in the 3013 Storage Room will not undergo a pressurized release during the initial earthquake. A pressurized release from these containers during the subsequent fire is prevented by 3013 Storage Room combustible controls and the design of the storage racks. 3013 containers residing in process areas will not fall from heights greater than those for which they have been qualified and are protected from falling objects by controls on the type and location of overhead equipment. The 3013 container, combustible controls, and the fire suppression system prevent releases from 3013 containers outside the 3013 Storage Room because of a fire. To maximize the consequences for this scenario, it is assumed that one of these containers is located in the glovebox. This container undergoes a pressurized release because the glovebox fire suppression system is not capable of preventing such a release. Check and calibration standards and sample containers are also assumed to undergo a pressurized release during the fire. The fire suppression system and combustible controls are credited with preventing a pressurized release from TRU waste drums. Waste drums are assumed to undergo seal failure resulting in a non-pressurized release. Waste bags are also assumed to undergo a non-pressurized release. Inventory residing on HEPA filters and in the ventilation ductwork leading to the HEPA's is subject to shaking by the earthquake but not subject to a fire stress. Combustible controls and the design of the filters, fan, and ventilation system prevent a fire involving this material. The mitigated consequences to the

offsite and 100 m onsite receptors from this event are 12 mrem and 16 rem, respectively. The calculated consequences to facility workers are reduced by the emergency preparedness program which trains workers to minimize exposures during these types of events.

6 RESULTS

The results of this EC are summarized in Table 2. Each event is listed with its corresponding consequences and the mitigative systems credited in calculating those consequences.

7 CONCLUSION

The consequences of all CSSC accidents have been determined and are summarized in Table 2. With mitigation, these consequences are all well below evaluation guidelines.

Event	Offsite Dose (rem)	Onsite Dose (rem)
PA-1	1.79E+00	2.35E+03
PA-3	9.96E+00	1.31E+04
RS-2	High	High
GB-1	1.80E+00	2.37E+03
OF-2	1.11E-02	1.51E+01
COM-3	High	High
GB-4	9.42E-01	1.24E+03
GB-4a	9.56E-01	1.26E+03
GB-4b	9.56E-01	1.26E+03
COM-40	2.11E-02	2.75E+01
COM-41	6.10E-02	8.01E+01
COM-42	9.42E-01	1.24E+03
RS-4	High	High
GB-8	9.56E-01	1.26E+03
GB-10	6.32E-03	8.61E+00
COM-X2	9.42E-01	1.24E+03
COM-X3	1.88E+00	2.48E+03
COM-18	9.42E-01	1.24E+03
COM-39	4.33E-02	5.72E+01
GB-17a	1.80E+00	2.37E+03
COM-25	8.95E+00	1.18E+04
COM-26	8.95E+00	1.18E+04
COM-27a	High	High
COM-27b	1.97E-02	2.63E+01
COM-28a	1.74E-02	2.33E+01
COM-28c	6.32E-03	8.61E+00
COM-28e	High	High
COM-28f	High	High

Table 1. Unmitigated consequences

Event	Offsite Consequences (rem)	Onsite Consequences (rem)	Credited Controls
PA-1	0	0	Container Room Fire Suppression Room Combustible Controls
PA-3	2.55E-04	3.36E-01	Container Room Fire Suppression Room Combustible Controls Facility HEPA Filtration
RS-2	0	0	Container Storage Room Controls
GB-1	5.41E-04	7.10E-01	Facility HEPA Filtration
OF-2	0	0	Fan/Filter Combustible Controls
COM-3	7.96E-04	1.05E+00	Container Room Fire Suppression Storage Room Controls Room Combustible Controls Facility HEPA Filtration
GB-4	2.83E-04	3.72E-01	Facility HEPA Filtration
GB-4a	2.83E-04	3.72E-01	Facility HEPA Filtration CPD Design/Operation
GB-4b	2.87E-04	3.77E-01	Facility HEPA Filtration
COM-40	0	0	Drum Vent
COM-41	0	0	Sample Vial Design
COM-42	0	0	Container ISSC Program
RS-4	0	0	Container Storage Room Controls Building Structure
GB-8	2.83E-04	3.72E-01	Facility HEPA Filtration CPD Design/Operation
GB-10	1.90E-06	2.58E-03	Facility HEPA Filtration
COM-X2	1.30E-05	1.72E-02	Facility HEPA Filtration
COM-X3	0	0	Container Building Structure Falling Object Controls
COM-18	0	0	Safeguards and Security Controls
COM-39	1.30E-05	1.72E-02	Facility HEPA Filtration
GB-17a	0	0	Criticality Program
COM-25	0	0	Criticality Program
COM-26	0	0	Criticality Program

Table 2. Summary of mitigated consequences and controls.

Event	Offsite Consequences (rem)	Onsite Consequences (rem)	Credited Controls
COM-27a	7.93E-04	1.04E+00	Container Room Fire Suppression Storage Room Controls Room Combustible Controls Facility HEPA Filtration
COM-27b	1.97E-02	2.63E+01	N/A
COM-28a	1.11E-02	1.47E+01	Fan/Filter Design including Damper
COM-28c	0	0	Fan/Filter Design including Damper
COM-28e	1.11E-02	1.48E+01	Storage Room Controls Criticality Program Fan/Filter Design including Damper Facility HEPA Filtration Building Structure Falling Object Controls ISSC Program
COM-28f	1.19E-02	1.58E+01	Container Room Fire Suppression Storage Room Controls Room Combustible Controls Facility HEPA Filtration Building Structure Falling Object Controls Fan/Filter Design including Damper
COM-X5	N/A	N/A	FM-200 Design/Controls
COM-20	N/A	N/A	Process Gas System Design/Controls

Table 2 (continued). Summary of mitigated consequences and controls.

	A	B	C	D	E	F	G	H	I
1	**CSSC Accident Consequences**								
2									
3	**Dose per MAR**								
4	**(rem/g Pu)**			**Offsite**	**Onsite**			**Controls**	
5									
6	3013/sample (1000 psig)			4.068E-04	5.341E-01		**1**	Container	
7	Calibration standards (1000 psig)			1.814E-04	2.385E-01		**2**	Room Fire Suppression	
8	Check standards (1000 psig)			1.886E-04	2.480E-01		**3**	Storage Room Controls	
9	Waste (pressurized)			5.333E-05	6.956E-02		**4**	Criticality Program	
10	Waste (non-pressurized)			7.267E-06	9.578E-03		**5**	Drum Vent	
11	Holdup in fire			2.122E-06	2.850E-03		**6**	Fan/Filter Design Including Damper	
12	HEPA in fire			2.694E-06	3.602E-03		**7**	Room Combustible Controls	
13	3013 (400 psig)			2.141E-04	2.818E-01		**8**	Fan/Filter Combustible Controls	
14	Holdup pressure wave			2.271E-05	2.992E-02		**9**	CPD Design/Operation	
15	Powder spill			9.844E-06	1.300E-02		**10**	Sample Vial Design	
16	Holdup earthquake plus fire			3.552E-06	4.730E-03		**11**	Facility HEPA Filtration	
17	HEPA earthquake plus fire			9.844E-06	1.300E-02		**12**	Building Structure	
18	Holdup earthquake			2.694E-06	3.602E-03		**13**	Falling Object Controls	
19	HEPA impact			8.414E-06	1.112E-02		**14**	Safeguards and Security Controls	
20	Holdup air reversal			1.264E-06	1.722E-03		**15**	ISSC Program	
21									
22								**HEPA LPF**	
23								3.00E-04	
24									
25									
26				**Unmitigated**			**Mitigated**		
27									
28	**Event**	**Material**	**MAR**	**Offsite**	**Onsite**		**Offsite**	**Onsite**	
29		**Category**		**Dose**	**Dose**		**Dose**	**Dose**	**Controls**
30			**(g)**	**(rem)**	**(rem)**		**(rem)**	**(rem)**	
31									
32	**PA-1**	3013	4400	**1.79E+00**	**2.35E+03**		**0**	**0**	1, 2, 7
33									
34	**PA-3**	drum	2400	1.28E-01	1.67E+02		5.23E-06	6.90E-03	2, 7, 11
35		3013	22000	8.95E+00	1.18E+04		0	0	1, 2, 7
36		check standard	500	9.43E-02	1.24E+02		2.83E-05	3.72E-02	2, 7, 11
37		drum	1000	5.33E-02	6.96E+01		2.18E-06	2.87E-03	2, 7, 11
38		sample	150	6.10E-02	8.01E+01		1.83E-05	2.40E-02	2, 7, 11
39		calibration standard	3700	6.71E-01	8.83E+02		2.01E-04	2.65E-01	2, 7, 11
40		bag	0.5	3.63E-06	4.79E-03		1.09E-09	1.44E-06	2, 7, 11
41			Total	**9.96E+00**	**1.31E+04**		**2.55E-04**	**3.36E-01**	
42									
43	**RS-2**	3013	8.45E+06	**HIGH**	**HIGH**		**0**	**0**	1, 3
44									
45	**GB-1**	3013	4400	1.79E+00	2.35E+03		5.37E-04	7.05E-01	11
46		holdup	600	1.36E-02	1.80E+01		4.09E-06	5.39E-03	11
47			Total	**1.80E+00**	**2.37E+03**		**5.41E-04**	**7.10E-01**	
48									
49	**OF-2**	HEPA	1000	2.69E-03	3.60E+00		0	0	8
50		holdup	1000	2.12E-03	2.85E+00		0	0	8
51		3013	4400	5.56E-03	7.58E+00		0	0	8
52		holdup	600	7.58E-04	1.03E+00		0	0	8
53			Total	**1.11E-02**	**1.51E+01**		**0.00E+00**	**0.00E+00**	

Figure 1. Calculation of mitigated consequences.

	A	B	C	D	E	F	G	H	I
55	**COM-3**	3013	8.43E+06	**HIGH**	**HIGH**		0	0	1, 3
56		drum	2400	1.28E-01	1.67E+02		5.23E-06	6.90E-03	2, 7, 11
57		3013	22000	8.95E+00	1.18E+04		5.37E-04	7.05E-01	1, 2, 7, 11
58		check standard	500	9.43E-02	1.24E+02		2.83E-05	3.72E-02	2, 7, 11
59		holdup	600	1.36E-02	1.80E+01		4.09E-06	5.39E-03	2, 7, 11
60		drum	1000	5.33E-02	6.96E+01		2.18E-06	2.87E-03	2, 7, 11
61		sample	150	6.10E-02	8.01E+01		1.83E-05	2.40E-02	2, 7, 11
62		calibration standard	3700	6.71E-01	8.83E+02		2.01E-04	2.65E-01	2, 7, 11
63		bag	0.5	3.63E-06	4.79E-03		1.09E-09	1.44E-06	2, 7, 11
64			Total	**HIGH**	**HIGH**		**7.96E-04**	**1.05E+00**	
65									
66	**GB-4**	3013	4400	**9.42E-01**	**1.24E+03**		**2.83E-04**	**3.72E-01**	11
67									
68	**GB-4a**	3013	4400	9.42E-01	1.24E+03		2.83E-04	3.72E-01	11
69		holdup	600	1.36E-02	1.80E+01		0	0	9
70			Total	**9.56E-01**	**1.26E+03**		**2.83E-04**	**3.72E-01**	
71									
72	**GB-4b**	3013	4400	9.42E-01	1.24E+03		2.83E-04	3.72E-01	11
73		holdup	600	1.36E-02	1.80E+01		4.09E-06	5.39E-03	11
74			Total	**9.56E-01**	**1.26E+03**		**2.87E-04**	**3.77E-01**	
75									
76	**COM-40**	drum	395	**2.11E-02**	**2.75E+01**		**0**	**0**	5
77									
78	**COM-41**	sample	150	**6.10E-02**	**8.01E+01**		**0**	**0**	10
79									
80	**COM-42**	3013	4400	**9.42E-01**	**1.24E+03**		**0**	**0**	1, 15
81									
82	**RS-4**	3013	5.28E+05	**HIGH**	**HIGH**		**0**	**0**	1, 3, 12
83									
84	**GB-8**	3013	4400	9.42E-01	1.24E+03		2.83E-04	3.72E-01	11
85		holdup	600	1.36E-02	1.80E+01		0	0	9
86			Total	**9.56E-01**	**1.26E+03**		**2.83E-04**	**3.72E-01**	
87									
88	**GB-10**	3013	4400	5.56E-03	7.58E+00		1.67E-06	2.27E-03	11
89		holdup	600	7.58E-04	1.03E+00		2.28E-07	3.10E-04	11
90			Total	**6.32E-03**	**8.61E+00**		**1.90E-06**	**2.58E-03**	
91									
92	**COM-X2**	3013	4400	**9.42E-01**	**1.24E+03**		**1.30E-05**	**1.72E-02**	11
93									
94	**COM-X3**	3013	8800	**1.88E+00**	**2.48E+03**		**0**	**0**	1, 12, 13
95									
96	**COM-18**	3013	4400	**9.42E-01**	**1.24E+03**		**0**	**0**	14
97									
98	**COM-39**	3013	4400	**4.33E-02**	**5.72E+01**		**1.30E-05**	**1.72E-02**	11
99									
100	**GB-17a**	3013	4400	1.79E+00	2.35E+03		**0**	**0**	4
101		holdup	600	1.36E-02	1.80E+01		0	0	4
102			Total	**1.80E+00**	**2.37E+03**		**0.00E+00**	**0.00E+00**	
103									
104	**COM-25**	3013	22000	**8.95E+00**	**1.18E+04**		0	0	4
105									
106	**COM-26**	3013	22000	**8.95E+00**	**1.18E+04**		0	0	4

Figure 1 (continued). Calculation of mitigated consequences.

	A	B	C	D	E	F	G	H	I
108	**COM-27a**	3013	8.45E+06	**HIGH**	**HIGH**		5.37E-04	7.05E-01	1, 2, 3, 7, 11
109		drum	2400	1.28E-01	1.67E+02		5.23E-06	6.90E-03	2, 7, 11
110		check standard	500	9.43E-02	1.24E+02		2.83E-05	3.72E-02	2, 7, 11
111		holdup	600	1.27E-03	1.71E+00		3.82E-07	5.13E-04	2, 7, 11
112		drum	1000	5.33E-02	6.96E+01		2.18E-06	2.87E-03	2, 7, 11
113		sample	150	6.10E-02	8.01E+01		1.83E-05	2.40E-02	2, 7, 11
114		calibration standard	3700	6.71E-01	8.83E+02		2.01E-04	2.65E-01	2, 7, 11
115		bag	0.5	3.63E-06	4.79E-03		1.09E-09	1.44E-06	2, 7, 11
116			Total	**HIGH**	**HIGH**		**7.93E-04**	**1.04E+00**	
117									
118	**COM-27b**	HEPA	1000	9.84E-03	1.30E+01		9.84E-03	1.30E+01	N/A
119		holdup	1000	3.55E-03	4.73E+00		3.55E-03	4.73E+00	N/A
120		3013	4400	5.56E-03	7.58E+00		5.56E-03	7.58E+00	N/A
121		holdup	600	7.58E-04	1.03E+00		7.58E-04	1.03E+00	N/A
122			Total	**1.97E-02**	**2.63E+01**		**1.97E-02**	**2.63E+01**	
123									
124	**COM-28a**	HEPA	1000	8.41E-03	1.11E+01		8.41E-03	1.11E+01	N/A
125		holdup	1000	2.69E-03	3.60E+00		2.69E-03	3.60E+00	N/A
126		3013	4400	5.56E-03	7.58E+00		0	0	6
127		holdup	600	7.58E-04	1.03E+00		0	0	6
128			Total	**1.74E-02**	**2.33E+01**		**1.11E-02**	**1.47E+01**	
129									
130	**COM-28c**	3013	4400	5.56E-03	7.58E+00		**0**	**0**	6
131		holdup	600	7.58E-04	1.03E+00		0	0	6
132			Total	**6.32E-03**	**8.61E+00**		**0.00E+00**	**0.00E+00**	
133									
134	**COM-28e**	3013	8.45E+06	**HIGH**	**HIGH**		3.56E-06	4.75E-03	3, 4, 6, 11, 12, 13
135		drum	2400	1.74E-02	2.30E+01		5.23E-06	6.90E-03	4, 11, 12
136		check standard	500	9.43E-02	1.24E+02		0	0	4, 11, 12, 13, 15
137		holdup	600	1.62E-03	2.16E+00		4.85E-07	6.48E-04	6, 11, 12
138		drum	1000	7.27E-03	9.58E+00		2.18E-06	2.87E-03	4, 11, 12
139		sample	150	6.10E-02	8.01E+01		1.83E-05	2.40E-02	4, 11, 12
140		calibration standard	3700	6.71E-01	8.83E+02		0	0	4, 11, 12, 13, 15
141		bag	0.5	3.63E-06	4.79E-03		1.09E-09	1.44E-06	4, 11, 12
142		HEPA	1000	8.41E-03	1.11E+01		8.41E-03	1.11E+01	6
143		holdup	1000	2.69E-03	3.60E+00		2.69E-03	3.60E+00	6
144			Total	**HIGH**	**HIGH**		**1.11E-02**	**1.48E+01**	
145									
146	**COM-28f**	3013	8.45E+06	**HIGH**	**HIGH**		5.37E-04	7.05E-01	1, 2, 3, 7, 11, 12, 13
147		drum	2400	1.28E-01	1.67E+02		5.23E-06	6.90E-03	2, 7, 11, 12
148		check standard	500	9.43E-02	1.24E+02		2.83E-05	3.72E-02	2, 7, 11, 12
149		holdup	600	2.13E-03	2.84E+00		6.39E-07	8.51E-04	2, 7, 11, 12
150		drum	1000	5.33E-02	6.96E+01		2.18E-06	2.87E-03	2, 7, 11, 12
151		sample	150	6.10E-02	8.01E+01		1.83E-05	2.40E-02	2, 7, 11, 12
152		calibration standard	3700	6.71E-01	8.83E+02		2.01E-04	2.65E-01	2, 7, 11, 12
153		bag	0.5	3.63E-06	4.79E-03		1.09E-09	1.44E-06	2, 7, 11, 12
154		HEPA	1000	9.84E-03	1.30E+01		8.41E-03	1.11E+01	6
155		holdup	1000	3.55E-03	4.73E+00		2.69E-03	3.60E+00	6
156			Total	**HIGH**	**HIGH**		**1.19E-02**	**1.58E+01**	

Figure 1 (continued). Calculation of mitigated consequences.

APPENDIX A. CONSEQUENCES OF FIRE INVOLVING TRU WASTE DRUM

This appendix provides a calculation of the consequences resulting from transuranic waste involved in a fire. The calculations are based on the methodology presented in Reference 3. Two scenarios are considered. The first is an intense fire, e.g., a fire involving an entire room or a significant portion of a room. This fire generally involves more radionuclide inventory than TRU waste. The second is an isolated fire of much lower intensity. This fire may be small enough to involve only TRU waste.

As recommended in Reference 3, waste is assumed conservatively to be 100% combustible (see Assumption 13). It is also assumed that none of the waste is present as loose oxide powder (see Assumption 14). SRS SWMF analyses assume the presence of small amounts of combustible liquid and that a small fraction of the inventory is present as loose powder. The ARF*RF used in SWMF analyses (5E-02) for unconfined burning solids is higher than that recommended in Reference 3 (1E-02). Because of other differences, however, SWMF analyses give lower doses than does an analysis performed in accordance with Reference 3. The present analysis is performed in accordance with Reference 3 and is judged to be reasonably bounding.

A room fire has sufficient intensity to pressurize a vented drum before enough heated gas can escape through the filter to relieve the internal pressure. The result is an explosive depressurization that ejects the lid of the drum and a portion of the drum's contents. It is important to determine the portion of the waste that becomes "un-agglomerated" as defined in SWMF analyses (Reference 13) because ARF*RF values for un-agglomerated waste are much larger than those for agglomerated waste. Agglomerated means "in a pile or container" such that the pile or container effectively limits the airborne release during a fire or resuspension. In this context, the term agglomerated is used interchangeably with the terms confined and contained.

All waste ejected by the rapid depressurization of the drum is assumed to become unconfined and to be subject to an elevated fire ARF*RF. The portion of the waste not ejected from the drum is subject to the ARF*RF appropriate for packaged mixed waste. Implicit in this development is the assumption that the radionuclide inventory is uniformly distributed throughout the waste, i.e., the inventory is not in such a form, or attached to a certain waste form, that the fraction of inventory becoming unconfined differs to a great extent from the fraction of waste becoming unconfined. The fraction of waste becoming unconfined during the fire is maintained for the subsequent resuspension phase of the event. This inventory is subject to an elevated resuspension ARF*RF relative to the inventory remaining in the drum. In keeping with the methodology presented in Reference 3, an impact ARF*RF is applied to the portion of the waste ejected from the drum. This indicates material made airborne as the ejected material strikes the ground.

Figure A-1 shows the calculation of the consequences resulting from 450 g of Pu present in a waste container pressurized by a fire. The fraction of waste ejected during the event is 33%. This material is considered to be unconfined. An ARF*RF of 1E-02 is applied to this material. The waste remaining in the drum (67%) is considered to be confined. An ARF*RF of 5E-04 is applied to this material. The inventory ejected from the drum is also subject to an impact ARF*RF of 1E-04. After the initial release, inventory is subject to resuspension. An ARF = ARR*Time = 4E-05/hr*8 hr = 3.2E-04 and an RF of one are applied to the portion ejected from

the drum. An ARR*Time = 4E-06*8 hr = 3.2E-05 and an RF of one are applied to the portion remaining in the drum.

	A	B	C	D	E	F	G	H	I	J
1	**CSSC Waste Drum Fire Consequences**									
2	**(With Pressurization)**									
3										
4	**MAR**									
5	**(g Pu)**									
6	**450**									
7							**Onsite**	**Offsite**	**Onsite**	**Offsite**
8		**MAR**	**DR**	**ARF**	**RF**	**ST**	**TEDE**	**TEDE**	**Dose**	**Dose**
9	**Stress**	**(g Pu)**				**(g Pu)**	**(rem/g Pu)**	**(rem/g Pu)**	**(rem)**	**(rem)**
10										
11	**Lid Ejection**	450	0.67	5.00E-04	1	1.51E-01	1.88E+01	1.43E-02	2.83E+00	2.16E-03
12	**Confined Burn**									
13										
14	**Lid Ejection**	450	0.33	1.00E-02	1	1.49E+00	1.88E+01	1.43E-02	2.79E+01	2.12E-02
15	**Unconfined Burn**									
16										
17	**Lid Ejection**	450	0.33	1.00E-03	0.1	1.49E-02	1.88E+01	1.43E-02	2.79E-01	2.12E-04
18	**Impact**									
19										
20	**Confined**	450	0.67	3.20E-05	1	9.65E-03	5.38E+00	3.95E-03	5.19E-02	3.81E-05
21	**Resuspension**									
22										
23	**Unconfined**	450	0.33	3.20E-04	1	4.75E-02	5.38E+00	3.95E-03	2.56E-01	1.88E-04
24	**Resuspension**									
25								**Total**	3.13E+01	2.38E-02

Figure A-1. Calculation of the consequences from a TRU waste drum involved in a room fire.

The consequences of an isolated fire are much lower than those for the room fire. For this fire, the drum is assumed to undergo seal failure instead of catastrophic lid ejection. The ARF*RF recommended in Reference 4 for packaged mixed waste (5E-04) is applied to the entire drum inventory (450 g Pu) as shown in Figure A-2. Also applied in this case is the confined resuspension ARF calculated previously (3.2E-05).

	A	B	C	D	E	F	G	H	I	J
1	**CSSC Waste Drum Fire Consequences**									
2	**(No Pressurization)**									
3										
4	**MAR**									
5	**(g Pu)**									
6	**450**									
7							**Onsite**	**Offsite**	**Onsite**	**Offsite**
8		**MAR**	**DR**	**ARF**	**RF**	**ST**	**TEDE**	**TEDE**	**Dose**	**Dose**
9	**Stress**	**(g Pu)**				**(g Pu)**	**(rem/g Pu)**	**(rem/g Pu)**	**(rem)**	**(rem)**
10										
11	**Confined Burn**	450	1	5.00E-04	1	2.25E-01	1.88E+01	1.43E-02	4.23E+00	3.22E-03
12										
13	**Confined**	450	1	3.20E-05	1	1.44E-02	5.38E+00	3.95E-03	7.75E-02	5.69E-05
14	**Resuspension**									
15								**Total**	4.31E+00	3.27E-03

Figure A-2. Calculation of the consequences from a TRU waste drum involved in an isolated fire.

APPENDIX B. PRESSURE IN A 3013 CONTAINER

This appendix provides a calculation of the bounding pressure in a 3013 caused by the accumulation of gases over its storage lifetime. This calculation applies to a 3013 containing Pu oxide. The calculation is based on equation 25 of Reference 9.

The pressure within the 3013 container is the sum of the partial pressures associated with the fill gas, hydrogen generated by radiolysis, and helium resulting from the alpha decay of Pu. The following equation can be used to calculate the pressure:

$$P = P_0\left(\frac{T_1}{T_0}\right) + 1.206\left(\frac{T_1}{V_1}\right)\dot{G}_H t + 7.517x10^{-5} Q_0 t\left(\frac{T_1}{V_1}\right) \qquad \text{(B-1)}$$

where P_0 is the fill pressure; T_1, the evaluation temperature; T_0, the fill temperature; V_1, the 3013 volume: $\dot{G}_H$, the hydrogen generation rate; *t*, the storage time; and Q_0, the heat generation rate.

This equation is equation 25 of Reference 9 with a modification to show the accumulation of hydrogen with time. The original equation assumed implicitly that all the water present in the container had been converted to hydrogen. The time variation was included by replacing the G term in equation 12 of Reference 9 by the hydrogen generation rate times the time ($\dot{G}_H t$). This modification is reflected in the second term on the right hand side of equation B-1. In Reference 9 (and in the spreadsheet described later in this appendix), the first term on the right hand side of equation B-1 is referred to as P_F, the fill gas partial pressure; the second term, P_G, the evolved gases partial pressure; and the third term, P_{He}, the decay helium partial pressure.

The volume used in equation B-1 is the free volume of the inner 3013. This volume is calculated by subtracting the volumes occupied by the convenience can (top, bottom, and walls, equal to 104.01 cm^3) and the Pu oxide residing in the inner 3013 (5 kg divided by 11.46 kg/l = 0.4363 l) from the volume of the inner 3013 (2074.53 cm^3). These are the only items occupying space within the inner 3013 container (see Assumption 10).

The hydrogen generation rate (14 cm^3/hr/W) is taken from Reference 17. This generation rate is very conservative because it does not take into account energy deposited in materials other than the small amount of liquid present. The wattage associated with a maximally loaded 3013 with the bounding CSSC composition is calculated in Figure B-1, as is the hydrogen generation rate in moles/hr based on the calculated wattage and the generation rate from Reference 17.

The input section of Figure B-1 includes the inventory (4,400 g Pu), the molar volume at 0 deg C (22.4 l/mole), and the generation rate (14 cm^3/hr/W) entered in cells A9, C9, and E9, respectively.

The main block of Figure B-1 determines the watts produced by each isotopic component and multiplies these Watts by the generation rate (after conversion to the proper units) to give the generation rate for each isotope in moles/hr. The total hydrogen generation rate is the sum of the rates associated with individual isotopes. Note that the total heat output (23.8 W) exceeds that allowed by Reference 9. Therefore, it is not possible to load a 3013 container with 4.4 kg Pu of

the composition assumed in the CSSC analysis. In the calculation that follows, the heat generation rate is set to 19 W instead of the value determined in Figure B-1.

Equation B-1 is implemented in the spreadsheet shown in Figure B-2. The calculation is done as a function of time. Only the first 46 rows of the spreadsheet are shown (from time = 0 through time = 74 hr). Input data is entered in the block defined by rows 4-23 and columns A-E. The inner 3013 container volume is calculated in cell A8 by subtracting the convenience can volume (104.01 cc) from the empty inner 3013 container volume (2074.53 cc). The free volume of the inner 3013 is calculated in cell A-33 by subtracting the Pu oxide volume from the inner 3013 volume. PF is independent of time and is calculated in cell C33 based on the fill pressure, fill temperature, and evaluation temperature. The maximum number of moles of hydrogen present in the container is calculated in cell A37 using the following equation:

Max H_2 = Pu oxide mass*moisture content/(H_2 mol wt + O mol wt) (B-3)

This amount of hydrogen is present when all the moisture in the container has been converted to hydrogen and oxygen by radiolysis.

PG is calculated in cell C37 using the following equation (equation 13 from 9):

PG = 0.67*Pu oxide mass*moisture content*evaluation temp/free volume (B-4)

The main calculational block of cells in Figure B-2 (columns G-I) calculates the pressure as a function of time using equation B-1 in conjunction with the input data and calculated quantities previously described.

The result of the calculation is shown in the charts shown in Figures B-3 and B-4. The pressure levels off at 388 psia (rounded up) at approximately 5 days. This pressure occurs when all the moisture in the container has been converted to hydrogen and oxygen. Because of helium generation, the pressure continues to rise after the moisture has been exhausted. This rise is so slow that it is not apparent in the Figures. The pressure remains below 390 psia at five years.

	A	B	C	D	E	F	G	H
1	**Calculation of Heat Output and Hydrogen Generation Rate**							
2								
3					**Bounding H2**			
4			**Molar**		**Generation**			
5			**Volume**		**Rate**			
6	**Inventory**		**at 0 deg C**		**at 0 deg C**			
7	**(g Pu)**		**(l/mole)**		**(cm3/hr/W)**			
8								
9	4400		22.4		14			
10								
11				**Heat**	**Specific**	**Heat**	**Heat**	**Hydrogen**
12		**Weight**	**Inventory**	**Rate**	**Activity**	**Rate**	**Rate**	**Rate**
13	**Isotope**	**Percent**	**(g)**	**(W/Ci)**	**(Ci/g)**	**(W/g)**	**(W)**	**(mole/hr)**
14								
15	Pu-238	0.1002	4.4088	3.26E-02	17.1	5.57E-01	2.46E+00	1.54E-03
16	Am-241	1.714	75.416	3.28E-02	3.44	1.13E-01	8.52E+00	5.32E-03
17	Pu-241	1.815	79.86	3.20E-05	103	3.30E-03	2.63E-01	1.65E-04
18	Pu-240	20.62	907.28	3.06E-02	0.227	6.94E-03	6.29E+00	3.93E-03
19	Pu-239	76.08	3347.52	3.02E-02	0.0621	1.88E-03	6.29E+00	3.93E-03
20	Pu-242	1.385	60.94	2.90E-02	0.00393	1.14E-04	6.95E-03	4.35E-06
21								
22						**Total**	2.382E+01	1.489E-02

Figure B-1. Heat output and hydrogen generation rate for CSSC material.

	A	B	C	D	E	F	G	H	I
1	**Calculation of 3013 Inner Container Pressure**								
2									
3							**Delta**		
4			**Standard**				(hr)		
5	**Volume**		**Molar**		**Evaluation**		2		
6	**3013**		**Volume**		**Temp**				
7	(l)		(l/mole)		(K)		**Time**	**Time**	**Pressure**
8	1.97052		22.4		340		(hr)	(d)	(psia)
9							0	0	16.66
10	**Pu Oxide**		**Moisture**		**Fill**		2	0.08333	23.0086307
11	**Inventory**		**Content**		**Temp**		4	0.16667	29.3572614
12	(kg)		(wt %)		(K)		6	0.25	35.7058921
13	5		0.5		300		8	0.33333	42.0545228
14							10	0.41667	48.4031535
15	**Container**		**Fill**		**Volume of**		12	0.5	54.7517843
16	**Heat Rate**		**Press**		**Pu Oxide**		14	0.58333	61.100415
17	(W)		(psia)		(l)		16	0.66667	67.4490457
18	19		14.7		0.4363		18	0.75	73.7976764
19							20	0.83333	80.1463071
20	**H2**						22	0.91667	86.4949378
21	**Rate**						24	1	92.8435685
22	(mole/hr)						26	1.08333	99.1921992
23	0.011877						28	1.16667	105.54083
24							30	1.25	111.889461
25							32	1.33333	118.238091
26							34	1.41667	124.586722
27							36	1.5	130.935353
28							38	1.58333	137.283983
29	**3013**						40	1.66667	143.632614
30	**Free**						42	1.75	149.981245
31	**Volume**		**PF**				44	1.83333	156.329876
32	(l)		(psia)				46	1.91667	162.678506
33	1.53422		16.66				48	2	169.027137
34							50	2.08333	175.375768
35	**Max H2**		**Max PG**				52	2.16667	181.724398
36	(moles)		(psia)				54	2.25	188.073029
37	1.3888889		371.198394				56	2.33333	194.42166
38							58	2.41667	200.770291
39							60	2.5	207.118921
40							62	2.58333	213.467552
41							64	2.66667	219.816183
42							66	2.75	226.164813
43							68	2.83333	232.513444
44							70	2.91667	238.862075
45							72	3	245.210706
46							74	3.08333	251.559336

Figure B-2. Calculation of 3013 inner container pressure as a function of time.

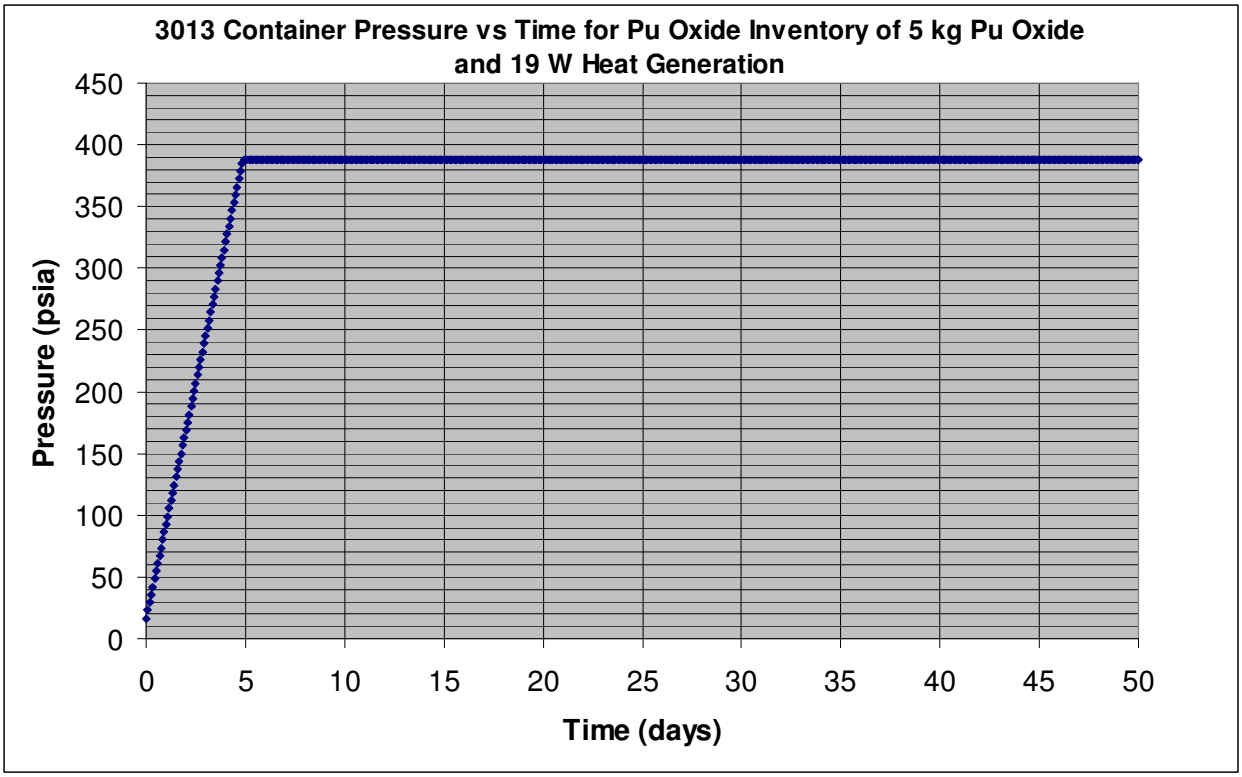

Figure B-3. 3013 pressure as a function of time (long times).

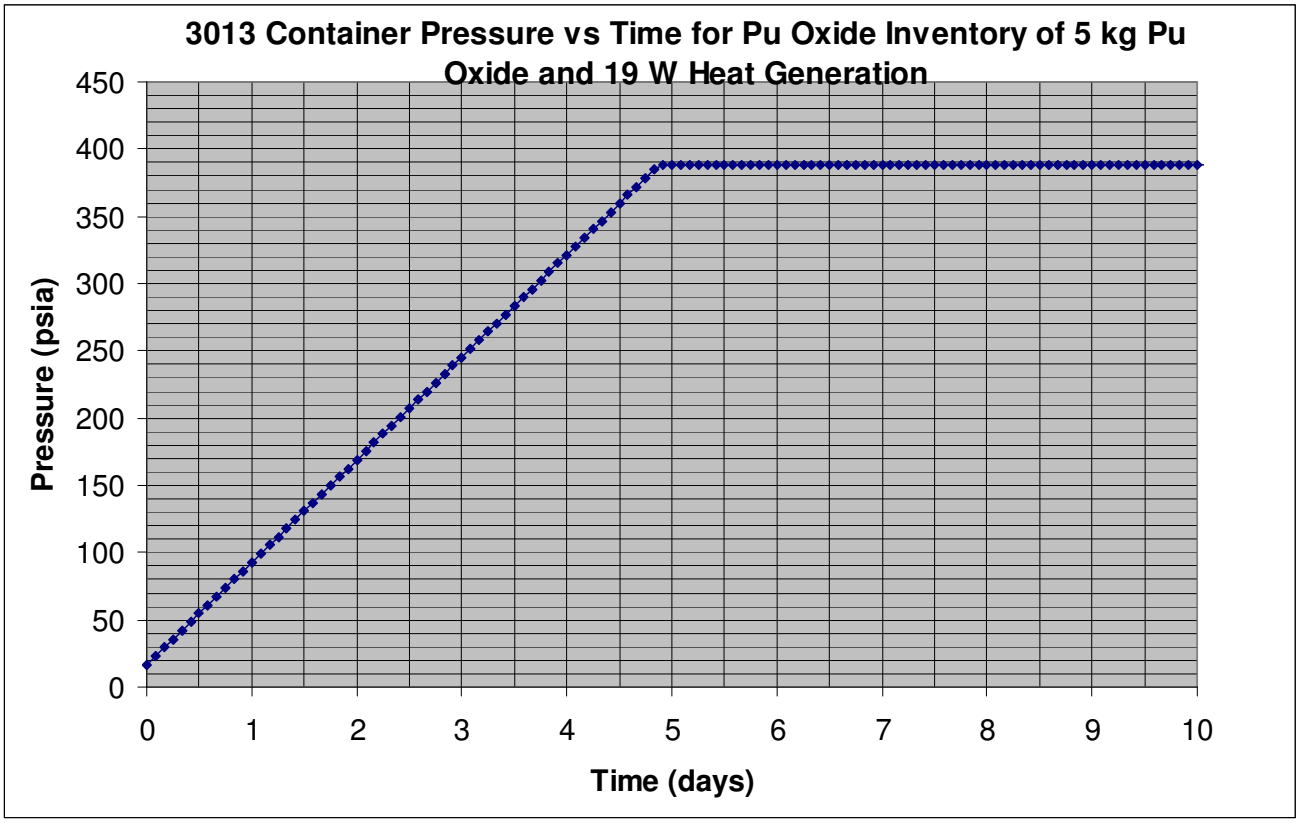

Figure B-4. 3013 pressure as a function of time (short times).

APPENDIX C. CONSEQUENCES FROM A PRESSURIZED RELEASE FROM A 3013 CONTAINER

This appendix provides a calculation of the consequences resulting from the rapid depressurization of a 3013 container after heatup in a fire. The calculation is based on the following equation from Reference 6:

$$\text{Bounding ARF} = 1.29\text{E-}03 * P^{0.7} \qquad \text{(C-1)}$$

where P is the release pressure.

The bounding RF (also taken from Reference 6) is 0.7.

Equation C-1 is applied in Figure C-1 to a maximally loaded 3013 container. As recommended in Reference 6, an ARF reduction factor of four has been applied to account for the configuration of the powder in the container. The dose factors are the standard dose factors used throughout this EC. The LPF has been set to one. ARF*RF values for the low pressure (< 25 psig) and the no-pressure cases have been taken from Reference 4.

	A	B	C	D	E
2	**Consequences of Pressurized Release from 3013 Container**				
3					
4	**MAR**	**LPF**	**TEDE (MOI)**	**TEDE (100m)**	
5	(kg Pu)		(rem/g Pu)	(rem/g Pu)	
6	4.4	1	1.43E-02	1.88E+01	
7					
8					
9	**Failure Pressure**	**ARFxRF**	**Offsite Dose**	**100 m Dose**	
10	(psig)		(rem)	(rem)	
11	0	6.00E-05	3.78E-03	4.96E+00	
12	< 25	2.00E-03	1.26E-01	1.65E+02	
13	25	0.002148749	1.35E-01	1.78E+02	
14	50	0.003490654	2.20E-01	2.89E+02	
15	100	0.005670584	3.57E-01	4.69E+02	
16	150	0.007531676	4.74E-01	6.23E+02	
17	200	0.00921189	5.80E-01	7.62E+02	
18	250	0.010769258	6.78E-01	8.91E+02	
19	300	0.012235244	7.70E-01	1.01E+03	
20	350	0.013629358	8.58E-01	1.13E+03	
21	400	0.01496476	9.42E-01	1.24E+03	
22	450	0.016250866	1.02E+00	1.34E+03	
23	500	0.017494711	1.10E+00	1.45E+03	
24	600	0.019876213	1.25E+00	1.64E+03	
25	700	0.022140957	1.39E+00	1.83E+03	
26	800	0.024310324	1.53E+00	2.01E+03	
27	900	0.02639961	1.66E+00	2.18E+03	
28	1000	0.028420241	1.79E+00	2.35E+03	

Figure C-1. 3013 container consequences.

APPENDIX D. DOSE FACTORS FOR CHECK AND CALIBRATION STANDARDS

Seven calibration standards and two check standards will be used in CSSC. This appendix provides a calculation of dose factors to be used to calculate consequences when one or more of these standards are involved in an event.

Dose factors are determined based on previously calculated factors for CSSC powder. These factors were calculated using the MACCS computer code (Reference 2) and are based on ICRP 68/72 inhalation factors. Reference 7 calculates "Normalized Dose Potential" values for the Pu and Am isotopes present in the CSSC composition. As discussed in Reference 7, other isotopes known to be present in these standards, e.g., uranium isotopes, are negligible. These factors are normalized to the dose potential of Pu-238 and indicate the dose potential without dispersion for each isotope. Assuming dispersion is independent of isotope, normalized dose potential factors and the composition of the standards can be used to determine equivalent dose factors for these standards.

Figure D-1 shows the calculation. Input data is entered in rows 1 through 21. All check standards have one composition and all calibration standards have another. The composition of CSSC powder, upon which the dose factors given in cells D29 and E29 are based, is also given as input. Normalized dose potential factors are entered in row 21.

The CSSC powder dose potential is calculated in cell A27 by multiplying the CSSC powder percent composition for each isotope (row 18) by the corresponding normalized dose potential (row 21) and summing. Similarly, the check standards dose potential (cell A35) and the calibration standards dose potential (cell A43) are calculated using their respective percent compositions and the normalized dose potential values. As expected, the dose potential for check standards and for calibration standards are smaller than the dose potential for CSSC powder.

Offsite and onsite dose factors for check standards and for calibration standards are calculated by multiplying the dose factors for CSSC powder by the ratio of the check standards and calibration standards dose potentials, respectively, to the CSSC powder dose potential. Offsite dose factors are calculated in cells D36 (check standards) and D43 (calibration standards). Onsite dose factors are calculated in cells F36 (check standards) and F43 (calibration standards).

	A	B	C	D	E	F	G	H	I
1	**Calculation of Dose Factors for Standards**								
2									
3						**Percent Composition**			
4									
5				**Pu-238**	**Pu-239**	**Pu-240**	**Pu-241**	**Pu-242**	**Am-241**
6									
7	**Check**	SR 1979		0.011	93.73	5.861	0.37	0.027	0.32893
8	**Standards**	LL 1979		0.011	93.73	5.861	0.37	0.027	0.32893
9									
10	**Calibration**	SRPSTDPUEU1		0.0144	93.778	5.8618	0.2798	0.0658	0.248742
11	**Standards**	SRPSTDPUEU2		0.0144	93.778	5.8618	0.2798	0.0658	0.248742
12		SRPSTDPUEU3		0.0144	93.778	5.8618	0.2798	0.0658	0.248742
13		SRPSTDPUEU4		0.0144	93.778	5.8618	0.2798	0.0658	0.248742
14		SRPSTDPUEU5		0.0144	93.778	5.8618	0.2798	0.0658	0.248742
15		SRPSTDPUEU6		0.0144	93.778	5.8618	0.2798	0.0658	0.248742
16		SRPSTDPUEU7		0.0144	93.778	5.8618	0.2798	0.0658	0.248742
17									
18	**CSSC Powder**			0.1002	76.08	20.62	1.815	1.385	1.714
19									
20									
21	**Normalized Dose Potential**			1	3.947E-03	0.01443	0.1178	2.398E-04	0.1837
22									
23									
24	**CSSC Powder**			**Offsite**		**Onsite**			
25	**Dose Potential**			**TEDE**		**TEDE**			
26				**(3 min)**		**(3 min)**			
27	1.227035283			**(rem/g Pu)**		**(rem/g Pu)**			
28									
29				1.43E-02		1.88E+01			
30									
31				**Offsite**		**Onsite**			
32	**Check Standards**			**TEDE**		**TEDE**			
33	**Dose Potential**			**(3 min)**		**(3 min)**			
34				**(rem/g Pu)**		**(rem/g Pu)**			
35	0.569543456								
36				6.64E-03		8.73E+00			
37									
38				**Offsite**		**Onsite**			
39				**TEDE**		**TEDE**			
40	**Calibration Standards**			**(3 min)**		**(3 min)**			
41	**Dose Potential**			**(rem/g Pu)**		**(rem/g Pu)**			
42									
43	0.547797701			6.38E-03		8.39E+00			

Figure D-1. Calculation of dose factors for standards.

APPENDIX E. UNMITIGATED CONSEQUENCES

The purpose of this appendix is to calculate the unmitigated consequences for all events addressed in this EC. Consequences are calculated for the Maximum Offsite Individual (MOI) and a receptor located 100 m from the event.

The methodology for calculating the source term is taken from Reference 4:

$$ST = MAR \times DR \times ARF \times RF \times LPF \qquad \text{(E-1)}$$

where ST = Source Term (Curies or grams)
MAR = Material at Risk (Curies or grams)
DR = Damage Ratio
ARF = Airborne Release Fraction (or Airborne Release Rate x Time for continuous release)
RF = Respirable Fraction
LPF = Leak Path Factor

The dose from the source term for a particular release mechanism (i.e., impact, resuspension, fire) is given by:

$$D_{ij} = ST \times TEDE_{ii} \qquad \text{(E-2)}$$

where D_{ij} = Dose for i^{th} receptor and j^{th} release duration
$TEDE_{ij}$ = TEDE for the ith receptor and j^{th} release duration

In general, ARF's and RF's are taken from Reference 4. The LPF is assumed to be one. TEDE's, or dose factors, are taken from Reference 2.

Because of the number of events addressed in this EC and because of the number material/confinement types involved, equations E-1 and E-2 have been applied in two steps. In the first step, an effective dose per unit MAR is calculated for the various material/confinement types. In the second step, these values are multiplied by the MARs associated with each event and, if necessary, the result totaled to determine the consequences for each event.

Figure E-1 shows the calculation of rem/MAR values for the required materials and confinement situations. The first three calculations are based on the calculations given in Appendix A and Appendix C. The doses corresponding to a particular MAR (450 g Pu for waste and 4.4 kg Pu for powder in a 3013) and the corresponding offsite and onsite doses are taken from those appendices. The doses are divided by the MAR in columns D and E to get the desired factors.

Calculations 4, 5, 7, 8, and 11-14 in Figure E-1 are similar. They are non-pressurized releases and include resuspension in addition to the initial release. The dose/MAR is calculated for these cases using

$ARF*RF_{initial}*TEDE_{3min} + ARF*RF_{resusp}*TEDE_{8hr}$.

Cases 6, 9, and 10 are pressurized releases and do not include resuspension (see Assumption 12). For case 6, the dose/MAR is calculated by dividing the dose at 400 psig from Appendix C by the MAR. For cases 9 and 10, the dose/MAR factor is $ARF*RF_{initial}*TEDE_{3min}$.

Case 15 is a non-pressurized release. It does not include resuspension because the initial release for this event (a glovebox air reversal) results from resuspension.

For all cases except 9 and 10, dose factors from Reference 2 are used. For cases 9 and 10, dose factors are taken from Appendix D.

The rem/MAR values determined in Figure E-1 are used in Figure E-2 to calculate the consequences for all CSSC events. Values from Figure E-1 are input at the top of Figure E-2 (rows 6-20). The main calculational portion of the Figure E-2 (beginning at row 32) is composed of columns A-C which give the event number and MAR from Reference 1 and columns D and E which calculate the offsite and onsite doses for each receptor by multiplying the dose/MAR by the MAR. When multiple MAR's are present, total doses are calculated by adding the doses from each MAR.

As in Reference 14, pressurized releases from 3013 containers in a fire are assumed to occur at 1000 psig. A pressurized release from a deflagration in one of these containers is assumed to occur at 400 psig. A flammable mixture is not anticipated to exist within a 3013 container if the container has been loaded according to Reference 9. As discussed in References 14 and 15, the pressure that may be produced by a deflagration within the 3013 is limited such that the maximum pressure (without a deflagration) expected over the storage lifetime of the container (see Appendix B) bounds the expected deflagration pressure. This pressure (400 psig) was used with the Figure C-1 (see Appendix C) to determine the ARF*RF used for this case in Figure E-1.

Releases from sample vials and standards are assumed to occur at a pressure of 1000 psig (see Assumption 7). A release resulting from a deflagration within the CPD (event GB-4) is also assumed to occur at a pressure of 1000 psig (see Assumption 18). The consequences of this event are calculated assuming artificially that the 3013 is not present to protect the powder residing in it from being released through the rupture in the CPD. In the mitigated scenario, the 3013 is credited and the consequences from this event are minimal.

	A	B	C	D	E	F	G	H
1	**Dose per MAR for Various Cases**							
2								
3	**1. Pressurized release of powder from 3013**							
4	**(1000 psig)**							
5		Offsite	Onsite	Offsite	Onsite			
6	MAR	Dose	Dose	Dose/MAR	Dose/MAR			
7	(g Pu)	(rem)	(rem)	(rem/g)	(rem/g)			
8	4400	1.79	2.35E+03	4.07E-04	5.34E-01			
9								
10	**2. Pressurized release of waste**							
11								
12		Offsite	Onsite	Offsite	Onsite			
13	MAR	Dose	Dose	Dose/MAR	Dose/MAR			
14	(g Pu)	(rem)	(rem)	(rem/g)	(rem/g)			
15	450	2.40E-02	31.3	5.33E-05	6.96E-02			
16								
17	**3. Non-pressurized release of waste**							
18								
19		Offsite	Onsite	Offsite	Onsite			
20	MAR	Dose	Dose	Dose/MAR	Dose/MAR			
21	(g Pu)	(rem)	(rem)	(rem/g)	(rem/g)			
22	450	3.27E-03	4.31E+00	7.27E-06	9.58E-03			
23								
24	**4. Release of holdup in fire**							
25			Offsite	Onsite	Offsite	Onsite		
26			TEDE	TEDE	TEDE	TEDE	Offsite	Onsite
27	Fire	Resuspension	(3 min)	(3 min)	(8 hr)	(8 hr)	Dose/MAR	Dose/MAR
28	ARF*RF	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)
29	6.00E-05	3.20E-04	0.0143	18.8	3.95E-03	5.38	2.12E-06	2.85E-03
30								
31	**5. Release of HEPA filter contamination in fire**							
32								
33			Offsite	Onsite	Offsite	Onsite		
34			TEDE	TEDE	TEDE	TEDE	Offsite	Onsite
35	Fire	Resuspension	(3 min)	(3 min)	(8 hr)	(8 hr)	Dose/MAR	Dose/MAR
36	ARF*RF	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)
37	1.00E-04	3.20E-04	0.0143	18.8	3.95E-03	5.38	2.69E-06	3.60E-03
38								
39	**6. Pressurized release of powder**							
40	**(400 psig)**							
41		Offsite	Onsite	Offsite	Onsite			
42	MAR	Dose	Dose	Dose/MAR	Dose/MAR			
43	(g Pu)	(rem)	(rem)	(rem/g)	(rem/g)			
44	4400	0.942	1.24E+03	2.14E-04	2.82E-01			
45								
46	**7. Release of holdup external to explosion**							
47								
48			Offsite	Onsite	Offsite	Onsite		
49			TEDE	TEDE	TEDE	TEDE	Offsite	Onsite
50	Initial	Resuspension	(3 min)	(3 min)	(8 hr)	(8 hr)	Dose/MAR	Dose/MAR
51	ARF*RF	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)
52	1.50E-03	3.20E-04	0.0143	18.8	3.95E-03	5.38	2.27E-05	2.99E-02
53								
54	**8. Powder spill**							
55			Offsite	Onsite	Offsite	Onsite		
56			TEDE	TEDE	TEDE	TEDE	Offsite	Onsite
57	Initial	Resuspension	(3 min)	(3 min)	(8 hr)	(8 hr)	Dose/MAR	Dose/MAR
58	ARF*RF	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)
59	6.00E-04	3.20E-04	0.0143	18.8	3.95E-03	5.38	9.84E-06	1.30E-02

Figure E-1. Dose per MAR factors.

	A	B	C	D	E	F	G	H
61	**9. Pressurized release of calibration standard**							
62	(1000 psig)							
63		Offsite	Onsite					
64		TEDE	TEDE	Offsite	Onsite			
65	Initial	(3 min)	(3 min)	Dose/MAR	Dose/MAR			
66	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)			
67	2.84E-02	0.006384093	8.393073061	1.81E-04	2.39E-01			
68								
69	**10. Pressurized release of check standard**							
70	(1000 psig)							
71		Offsite	Onsite					
72		TEDE	TEDE	Offsite	Onsite			
73	Initial	(3 min)	(3 min)	Dose/MAR	Dose/MAR			
74	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)			
75	2.84E-02	0.00663752	8.726250266	1.89E-04	2.48E-01			
76								
77	**11. Release of holdup in earthquake plus fire**							
78			Offsite	Onsite	Offsite	Onsite		
79			TEDE	TEDE	TEDE	TEDE	Offsite	Onsite
80	Initial	Resuspension	(3 min)	(3 min)	(8 hr)	(8 hr)	Dose/MAR	Dose/MAR
81	ARF*RF	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)
82	1.60E-04	3.20E-04	0.0143	18.8	3.95E-03	5.38	3.55E-06	4.73E-03
83								
84	**12. HEPA in earthquake plus fire**							
85			Offsite	Onsite	Offsite	Onsite		
86			TEDE	TEDE	TEDE	TEDE	Offsite	Onsite
87	Initial	Resuspension	(3 min)	(3 min)	(8 hr)	(8 hr)	Dose/MAR	Dose/MAR
88	ARF*RF	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)
89	6.00E-04	3.20E-04	0.0143	18.8	3.95E-03	5.38	9.84E-06	1.30E-02
90								
91	**13. Release of holdup in earthquake**							
92			Offsite	Onsite	Offsite	Onsite		
93			TEDE	TEDE	TEDE	TEDE	Offsite	Onsite
94	Initial	Resuspension	(3 min)	(3 min)	(8 hr)	(8 hr)	Dose/MAR	Dose/MAR
95	ARF*RF	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)
96	1.00E-04	3.20E-04	0.0143	18.8	3.95E-03	5.38	2.69E-06	3.60E-03
97								
98	**14. HEPA in earthquake**							
99			Offsite	Onsite	Offsite	Onsite		
100			TEDE	TEDE	TEDE	TEDE	Offsite	Onsite
101	Initial	Resuspension	(3 min)	(3 min)	(8 hr)	(8 hr)	Dose/MAR	Dose/MAR
102	ARF*RF	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)
103	5.00E-04	3.20E-04	0.0143	18.8	3.95E-03	5.38	8.41E-06	1.11E-02
104								
105	**15. Holdup in air reversal**							
106	(1000 psig)							
107		Offsite	Onsite					
108		TEDE	TEDE	Offsite	Onsite			
109	Initial	(8 hr)	(8 hr)	Dose/MAR	Dose/MAR			
110	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)			
111	3.20E-04	3.95E-03	5.38	1.26E-06	1.72E-03			

Figure E-1 (continued). Dose per MAR factors.

	A	B	C	D	E
1	**CSSC Accident Consequences**				
2					
3	**Dose per MAR**				
4	**(rem/g Pu)**			**Offsite**	**Onsite**
5					
6	3013/sample (1000 psig)			4.068E-04	5.341E-01
7	Calibration standards (1000 psig)			1.814E-04	2.385E-01
8	Check standards (1000 psig)			1.886E-04	2.480E-01
9	Waste (pressurized)			5.333E-05	6.956E-02
10	Waste (non-pressurized)			7.267E-06	9.578E-03
11	Holdup in fire			2.122E-06	2.850E-03
12	HEPA in fire			2.694E-06	3.602E-03
13	3013 (400 psig)			2.141E-04	2.818E-01
14	Holdup pressure wave			2.271E-05	2.992E-02
15	Powder spill			9.844E-06	1.300E-02
16	Holdup earthquake plus fire			3.552E-06	4.730E-03
17	HEPA earthquake plus fire			9.844E-06	1.300E-02
18	Holdup earthquake			2.694E-06	3.602E-03
19	HEPA impact			8.414E-06	1.112E-02
20	Holdup air reversal			1.264E-06	1.722E-03
21					
22					
23					
24					
25					
26				**Unmitigated**	
27					
28	**Event**	**Material**	**MAR**	**Offsite**	**Onsite**
29		**Category**		**Dose**	**Dose**
30			**(g)**	**(rem)**	**(rem)**
31					
32	**PA-1**	3013	4400	**1.79E+00**	**2.35E+03**
33					
34	**PA-3**	drum	2400	1.28E-01	1.67E+02
35		3013	22000	8.95E+00	1.18E+04
36		check standard	500	9.43E-02	1.24E+02
37		drum	1000	5.33E-02	6.96E+01
38		sample	150	6.10E-02	8.01E+01
39		calibration standard	3700	6.71E-01	8.83E+02
40		bag	0.5	3.63E-06	4.79E-03
41			Total	**9.96E+00**	**1.31E+04**
42					
43	**RS-2**	3013	8.45E+06	**HIGH**	**HIGH**
44					
45	**GB-1**	3013	4400	1.79E+00	2.35E+03
46		holdup	600	1.36E-02	1.80E+01
47			Total	**1.80E+00**	**2.37E+03**
48					
49	**OF-2**	HEPA	1000	2.69E-03	3.60E+00
50		holdup	1000	2.12E-03	2.85E+00
51		3013	4400	5.56E-03	7.58E+00
52		holdup	600	7.58E-04	1.03E+00
53			Total	**1.11E-02**	**1.51E+01**

Figure E-2. Unmitigated Consequences.

	A	B	C	D	E
55	**COM-3**	3013	8.43E+06	**HIGH**	**HIGH**
56		drum	2400	1.28E-01	1.67E+02
57		3013	22000	8.95E+00	1.18E+04
58		check standard	500	9.43E-02	1.24E+02
59		holdup	600	1.36E-02	1.80E+01
60		drum	1000	5.33E-02	6.96E+01
61		sample	150	6.10E-02	8.01E+01
62		calibration standard	3700	6.71E-01	8.83E+02
63		bag	0.5	3.63E-06	4.79E-03
64			Total	**HIGH**	**HIGH**
65					
66	**GB-4**	3013	4400	**9.42E-01**	**1.24E+03**
67					
68	**GB-4a**	3013	4400	9.42E-01	1.24E+03
69		holdup	600	1.36E-02	1.80E+01
70			Total	**9.56E-01**	**1.26E+03**
71					
72	**GB-4b**	3013	4400	9.42E-01	1.24E+03
73		holdup	600	1.36E-02	1.80E+01
74			Total	**9.56E-01**	**1.26E+03**
75					
76	**COM-40**	drum	395	**2.11E-02**	**2.75E+01**
77					
78	**COM-41**	sample	150	**6.10E-02**	**8.01E+01**
79					
80	**COM-42**	3013	4400	**9.42E-01**	**1.24E+03**
81					
82	**RS-4**	3013	5.28E+05	**HIGH**	**HIGH**
83					
84	**GB-8**	3013	4400	9.42E-01	1.24E+03
85		holdup	600	1.36E-02	1.80E+01
86			Total	**9.56E-01**	**1.26E+03**
87					
88	**GB-10**	3013	4400	5.56E-03	7.58E+00
89		holdup	600	7.58E-04	1.03E+00
90			Total	**6.32E-03**	**8.61E+00**
91					
92	**COM-X2**	3013	4400	**9.42E-01**	**1.24E+03**
93					
94	**COM-X3**	3013	8800	**1.88E+00**	**2.48E+03**
95					
96	**COM-18**	3013	4400	**9.42E-01**	**1.24E+03**
97					
98	**COM-39**	3013	4400	**4.33E-02**	**5.72E+01**
99					
100	**GB-17a**	3013	4400	1.79E+00	2.35E+03
101		holdup	600	1.36E-02	1.80E+01
102			Total	**1.80E+00**	**2.37E+03**
103					
104	**COM-25**	3013	22000	**8.95E+00**	**1.18E+04**
105					
106	**COM-26**	3013	22000	**8.95E+00**	**1.18E+04**

Figure E-2 (continued). Unmitigated Consequences.

	A	B	C	D	E
108	**COM-27a**	3013	8.45E+06	**HIGH**	**HIGH**
109		drum	2400	1.28E-01	1.67E+02
110		check standard	500	9.43E-02	1.24E+02
111		holdup	600	1.27E-03	1.71E+00
112		drum	1000	5.33E-02	6.96E+01
113		sample	150	6.10E-02	8.01E+01
114		calibration standard	3700	6.71E-01	8.83E+02
115		bag	0.5	3.63E-06	4.79E-03
116			Total	**HIGH**	**HIGH**
117					
118	**COM-27b**	HEPA	1000	9.84E-03	1.30E+01
119		holdup	1000	3.55E-03	4.73E+00
120		3013	4400	5.56E-03	7.58E+00
121		holdup	600	7.58E-04	1.03E+00
122			Total	**1.97E-02**	**2.63E+01**
123					
124	**COM-28a**	HEPA	1000	8.41E-03	1.11E+01
125		holdup	1000	2.69E-03	3.60E+00
126		3013	4400	5.56E-03	7.58E+00
127		holdup	600	7.58E-04	1.03E+00
128			Total	**1.74E-02**	**2.33E+01**
129					
130	**COM-28c**	3013	4400	5.56E-03	7.58E+00
131		holdup	600	7.58E-04	1.03E+00
132			Total	**6.32E-03**	**8.61E+00**
133					
134	**COM-28e**	3013	8.45E+06	**HIGH**	**HIGH**
135		drum	2400	1.74E-02	2.30E+01
136		check standard	500	9.43E-02	1.24E+02
137		holdup	600	1.62E-03	2.16E+00
138		drum	1000	7.27E-03	9.58E+00
139		sample	150	6.10E-02	8.01E+01
140		calibration standard	3700	6.71E-01	8.83E+02
141		bag	0.5	3.63E-06	4.79E-03
142		HEPA	1000	8.41E-03	1.11E+01
143		holdup	1000	2.69E-03	3.60E+00
144			Total	**HIGH**	**HIGH**
145					
146	**COM-28f**	3013	8.45E+06	**HIGH**	**HIGH**
147		drum	2400	1.28E-01	1.67E+02
148		check standard	500	9.43E-02	1.24E+02
149		holdup	600	2.13E-03	2.84E+00
150		drum	1000	5.33E-02	6.96E+01
151		sample	150	6.10E-02	8.01E+01
152		calibration standard	3700	6.71E-01	8.83E+02
153		bag	0.5	3.63E-06	4.79E-03
154		HEPA	1000	9.84E-03	1.30E+01
155		holdup	1000	3.55E-03	4.73E+00
156			Total	**HIGH**	**HIGH**

Figure E-2 (continued). Unmitigated Consequences.

APPENDIX F. FORMULA SPREADSHEETS

	A	B	C	D	E	F	G	H	I
1	**CSS**								
2									
3	**Dose pe**								
4	**(rem/g**			**Offsite**	**Onsite**			**Controls**	
5									
6	3013/sa			0.0004068181818181	0.534090909090909		**1**	Container	
7	Calibrat			0.0001814359175721	0.238531136388529		**2**	Room Fire Suppression	
8	Check s			0.0001886383226492	0.248000032573845		**3**	Storage Room Controls	
9	Waste (			0.0000533333333333	0.069555555555555		**4**	Criticality Program	
10	Waste (			7.26666666666667E-	0.009577777777777		**5**	Drum Vent	
11	Holdup			0.000002122	0.0028496		**6**	Fan/Filter Design Includir	
12	HEPA i			0.000002694	0.0036016		**7**	Room Combustible Contr	
13	3013 (4			0.0002140909090909	0.281818181818182		**8**	Fan/Filter Combustible Co	
14	Holdup			0.000022714	0.0299216		**9**	CPD Design/Operation	
15	Powder			0.000009844	0.0130016		**10**	Sample Vial Design	
16	Holdup			0.000003552	0.0047296		**11**	Facility HEPA Filtration	
17	HEPA e			0.000009844	0.0130016		**12**	Building Structure	
18	Holdup			0.000002694	0.0036016		**13**	Falling Object Controls	
19	HEPA i			0.000008414	0.0111216		**14**	Safeguards and Security C	
20	Holdup			0.000001264	0.0017216		**15**	ISSC Program	
21									
22								**HEPA LPF**	
23								=1-0.9997	
24									
25									
26				**Unmitigated**			**Mitigated**		
27									
28	**Event**	**Material**	**MAR**	**Offsite**	**Onsite**		**Offsite**	**Onsite**	
29		**Category**		**Dose**	**Dose**		**Dose**	**Dose**	**Controls**
30			**(g)**	**(rem)**	**(rem)**		**(rem)**	**(rem)**	
31									
32	**PA-1**	3013	4400	**=C32*$D$6**	**=C32*$E$6**		**0**	**0**	1, 2, 7
33									
34	**PA-3**	drum	2400	=C34*$D$9	=C34*$E$9		=C34*$D$10*$H$23	=C34*$E$10*H23	2, 7, 11
35		3013	22000	=C35*$D$6	=C35*$E$6		0	0	1, 2, 7
36		eck standard	500	=C36*$D$8	=C36*$E$8		=C36*$D$8*$H$23	=C36*$E$8*$H$23	2, 7, 11
37		drum	1000	=C37*$D$9	=C37*$E$9		=C37*$D$10*$H$23	=C37*$E$10*$H$23	2, 7, 11
38		sample	150	=C38*$D$6	=C38*$E$6		=C38*$D$6*$H$23	=C38*$E$6*$H$23	2, 7, 11
39		ion standard	3700	=C39*$D$7	=C39*$E$7		=C39*$D$7*$H$23	=C39*$E$7*$H$23	2, 7, 11
40		bag	0.5	=C40*$D$10	=C40*$E$10		=C40*$D$10*$H$23	=C40*$E$10*$H$23	2, 7, 11
41			Total	**=SUM(D34:D40)**	**=SUM(E34:E40)**		**=SUM(G34:G40)**	**=SUM(H34:H40)**	
42									
43	**RS-2**	3013	8448000	**HIGH**	**HIGH**		**0**	**0**	1, 3
44									
45	**GB-1**	3013	4400	=C45*$D$6	=C45*$E$6		=C45*$D$6*$H$23	=C45*$E$6*$H$23	11
46		holdup	600	=C46*$D$14	=C46*$E$14		=C46*$D$14*$H$23	=C46*$E$14*$H$23	11
47			Total	**=SUM(D45:D46)**	**=SUM(E45:E46)**		**=SUM(G45:G46)**	**=SUM(H45:H46)**	
48									
49	**OF-2**	HEPA	1000	=C49*$D$12	=C49*$E$12		0	0	8
50		holdup	1000	=C50*$D$11	=C50*$E$11		0	0	8
51		3013	4400	=C51*$D$20	=C51*$E$20		0	0	8
52		holdup	600	=C52*$D$20	=C52*$E$20		0	0	8
53			Total	**=SUM(D49:D52)**	**=SUM(E49:E52)**		**=SUM(G49:G52)**	**=SUM(H49:H52)**	

	A	B	C	D	E	F	G	H	I
55	**COM-3**	3013	=8448000-C57	**HIGH**	**HIGH**		0	0	1, 3
56		drum	2400	=C56*$D$9	=C56*$E$9		=C56*$D$10*$H$23	=C56*$E$10*$H$23	2, 7, 11
57		3013	22000	=C57*$D$6	=C57*$E$6		=4400*$D$6*$H$23	=4400*$E$6*$H$23	1, 2, 7, 11
58		eck standard	500	=C58*$D$8	=C58*$E$8		=C58*$D$8*$H$23	=C58*$E$8*$H$23	2, 7, 11
59		holdup	600	=C59*$D$14	=C59*$E$14		=C59*$D$14*$H$23	=C59*$E$14*$H$23	2, 7, 11
60		drum	1000	=C60*$D$9	=C60*$E$9		=C60*$D$10*$H$23	=C60*$E$10*$H$23	2, 7, 11
61		sample	150	=C61*$D$6	=C61*$E$6		=C61*$D$6*$H$23	=C61*$E$6*$H$23	2, 7, 11
62		ion standard	3700	=C62*$D$7	=C62*$E$7		=C62*$D$7*$H$23	=C62*$E$7*$H$23	2, 7, 11
63		bag	0.5	=C63*$D$10	=C63*$E$10		=C63*$D$10*$H$23	=C63*$E$10*$H$23	2, 7, 11
64			Total	**HIGH**	**HIGH**		**=SUM(G55:G63)**	**=SUM(H55:H63)**	
65									
66	**GB-4**	3013	4400	**=C66*$D$13**	**=C66*$E$13**		**=C66*$D$13*$H$23**	**=C66*$E$13*$H$23**	11
67									
68	**GB-4a**	3013	4400	=C68*$D$13	=C68*$E$13		=C68*$D$13*$H$23	=C68*$E$13*$H$23	11
69		holdup	600	=C69*$D$14	=C69*$E$14		0	0	9
70			Total	**=SUM(D68:D69)**	**=SUM(E68:E69)**		**=SUM(G68:G69)**	**=SUM(H68:H69)**	
71									
72	**GB-4b**	3013	4400	=C72*$D$13	=C72*$E$13		=C72*$D$13*$H$23	=C72*$E$13*$H$23	11
73		holdup	600	=C73*$D$14	=C73*$E$14		=C73*$D$14*$H$23	=C73*$E$14*$H$23	11
74			Total	**=SUM(D72:D73)**	**=SUM(E72:E73)**		**=SUM(G72:G73)**	**=SUM(H72:H73)**	
75									
76	**COM-4**	drum	395	**=C76*$D$9**	**=C76*$E$9**		**0**	**0**	5
77									
78	**COM-4**	sample	150	**=C78*$D$6**	**=C78*$E$6**		**0**	**0**	10
79									
80	**COM-4**	3013	4400	**=C80*$D$13**	**=C80*$E$13**		**0**	**0**	1, 15
81									
82	**RS-4**	3013	528000	**HIGH**	**HIGH**		**0**	**0**	1, 3, 12
83									
84	**GB-8**	3013	4400	=C84*$D$13	=C84*$E$13		=C84*$D$13*$H$23	=C84*$E$13*$H$23	11
85		holdup	600	=C85*$D$14	=C85*$E$14		0	0	9
86			Total	**=SUM(D84:D85)**	**=SUM(E84:E85)**		**=SUM(G84:G85)**	**=SUM(H84:H85)**	
87									
88	**GB-10**	3013	4400	=C88*$D$20	=C88*$E$20		=C88*$D$20*$H$23	=C88*$E$20*$H$23	11
89		holdup	600	=C89*$D$20	=C89*$E$20		=C89*$D$20*$H$23	=C89*$E$20*$H$23	11
90			Total	**=SUM(D88:D89)**	**=SUM(E88:E89)**		**=SUM(G88:G89)**	**=SUM(H88:H89)**	
91									
92	**COM-X**	3013	4400	**=C92*$D$13**	**=C92*$E$13**		**=C92*$D$15*$H$23**	**=C92*$E$15*$H$23**	11
93									
94	**COM-X**	3013	8800	**=C94*$D$13**	**=C94*$E$13**		**0**	**0**	1, 12, 13
95									
96	**COM-1**	3013	4400	**=C96*$D$13**	**=C96*$E$13**		**0**	**0**	14
97									
98	**COM-3**	3013	4400	**=C98*$D$15**	**=C98*$E$15**		**=C98*$D$15*$H$23**	**=C98*$E$15*$H$23**	11
99									
100	**GB-17a**	3013	4400	=C100*$D$6	=C100*$E$6		**0**	**0**	4
101		holdup	600	=C101*$D$14	=C101*$E$14		0	0	4
102			Total	**=SUM(D100:D101)**	**=SUM(E100:E101)**		**=SUM(G100:G101)**	**=SUM(H100:H101)**	
103									
104	**COM-2**	3013	=4400*5	**=C104*$D$6**	**=C104*$E$6**		0	0	4
105									
106	**COM-2**	3013	=4400*5	**=C106*$D$6**	**=C106*$E$6**		0	0	4

	A	B	C	D	E	F	G	H	I
108	**COM-2**	3013	8448000	**HIGH**	**HIGH**		=4400*$D$6*$H$23	=4400*$E$6*$H$23	1, 2, 3, 7, 11
109		drum	2400	=C109*$D$9	=C109*$E$9		=C109*$D$10*$H$23	=C109*$E$10*$H$23	2, 7, 11
110		eck standard	500	=C110*$D$8	=C110*$E$8		=C110*$D$8*$H$23	=C110*$E$8*$H$23	2, 7, 11
111		holdup	600	=C111*$D$11	=C111*$E$11		=C111*$D$11*$H$23	=C111*$E$11*$H$23	2, 7, 11
112		drum	1000	=C112*$D$9	=C112*$E$9		=C112*$D$10*$H$23	=C112*$E$10*$H$23	2, 7, 11
113		sample	150	=C113*$D$6	=C113*$E$6		=C113*$D$6*$H$23	=C113*$E$6*$H$23	2, 7, 11
114		ion standard	3700	=C114*$D$7	=C114*$E$7		=C114*$D$7*$H$23	=C114*$E$7*$H$23	2, 7, 11
115		bag	0.5	=C115*$D$10	=C115*$E$10		=C115*$D$10*$H$23	=C115*$E$10*$H$23	2, 7, 11
116			Total	**HIGH**	**HIGH**		**=SUM(G108:G115)**	**=SUM(H108:H115)**	
117									
118	**COM-2**	HEPA	1000	=C118*$D$17	=C118*$E$17		=C118*$D$17	=C118*$E$17	N/A
119		holdup	1000	=C119*$D$16	=C119*$E$16		=C119*$D$16	=C119*$E$16	N/A
120		3013	4400	=C120*$D$20	=C120*$E$20		=C120*$D$20	=C120*$E$20	N/A
121		holdup	600	=C121*$D$20	=C121*$E$20		=C121*$D$20	=C121*$E$20	N/A
122			Total	**=SUM(D118:D121)**	**=SUM(E118:E121)**		**=SUM(G118:G121)**	**=SUM(H118:H121)**	
123									
124	**COM-2**	HEPA	1000	=C124*$D$19	=C124*$E$19		=C124*$D$19	=C124*$E$19	N/A
125		holdup	1000	=C125*$D$18	=C125*$E$18		=C125*$D$18	=C125*$E$18	N/A
126		3013	4400	=C126*$D$20	=C126*$E$20		0	0	6
127		holdup	600	=C127*$D$20	=C127*$E$20		0	0	6
128			Total	**=SUM(D124:D127)**	**=SUM(E124:E127)**		**=SUM(G124:G127)**	**=SUM(H124:H127)**	
129									
130	**COM-2**	3013	4400	=C130*$D$20	=C130*$E$20		**0**	**0**	6
131		holdup	600	=C131*$D$20	=C131*$E$20		0	0	6
132			Total	**=SUM(D129:D131)**	**=SUM(E129:E131)**		**=SUM(G129:G131)**	**=SUM(H129:H131)**	
133									
134	**COM-2**	3013	8448000	**HIGH**	**HIGH**		=4400*$D$18*$H$23	=4400*$E$18*$H$23	3, 4, 6, 11, 12, 13
135		drum	2400	=C135*$D$10	=C135*$E$10		=C135*$D$10*$H$23	=C135*$E$10*$H$23	4, 11, 12
136		eck standard	500	=C136*$D$8	=C136*$E$8		0	0	4, 11, 12, 13, 15
137		holdup	600	=C137*$D$18	=C137*$E$18		=C137*$D$18*$H$23	=C137*$E$18*$H$23	6, 11, 12
138		drum	1000	=C138*$D$10	=C138*$E$10		=C138*$D$10*$H$23	=C138*$E$10*$H$23	4, 11, 12
139		sample	150	=C139*$D$6	=C139*$E$6		=C139*$D$6*$H$23	=C139*$E$6*$H$23	4, 11, 12
140		ion standard	3700	=C140*$D$7	=C140*$E$7		0	0	4, 11, 12, 13, 15
141		bag	0.5	=C141*$D$10	=C141*$E$10		=C141*$D$10*$H$23	=C141*$E$10*$H$23	4, 11, 12
142		HEPA	1000	=C142*$D$19	=C142*$E$19		=C142*$D$19	=C142*$E$19	6
143		holdup	1000	=C143*$D$18	=C143*$E$18		=C143*$D$18	=C143*$E$18	6
144			Total	**HIGH**	**HIGH**		**=SUM(G134:G143)**	**=SUM(H134:H143)**	
145									
146	**COM-2**	3013	8448000	**HIGH**	**HIGH**		=4400*$D$6*$H$23	=4400*$E$6*$H$23	, 2, 3, 7, 11, 12, 1
147		drum	2400	=C147*$D$9	=C147*$E$9		=C147*$D$10*$H$23	=C147*$E$10*$H$23	2, 7, 11, 12
148		eck standard	500	=C148*$D$8	=C148*$E$8		=C148*$D$8*$H$23	=C148*$E$8*$H$23	2, 7, 11, 12
149		holdup	600	=C149*$D$16	=C149*$E$16		=C149*$D$16*$H$23	=C149*$E$16*$H$23	2, 7, 11, 12
150		drum	1000	=C150*$D$9	=C150*$E$9		=C150*$D$10*$H$23	=C150*$E$10*$H$23	2, 7, 11, 12
151		sample	150	=C151*$D$6	=C151*$E$6		=C151*$D$6*$H$23	=C151*$E$6*$H$23	2, 7, 11, 12
152		ion standard	3700	=C152*$D$7	=C152*$E$7		=C152*$D$7*$H$23	=C152*$E$7*$H$23	2, 7, 11, 12
153		bag	0.5	=C153*$D$10	=C153*$E$10		=C153*$D$10*$H$23	=C153*$E$10*$H$23	2, 7, 11, 12
154		HEPA	1000	=C154*$D$17	=C154*$E$17		=C154*$D$19	=C154*$E$19	6
155		holdup	1000	=C155*$D$16	=C155*$E$16		=C155*$D$18	=C155*$E$18	6
156			Total	**HIGH**	**HIGH**		**=SUM(G146:G155)**	**=SUM(H146:H155)**	

	A	B	C	D	E	F	G	H	I	J
1	**CSSC**									
2	**(No Pr**									
3										
4	**MAR**									
5	**(g Pu)**									
6	**450**									
7							**Onsite**	**Offsite**	**Onsite**	**Offsite**
8		**MAR**	**DR**	**ARF**	**RF**	**ST**	**TEDE**	**TEDE**	**Dose**	**Dose**
9	**Stress**	**(g Pu)**				**(g Pu)**	**(rem/g Pu**	**(rem/g Pu)**	**(rem)**	**(rem)**
10										
11	**Confin**	=$A$6	1	0.0005	1	=B11*C11*D11*E11	18.8	0.0143	=F11*G11	=F11*H11
12										
13	**Confin**	=$A$6	1	=0.000004*8	1	=B13*C13*D13*E13	5.38	0.00395	=F13*G13	=F13*H13
14	**Resus**									
15								**Total**	=SUM(I11:I14)	=SUM(J11:J14)

	A	B	C	D	E	F	G	H	I	J
1	**CSSC Wa**									
2	**(With Press**									
3										
4	**MAR**									
5	**(g Pu)**									
6	**450**									
7							**Onsite**	**Offsite**	**Onsite**	**Offsite**
8		**MAR**	**DR**	**ARF**	**RF**	**ST**	**TEDE**	**TEDE**	**Dose**	**Dose**
9	**Stress**	**(g Pu)**				**(g Pu)**	**(rem/g I**	**(rem/g**	**(rem)**	**(rem)**
10										
11	**Lid Ejection**	=$A$6	0.67	0.0005	1	=B11*C11*D11*E11	18.8	0.0143	=F11*G11	=F11*H11
12	**Confined Bu**									
13										
14	**Lid Ejection**	=$A$6	0.33	0.01	1	=B14*C14*D14*E14	18.8	0.0143	=F14*G14	=F14*H14
15	**Unconfined**									
16										
17	**Lid Ejection**	=$A$6	0.33	0.001	0.1	=B17*C17*D17*E17	18.8	0.0143	=F17*G17	=F17*H17
18	**Impact**									
19										
20	**Confined**	=$A$6	=0.67	=0.000004*8	1	=B20*C20*D20*E20	5.38	0.0039	=F20*G20	=F20*H20
21	**Resuspensi**									
22										
23	**Unconfined**	=$A$6	0.33	=0.00004*8	1	=B23*C23*D23*E23	5.38	0.0039	=F23*G23	=F23*H23
24	**Resuspensi**									
25								**Total**	=SUM(I11:I23)	=SUM(J11:J23)

	A	B	C	D	E	F	G	H
1	**Calculat**							
2								
3					**Boundin**			
4			**Molar**		**Generati**			
5			**Volume**		**Rate**			
6	**Inventory**		**at 0 deg C**		**at 0 deg**			
7	**(g Pu)**		**(l/mole)**		**(cm3/hr/**			
8								
9	4400		22.4		14			
10								
11				**Heat**	**Specific**	**Heat**	**Heat**	**Hydrogen**
12		**Weight**	**Inventory**	**Rate**	**Activity**	**Rate**	**Rate**	**Rate**
13	**Isotope**	**Percent**	**(g)**	**(W/Ci)**	**(Ci/g)**	**(W/g)**	**(W)**	**(mole/hr)**
14								
15	Pu-238	0.1002	=$A$9*B15/100	0.032593	17.1	=D15*E15	=C15*F15	=G15/$C$9/1000*$E$9
16	Am-241	1.714	=$A$9*B16/100	0.03283	3.44	=D16*E16	=C16*F16	=G16/$C$9/1000*$E$9
17	Pu-241	1.815	=$A$9*B17/100	0.000032	103	=D17*E17	=C17*F17	=G17/$C$9/1000*$E$9
18	Pu-240	20.62	=$A$9*B18/100	0.03056	0.227	=D18*E18	=C18*F18	=G18/$C$9/1000*$E$9
19	Pu-239	76.08	=$A$9*B19/100	0.03024	0.0621	=D19*E19	=C19*F19	=G19/$C$9/1000*$E$9
20	Pu-242	1.385	=$A$9*B20/100	0.02904	0.00393	=D20*E20	=C20*F20	=G20/$C$9/1000*$E$9
21								
22						**Total**	=SUM(G15:G20)	=G22/$C$9/1000*$E$9

	A	B	C	D	E	F
1	**Calculation of 3013 Conta**					
2						
3						
4			**Standard**			
5	**Volume**		**Molar**		**E**	
6	**3013**		**Volume**		**T**	
7	(l)		(l/mole)		(K	
8	2.068		22.4		3	
9						
10	**Pu Oxide**		**Moisture**		**F**	
11	**Inventory**		**Content**		**T**	
12	(kg)		(wt %)		(K	
13	5		0.5		3	
14						
15	**Container**		**Fill**		**V**	
16	**Heat Rate**		**Press**		**P**	
17	(W)		(psia)		(l	
18	19		14.7		0.	
19						
20	**H2**					
21	**Rate**					
22	(mole/hr)					
23	=0.01489*A18/23.82					
24						
25						
26						
27						
28						
29	**3013**					
30	**Free**					
31	**Volume**		**PF**			
32	(l)		(psia)			
33	=A8-E18		=C18*E8/E13			
34						
35	**Max H2**		**Max PG**			
36	(moles)		(psia)			
37	=A13*$C$13/100*2/(2+16)/2*1000		=0.67*A13*$C$13*$E$8/$A$33			

	G	H
1		
2		
3	**Delta**	
4	(hr)	
5	2	
6		
7	**Time**	**Time**
8	(hr)	(d)
9	0	=G9/24
10	=G9+$G$5	=G10/24
11	=G10+$G$5	=G11/24
12	=G11+$G$5	=G12/24
13	=G12+$G$5	=G13/24
14	=G13+$G$5	=G14/24
15	=G14+$G$5	=G15/24
16	=G15+$G$5	=G16/24
17	=G16+$G$5	=G17/24
18	=G17+$G$5	=G18/24
19	=G18+$G$5	=G19/24
20	=G19+$G$5	=G20/24
21	=G20+$G$5	=G21/24
22	=G21+$G$5	=G22/24
23	=G22+$G$5	=G23/24
24	=G23+$G$5	=G24/24
25	=G24+$G$5	=G25/24
26	=G25+$G$5	=G26/24
27	=G26+$G$5	=G27/24
28	=G27+$G$5	=G28/24
29	=G28+$G$5	=G29/24
30	=G29+$G$5	=G30/24
31	=G30+$G$5	=G31/24
32	=G31+$G$5	=G32/24
33	=G32+$G$5	=G33/24
34	=G33+$G$5	=G34/24
35	=G34+$G$5	=G35/24
36	=G35+$G$5	=G36/24
37	=G36+$G$5	=G37/24
38	=G37+$G$5	=G38/24
39	=G38+$G$5	=G39/24
40	=G39+$G$5	=G40/24
41	=G40+$G$5	=G41/24
42	=G41+$G$5	=G42/24
43	=G42+$G$5	=G43/24
44	=G43+$G$5	=G44/24
45	=G44+$G$5	=G45/24
46	=G45+$G$5	=G46/24

	I
1	
2	
3	
4	
5	
6	
7	**Pressure**
8	(psia)
9	=$C$33+1.206*$A$23*G9*$E$8/$A$33+0.00007517*$A$18*H9/365*$E$8/$A$33
10	=IF($A$23*G10<$A$37,$C$33+1.206*$A$23*G10*$E$8/$A$33+0.00007517*$A$18*H10/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H10/365*$E$8/$A$33)
11	=IF($A$23*G11<$A$37,$C$33+1.206*$A$23*G11*$E$8/$A$33+0.00007517*$A$18*H11/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H11/365*$E$8/$A$33)
12	=IF($A$23*G12<$A$37,$C$33+1.206*$A$23*G12*$E$8/$A$33+0.00007517*$A$18*H12/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H12/365*$E$8/$A$33)
13	=IF($A$23*G13<$A$37,$C$33+1.206*$A$23*G13*$E$8/$A$33+0.00007517*$A$18*H13/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H13/365*$E$8/$A$33)
14	=IF($A$23*G14<$A$37,$C$33+1.206*$A$23*G14*$E$8/$A$33+0.00007517*$A$18*H14/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H14/365*$E$8/$A$33)
15	=IF($A$23*G15<$A$37,$C$33+1.206*$A$23*G15*$E$8/$A$33+0.00007517*$A$18*H15/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H15/365*$E$8/$A$33)
16	=IF($A$23*G16<$A$37,$C$33+1.206*$A$23*G16*$E$8/$A$33+0.00007517*$A$18*H16/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H16/365*$E$8/$A$33)
17	=IF($A$23*G17<$A$37,$C$33+1.206*$A$23*G17*$E$8/$A$33+0.00007517*$A$18*H17/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H17/365*$E$8/$A$33)
18	=IF($A$23*G18<$A$37,$C$33+1.206*$A$23*G18*$E$8/$A$33+0.00007517*$A$18*H18/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H18/365*$E$8/$A$33)
19	=IF($A$23*G19<$A$37,$C$33+1.206*$A$23*G19*$E$8/$A$33+0.00007517*$A$18*H19/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H19/365*$E$8/$A$33)
20	=IF($A$23*G20<$A$37,$C$33+1.206*$A$23*G20*$E$8/$A$33+0.00007517*$A$18*H20/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H20/365*$E$8/$A$33)
21	=IF($A$23*G21<$A$37,$C$33+1.206*$A$23*G21*$E$8/$A$33+0.00007517*$A$18*H21/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H21/365*$E$8/$A$33)
22	=IF($A$23*G22<$A$37,$C$33+1.206*$A$23*G22*$E$8/$A$33+0.00007517*$A$18*H22/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H22/365*$E$8/$A$33)
23	=IF($A$23*G23<$A$37,$C$33+1.206*$A$23*G23*$E$8/$A$33+0.00007517*$A$18*H23/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H23/365*$E$8/$A$33)
24	=IF($A$23*G24<$A$37,$C$33+1.206*$A$23*G24*$E$8/$A$33+0.00007517*$A$18*H24/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H24/365*$E$8/$A$33)
25	=IF($A$23*G25<$A$37,$C$33+1.206*$A$23*G25*$E$8/$A$33+0.00007517*$A$18*H25/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H25/365*$E$8/$A$33)
26	=IF($A$23*G26<$A$37,$C$33+1.206*$A$23*G26*$E$8/$A$33+0.00007517*$A$18*H26/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H26/365*$E$8/$A$33)
27	=IF($A$23*G27<$A$37,$C$33+1.206*$A$23*G27*$E$8/$A$33+0.00007517*$A$18*H27/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H27/365*$E$8/$A$33)
28	=IF($A$23*G28<$A$37,$C$33+1.206*$A$23*G28*$E$8/$A$33+0.00007517*$A$18*H28/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H28/365*$E$8/$A$33)
29	=IF($A$23*G29<$A$37,$C$33+1.206*$A$23*G29*$E$8/$A$33+0.00007517*$A$18*H29/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H29/365*$E$8/$A$33)
30	=IF($A$23*G30<$A$37,$C$33+1.206*$A$23*G30*$E$8/$A$33+0.00007517*$A$18*H30/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H30/365*$E$8/$A$33)
31	=IF($A$23*G31<$A$37,$C$33+1.206*$A$23*G31*$E$8/$A$33+0.00007517*$A$18*H31/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H31/365*$E$8/$A$33)
32	=IF($A$23*G32<$A$37,$C$33+1.206*$A$23*G32*$E$8/$A$33+0.00007517*$A$18*H32/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H32/365*$E$8/$A$33)
33	=IF($A$23*G33<$A$37,$C$33+1.206*$A$23*G33*$E$8/$A$33+0.00007517*$A$18*H33/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H33/365*$E$8/$A$33)
34	=IF($A$23*G34<$A$37,$C$33+1.206*$A$23*G34*$E$8/$A$33+0.00007517*$A$18*H34/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H34/365*$E$8/$A$33)
35	=IF($A$23*G35<$A$37,$C$33+1.206*$A$23*G35*$E$8/$A$33+0.00007517*$A$18*H35/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H35/365*$E$8/$A$33)
36	=IF($A$23*G36<$A$37,$C$33+1.206*$A$23*G36*$E$8/$A$33+0.00007517*$A$18*H36/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H36/365*$E$8/$A$33)
37	=IF($A$23*G37<$A$37,$C$33+1.206*$A$23*G37*$E$8/$A$33+0.00007517*$A$18*H37/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H37/365*$E$8/$A$33)
38	=IF($A$23*G38<$A$37,$C$33+1.206*$A$23*G38*$E$8/$A$33+0.00007517*$A$18*H38/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H38/365*$E$8/$A$33)
39	=IF($A$23*G39<$A$37,$C$33+1.206*$A$23*G39*$E$8/$A$33+0.00007517*$A$18*H39/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H39/365*$E$8/$A$33)
40	=IF($A$23*G40<$A$37,$C$33+1.206*$A$23*G40*$E$8/$A$33+0.00007517*$A$18*H40/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H40/365*$E$8/$A$33)
41	=IF($A$23*G41<$A$37,$C$33+1.206*$A$23*G41*$E$8/$A$33+0.00007517*$A$18*H41/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H41/365*$E$8/$A$33)
42	=IF($A$23*G42<$A$37,$C$33+1.206*$A$23*G42*$E$8/$A$33+0.00007517*$A$18*H42/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H42/365*$E$8/$A$33)
43	=IF($A$23*G43<$A$37,$C$33+1.206*$A$23*G43*$E$8/$A$33+0.00007517*$A$18*H43/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H43/365*$E$8/$A$33)
44	=IF($A$23*G44<$A$37,$C$33+1.206*$A$23*G44*$E$8/$A$33+0.00007517*$A$18*H44/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H44/365*$E$8/$A$33)
45	=IF($A$23*G45<$A$37,$C$33+1.206*$A$23*G45*$E$8/$A$33+0.00007517*$A$18*H45/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H45/365*$E$8/$A$33)
46	=IF($A$23*G46<$A$37,$C$33+1.206*$A$23*G46*$E$8/$A$33+0.00007517*$A$18*H46/365*$E$8/$A$33,$C$33+$C$37+0.00007517*$A$18*H46/365*$E$8/$A$33)

	A	B	C	D
2	**Consequen**			
3				
4	**MAR**	**LPF**	**TEDE (MOI)**	**TEDE (100m)**
5	(kg Pu)		(rem/g Pu)	(rem/g Pu)
6	4.4	1	0.0143	18.8
7				
8				
9	**Failure Pressure**	**ARFxRF**	**Offsite Dose**	**100 m Dose**
10	(psig)		(rem)	(rem)
11	0	0.00006	=$A$6*B11*$B$6*$C$6*1000	=$A$6*B11*$B$6*$D$6*1000
12	< 25	0.002	=$A$6*B12*$B$6*$C$6*1000	=$A$6*B12*$B$6*$D$6*1000
13	25	=0.00129*A13^0.7*0.7/4	=$A$6*B13*$B$6*$C$6*1000	=$A$6*B13*$B$6*$D$6*1000
14	=A13+25	=0.00129*A14^0.7*0.7/4	=$A$6*B14*$B$6*$C$6*1000	=$A$6*B14*$B$6*$D$6*1000
15	=A14+50	=0.00129*A15^0.7*0.7/4	=$A$6*B15*$B$6*$C$6*1000	=$A$6*B15*$B$6*$D$6*1000
16	=A15+50	=0.00129*A16^0.7*0.7/4	=$A$6*B16*$B$6*$C$6*1000	=$A$6*B16*$B$6*$D$6*1000
17	=A16+50	=0.00129*A17^0.7*0.7/4	=$A$6*B17*$B$6*$C$6*1000	=$A$6*B17*$B$6*$D$6*1000
18	=A17+50	=0.00129*A18^0.7*0.7/4	=$A$6*B18*$B$6*$C$6*1000	=$A$6*B18*$B$6*$D$6*1000
19	=A18+50	=0.00129*A19^0.7*0.7/4	=$A$6*B19*$B$6*$C$6*1000	=$A$6*B19*$B$6*$D$6*1000
20	=A19+50	=0.00129*A20^0.7*0.7/4	=$A$6*B20*$B$6*$C$6*1000	=$A$6*B20*$B$6*$D$6*1000
21	=A20+50	=0.00129*A21^0.7*0.7/4	=$A$6*B21*$B$6*$C$6*1000	=$A$6*B21*$B$6*$D$6*1000
22	=A21+50	=0.00129*A22^0.7*0.7/4	=$A$6*B22*$B$6*$C$6*1000	=$A$6*B22*$B$6*$D$6*1000
23	=A22+50	=0.00129*A23^0.7*0.7/4	=$A$6*B23*$B$6*$C$6*1000	=$A$6*B23*$B$6*$D$6*1000
24	=A23+100	=0.00129*A24^0.7*0.7/4	=$A$6*B24*$B$6*$C$6*1000	=$A$6*B24*$B$6*$D$6*1000
25	=A24+100	=0.00129*A25^0.7*0.7/4	=$A$6*B25*$B$6*$C$6*1000	=$A$6*B25*$B$6*$D$6*1000
26	=A25+100	=0.00129*A26^0.7*0.7/4	=$A$6*B26*$B$6*$C$6*1000	=$A$6*B26*$B$6*$D$6*1000
27	=A26+100	=0.00129*A27^0.7*0.7/4	=$A$6*B27*$B$6*$C$6*1000	=$A$6*B27*$B$6*$D$6*1000
28	=A27+100	=0.00129*A28^0.7*0.7/4	=$A$6*B28*$B$6*$C$6*1000	=$A$6*B28*$B$6*$D$6*1000

	A	B	C	D	E	F	G	H	I
1	**Calculation of Dose Factors for Standards**								
2									
3						**Percent Composit**			
4									
5				**Pu-238**	**Pu-239**	**Pu-240**	**Pu-241**	**Pu-242**	**Am-241**
6									
7	**Check**	SR 1979		0.011	93.73	5.861	0.37	0.027	0.32893
8	**Standards**	LL 1979		0.011	93.73	5.861	0.37	0.027	0.32893
9									
10	**Calibration**	SRPSTDPUEU1		0.0144	93.778	5.8618	0.2798	0.0658	0.248742
11	**Standards**	SRPSTDPUEU2		0.0144	93.778	5.8618	0.2798	0.0658	0.248742
12		SRPSTDPUEU3		0.0144	93.778	5.8618	0.2798	0.0658	0.248742
13		SRPSTDPUEU4		0.0144	93.778	5.8618	0.2798	0.0658	0.248742
14		SRPSTDPUEU5		0.0144	93.778	5.8618	0.2798	0.0658	0.248742
15		SRPSTDPUEU6		0.0144	93.778	5.8618	0.2798	0.0658	0.248742
16		SRPSTDPUEU7		0.0144	93.778	5.8618	0.2798	0.0658	0.248742
17									
18	**CSSC Powder**			0.1002	76.08	20.62	1.815	1.385	1.714
19									
20									
21	**Normalized Dose Potential**			1	0.003947	0.01443	0.1178	0.0002398	0.1837
22									
23									
24	**CSSC Powder**			**Offsite**		**Onsite**			
25	**Dose Potential**			**TEDE**		**TEDE**			
26				**(3 min)**		**(3 min)**			
27	=D18*D21+E18*E21+F18*F21+G18*G21+H18*H21+I18*I21			**(rem/g Pu)**		**(rem/g Pu)**			
28									
29				0.0143		18.8			
30									
31				**Offsite**		**Onsite**			
32	**Check Standards**			**TEDE**		**TEDE**			
33	**Dose Potential**			**(3 min)**		**(3 min)**			
34				**(rem/g Pu)**		**(rem/g Pu)**			
35	=D8*D21+E8*E21+F8*F21+G8*G21+H8*H21+I8*I21								
36				=D29*A35/A27		=F29*A35/A27			
37									
38				**Offsite**		**Onsite**			
39				**TEDE**		**TEDE**			
40	**Calibration Standards**			**(3 min)**		**(3 min)**			
41	**Dose Potential**			**(rem/g Pu)**		**(rem/g Pu)**			
42									
43	=D16*D21+E16*E21+F16*F21+G16*G21+H16*H21+I16*I21			=D29*A43/A27		=F29*A43/A27			

	A	B	C	D	E	F	G	H
1	**Dose per MA**							
2								
3	**1. Pressurized relea**							
4	**(1000 psig)**							
5		Offsite	Onsite	Offsite	Onsite			
6	MAR	Dose	Dose	Dose/MAR	Dose/MAR			
7	(g Pu)	(rem)	(rem)	(rem/g)	(rem/g)			
8	4400	1.79	2350	=B8/A8	=C8/A8			
9								
10	**2. Pressurized relea**							
11								
12		Offsite	Onsite	Offsite	Onsite			
13	MAR	Dose	Dose	Dose/MAR	Dose/MAR			
14	(g Pu)	(rem)	(rem)	(rem/g)	(rem/g)			
15	450	0.024	31.3	=B15/A15	=C15/A15			
16								
17	**3. Non-pressurized**							
18								
19		Offsite	Onsite	Offsite	Onsite			
20	MAR	Dose	Dose	Dose/MAR	Dose/MAR			
21	(g Pu)	(rem)	(rem)	(rem/g)	(rem/g)			
22	450	0.00327	4.31	=B22/A22	=C22/A22			
23								
24	**4. Release of holdu**							
25			Offsite	Onsite	Offsite	Onsite		
26			TEDE	TEDE	TEDE	TEDE	Offsite	Onsite
27	Fire	Resuspension	(3 min)	(3 min)	(8 hr)	(8 hr)	Dose/MAR	Dose/MAR
28	ARF*RF	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)
29	0.00006	0.00032	0.0143	18.8	0.00395	5.38	=A29*C29+B29*E29	=A29*D29+B29*F29
30								
31	**5. Release of HEPA**							
32								
33			Offsite	Onsite	Offsite	Onsite		
34			TEDE	TEDE	TEDE	TEDE	Offsite	Onsite
35	Fire	Resuspension	(3 min)	(3 min)	(8 hr)	(8 hr)	Dose/MAR	Dose/MAR
36	ARF*RF	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)
37	0.0001	0.00032	0.0143	18.8	0.00395	5.38	=A37*C37+B37*E37	=A37*D37+B37*F37
38								
39	**6. Pressurized relea**							
40	**(400 psig)**							
41		Offsite	Onsite	Offsite	Onsite			
42	MAR	Dose	Dose	Dose/MAR	Dose/MAR			
43	(g Pu)	(rem)	(rem)	(rem/g)	(rem/g)			
44	4400	0.942	1240	=B44/A44	=C44/A44			

	A	B	C	D	E	F	G	H
46	**7. Release of holdu**							
47								
48			Offsite	Onsite	Offsite	Onsite		
49			TEDE	TEDE	TEDE	TEDE	Offsite	Onsite
50	Initial	Resuspension	(3 min)	(3 min)	(8 hr)	(8 hr)	Dose/MAR	Dose/MAR
51	ARF*RF	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)
52	=0.005*0.3	0.00032	0.0143	18.8	0.00395	5.38	=A52*C52+B52*E52	=A52*D52+B52*F52
53								
54	**8. Powder spill**							
55			Offsite	Onsite	Offsite	Onsite		
56			TEDE	TEDE	TEDE	TEDE	Offsite	Onsite
57	Initial	Resuspension	(3 min)	(3 min)	(8 hr)	(8 hr)	Dose/MAR	Dose/MAR
58	ARF*RF	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)
59	=0.002*0.3	0.00032	0.0143	18.8	0.00395	5.38	=A59*C59+B59*E59	=A59*D59+B59*F59
60								
61	**9. Pressurized relea**							
62	(1000 psig)							
63		Offsite	Onsite					
64		TEDE	TEDE	Offsite	Onsite			
65	Initial	(3 min)	(3 min)	Dose/MAR	Dose/MAR			
66	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)			
67	0.02842	0.0063840928069	8.39307306082	=A67*B67	=A67*C67			
68								
69	**10. Pressurized rele**							
70	(1000 psig)							
71		Offsite	Onsite					
72		TEDE	TEDE	Offsite	Onsite			
73	Initial	(3 min)	(3 min)	Dose/MAR	Dose/MAR			
74	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)			
75	0.02842	0.00663752014495	8.72625026649	=A75*B75	=A75*C75			
76								
77	**11. Release of holdu**							
78			Offsite	Onsite	Offsite	Onsite		
79			TEDE	TEDE	TEDE	TEDE	Offsite	Onsite
80	Initial	Resuspension	(3 min)	(3 min)	(8 hr)	(8 hr)	Dose/MAR	Dose/MAR
81	ARF*RF	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)
82	=0.00006+0.0001	0.00032	0.0143	18.8	0.00395	5.38	=A82*C82+B82*E82	=A82*D82+B82*F82
83								
84	**12. HEPA in earthc**							
85			Offsite	Onsite	Offsite	Onsite		
86			TEDE	TEDE	TEDE	TEDE	Offsite	Onsite
87	Initial	Resuspension	(3 min)	(3 min)	(8 hr)	(8 hr)	Dose/MAR	Dose/MAR
88	ARF*RF	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)
89	=0.0001+0.0005	0.00032	0.0143	18.8	0.00395	5.38	=A89*C89+B89*E89	=A89*D89+B89*F89
90								
91	**13. Release of holdu**							
92			Offsite	Onsite	Offsite	Onsite		
93			TEDE	TEDE	TEDE	TEDE	Offsite	Onsite
94	Initial	Resuspension	(3 min)	(3 min)	(8 hr)	(8 hr)	Dose/MAR	Dose/MAR
95	ARF*RF	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)
96	=0.0001	0.00032	0.0143	18.8	0.00395	5.38	=A96*C96+B96*E96	=A96*D96+B96*F96
97								
98	**14. HEPA in earthc**							
99			Offsite	Onsite	Offsite	Onsite		
100			TEDE	TEDE	TEDE	TEDE	Offsite	Onsite
101	Initial	Resuspension	(3 min)	(3 min)	(8 hr)	(8 hr)	Dose/MAR	Dose/MAR
102	ARF*RF	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)
103	=0.0005	0.00032	0.0143	18.8	0.00395	5.38	=A103*C103+B103*E10	=A103*D103+B103*F1
104								
105	**15. Holdup in air re**							
106	(1000 psig)							
107		Offsite	Onsite					
108		TEDE	TEDE	Offsite	Onsite			
109	Initial	(8 hr)	(8 hr)	Dose/MAR	Dose/MAR			
110	ARF*RF	(rem/g Pu)	(rem/g Pu)	(rem/g)	(rem/g)			
111	0.00032	0.00395	5.38	=A111*B111	=A111*C111			

	A	B	C	D	E
1	**CSSC**				
2					
3	**Dose per M**				
4	**(rem/g Pu)**			**Offsite**	**Onsite**
5					
6	3013/sample			0.00040681818181818	0.534090909090909
7	Calibration			0.00018143591757212	0.238531136388529
8	Check stand			0.00018863832264925	0.248000032573845
9	Waste (pres			0.00005333333333333	0.0695555555555556
10	Waste (non-			7.26666666666667E-0	0.00957777777777778
11	Holdup in fi			0.000002122	0.0028496
12	HEPA in fir			0.000002694	0.0036016
13	3013 (400 p			0.00021409090909090	0.281818181818182
14	Holdup pres			0.000022714	0.0299216
15	Powder spil			0.000009844	0.0130016
16	Holdup eart			0.000003552	0.0047296
17	HEPA earth			0.000009844	0.0130016
18	Holdup eart			0.000002694	0.0036016
19	HEPA impa			0.000008414	0.0111216
20	Holdup air r			0.000001264	0.0017216
21					
22					
23					
24					
25					
26				**Unmitigated**	
27					
28	**Event**	**Material**	**MAR**	**Offsite**	**Onsite**
29		**Category**		**Dose**	**Dose**
30			**(g)**	**(rem)**	**(rem)**
31					
32	**PA-1**	3013	4400	**=C32*$D$6**	**=C32*$E$6**
33					
34	**PA-3**	drum	2400	=C34*$D$9	=C34*$E$9
35		3013	22000	=C35*$D$6	=C35*$E$6
36		heck standard	500	=C36*$D$8	=C36*$E$8
37		drum	1000	=C37*$D$9	=C37*$E$9
38		sample	150	=C38*$D$6	=C38*$E$6
39		tion standard	3700	=C39*$D$7	=C39*$E$7
40		bag	0.5	=C40*$D$10	=C40*$E$10
41			Total	**=SUM(D34:D40)**	**=SUM(E34:E40)**
42					
43	**RS-2**	3013	8448000	**HIGH**	**HIGH**
44					
45	**GB-1**	3013	4400	=C45*$D$6	=C45*$E$6
46		holdup	600	=C46*$D$14	=C46*$E$14
47			Total	**=SUM(D45:D46)**	**=SUM(E45:E46)**
48					
49	**OF-2**	HEPA	1000	=C49*$D$12	=C49*$E$12
50		holdup	1000	=C50*$D$11	=C50*$E$11
51		3013	4400	=C51*$D$20	=C51*$E$20
52		holdup	600	=C52*$D$20	=C52*$E$20
53			Total	**=SUM(D49:D52)**	**=SUM(E49:E52)**

	A	B	C	D	E
55	**COM-3**	3013	=8448000-C57	**HIGH**	**HIGH**
56		drum	2400	=C56*$D$9	=C56*$E$9
57		3013	22000	=C57*$D$6	=C57*$E$6
58		heck standard	500	=C58*$D$8	=C58*$E$8
59		holdup	600	=C59*$D$14	=C59*$E$14
60		drum	1000	=C60*$D$9	=C60*$E$9
61		sample	150	=C61*$D$6	=C61*$E$6
62		ation standard	3700	=C62*$D$7	=C62*$E$7
63		bag	0.5	=C63*$D$10	=C63*$E$10
64			Total	**HIGH**	**HIGH**
65					
66	**GB-4**	3013	4400	**=C66*$D$13**	**=C66*$E$13**
67					
68	**GB-4a**	3013	4400	=C68*$D$13	=C68*$E$13
69		holdup	600	=C69*$D$14	=C69*$E$14
70			Total	**=SUM(D68:D69)**	**=SUM(E68:E69)**
71					
72	**GB-4b**	3013	4400	=C72*$D$13	=C72*$E$13
73		holdup	600	=C73*$D$14	=C73*$E$14
74			Total	**=SUM(D72:D73)**	**=SUM(E72:E73)**
75					
76	**COM-40**	drum	395	**=C76*$D$9**	**=C76*$E$9**
77					
78	**COM-41**	sample	150	**=C78*$D$6**	**=C78*$E$6**
79					
80	**COM-42**	3013	4400	**=C80*$D$13**	**=C80*$E$13**
81					
82	**RS-4**	3013	528000	**HIGH**	**HIGH**
83					
84	**GB-8**	3013	4400	=C84*$D$13	=C84*$E$13
85		holdup	600	=C85*$D$14	=C85*$E$14
86			Total	**=SUM(D84:D85)**	**=SUM(E84:E85)**
87					
88	**GB-10**	3013	4400	=C88*$D$20	=C88*$E$20
89		holdup	600	=C89*$D$20	=C89*$E$20
90			Total	**=SUM(D88:D89)**	**=SUM(E88:E89)**
91					
92	**COM-X2**	3013	4400	**=C92*$D$13**	**=C92*$E$13**
93					
94	**COM-X3**	3013	8800	**=C94*$D$13**	**=C94*$E$13**

	A	B	C	D	E
96	**COM-18**	3013	4400	**=C96*$D$13**	**=C96*$E$13**
97					
98	**COM-39**	3013	4400	**=C98*$D$15**	**=C98*$E$15**
99					
100	**GB-17a**	3013	4400	=C100*$D$6	=C100*$E$6
101		holdup	600	=C101*$D$14	=C101*$E$14
102			Total	**=SUM(D100:D101)**	**=SUM(E100:E101)**
103					
104	**COM-25**	3013	=4400*5	**=C104*$D$6**	**=C104*$E$6**
105					
106	**COM-26**	3013	=4400*5	**=C106*$D$6**	**=C106*$E$6**
107					
108	**COM-27a**	3013	8448000	**HIGH**	**HIGH**
109		drum	2400	=C109*$D$9	=C109*$E$9
110		heck standard	500	=C110*$D$8	=C110*$E$8
111		holdup	600	=C111*$D$11	=C111*$E$11
112		drum	1000	=C112*$D$9	=C112*$E$9
113		sample	150	=C113*$D$6	=C113*$E$6
114		tion standard	3700	=C114*$D$7	=C114*$E$7
115		bag	0.5	=C115*$D$10	=C115*$E$10
116			Total	**HIGH**	**HIGH**
117					
118	**COM-27b**	HEPA	1000	=C118*$D$17	=C118*$E$17
119		holdup	1000	=C119*$D$16	=C119*$E$16
120		3013	4400	=C120*$D$20	=C120*$E$20
121		holdup	600	=C121*$D$20	=C121*$E$20
122			Total	**=SUM(D118:D121)**	**=SUM(E118:E121)**
123					
124	**COM-28a**	HEPA	1000	=C124*$D$19	=C124*$E$19
125		holdup	1000	=C125*$D$18	=C125*$E$18
126		3013	4400	=C126*$D$20	=C126*$E$20
127		holdup	600	=C127*$D$20	=C127*$E$20
128			Total	**=SUM(D124:D127)**	**=SUM(E124:E127)**
129					
130	**COM-28c**	3013	4400	=C130*$D$20	=C130*$E$20
131		holdup	600	=C131*$D$20	=C131*$E$20
132			Total	**=SUM(D129:D131)**	**=SUM(E129:E131)**
133					
134	**COM-28e**	3013	8448000	**HIGH**	**HIGH**
135		drum	2400	=C135*$D$10	=C135*$E$10
136		heck standard	500	=C136*$D$8	=C136*$E$8
137		holdup	600	=C137*$D$18	=C137*$E$18
138		drum	1000	=C138*$D$10	=C138*$E$10
139		sample	150	=C139*$D$6	=C139*$E$6
140		tion standard	3700	=C140*$D$7	=C140*$E$7
141		bag	0.5	=C141*$D$10	=C141*$E$10
142		HEPA	1000	=C142*$D$19	=C142*$E$19
143		holdup	1000	=C143*$D$18	=C143*$E$18
144			Total	**HIGH**	**HIGH**
145					
146	**COM-28f**	3013	8448000	**HIGH**	**HIGH**
147		drum	2400	=C147*$D$9	=C147*$E$9
148		heck standard	500	=C148*$D$8	=C148*$E$8
149		holdup	600	=C149*$D$16	=C149*$E$16
150		drum	1000	=C150*$D$9	=C150*$E$9
151		sample	150	=C151*$D$6	=C151*$E$6
152		tion standard	3700	=C152*$D$7	=C152*$E$7
153		bag	0.5	=C153*$D$10	=C153*$E$10
154		HEPA	1000	=C154*$D$17	=C154*$E$17
155		holdup	1000	=C155*$D$16	=C155*$E$16
156			Total	**HIGH**	**HIGH**