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CONTAMINATION CONTROL AREA – AIRLOCK – TOXIC FREE AREA PROCESS ANALYSIS (BRIEFING CHARTS)

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Air Force Research Laboratory**

MAY 2007

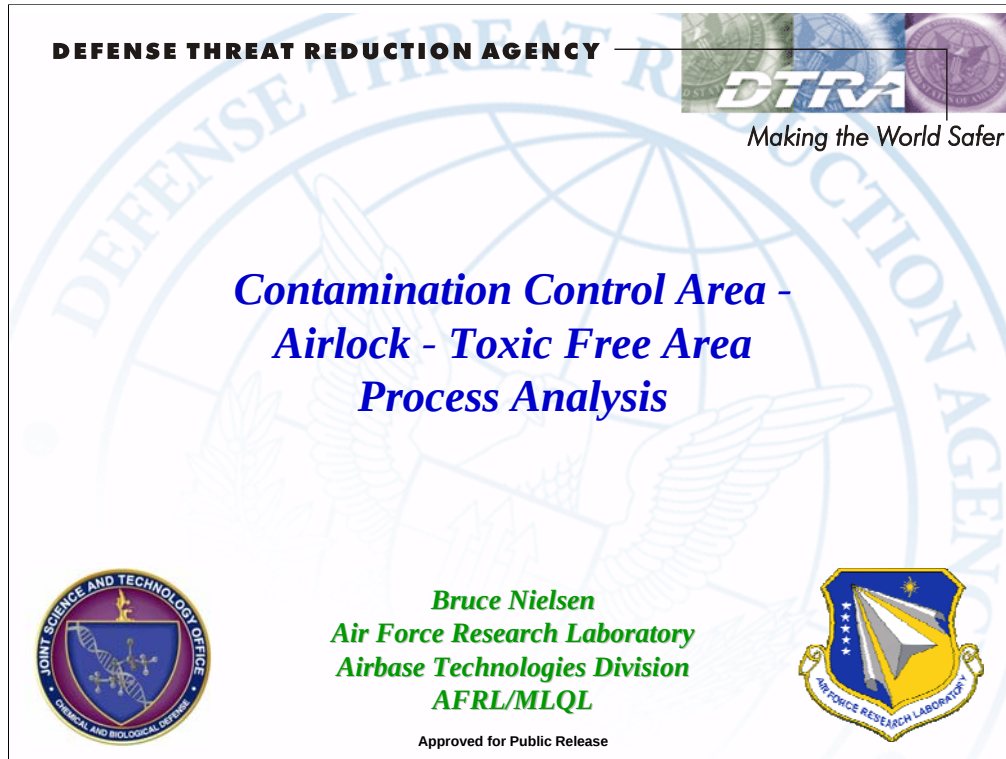
Interim Report for 1 April 2006 to 1 January 2007

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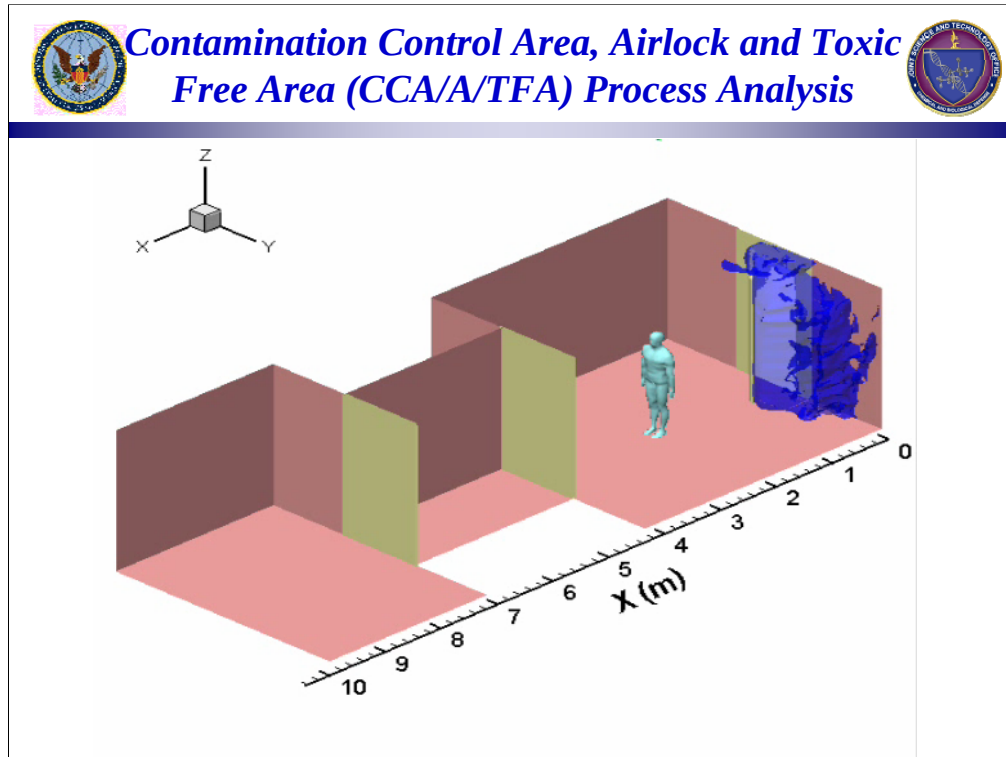
Good Morning!

In my past position as DTRA COLPRO Thrust Manager I heard many discussions regarding CCA/A/TFA Processing, usually focusing on one component of the process by many of the capability areas to include: Individual Protection, DECON, Collective Protection, Detection, Threat Agent Science and Modeling & Simulation.

But no one really was looking at the whole process.

I saw many proposals for airlocks citing that they are a “bottleneck” to COLPRO ingress/egress while others looked at the CCA process as the most cumbersome process

A better understanding of the CCA/A/TFA Process as a system was needed.



This project attempts to better understand that process and then to identify best approaches for providing throughput while minimizing contaminant transport



Contamination Control Area, Airlock and Toxic Free Area (CCA/A/TFA) Process Analysis

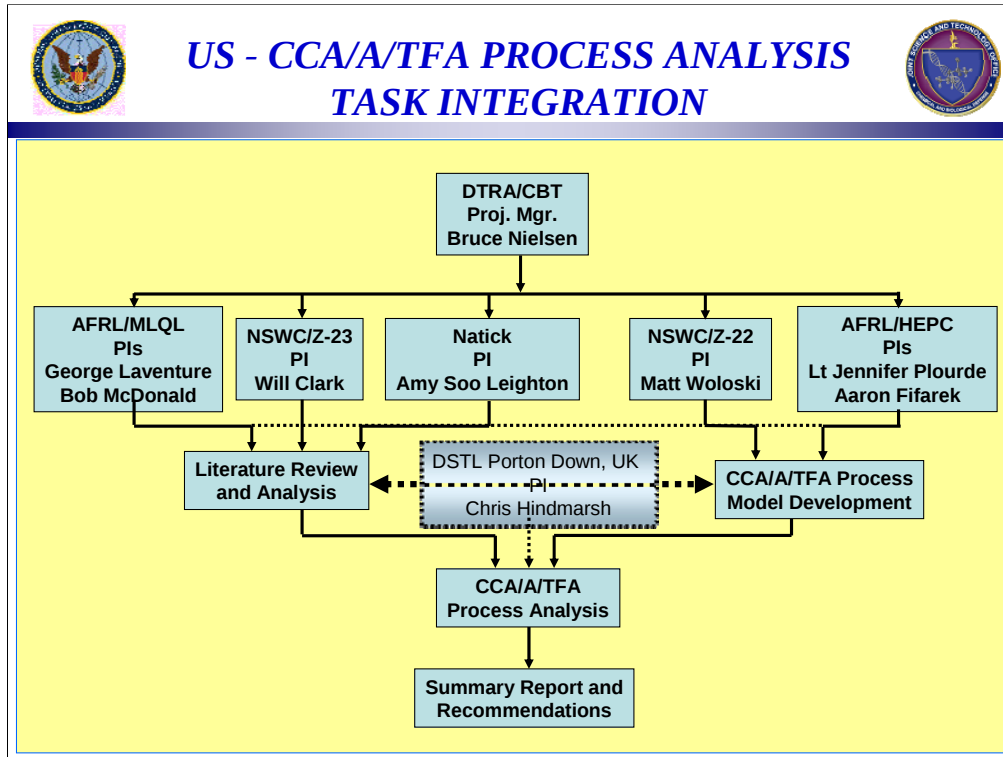


Objectives

- Establish an Integrated Process Team (IPT) to perform an analysis of CCA/A/TFA process.
- Develop comprehensive knowledge base of CCA/A/TFA process to include characterization of transport and fate of agents to minimize contamination and exposure levels.
- Apply current modeling capabilities to perform parametric analyses of CCA/A/TFA processes.

We formed a joint Air Force, Navy and Army team to develop a knowledge base and initial model of the process.

Knowledge and modeling capability will focus on mitigation of contaminant transport through process and the resulting exposure in the TFA by personnel.



Acknowledge team of individuals



CCA/A/TFA Process Analysis



Challenges

- Characterizing performance across a wide range of platforms (Expeditionary, Mobile, Fixed) and functions (rest and relief, medical, command and control).
- Understanding fate and transport of threat through CCA/A/TFA process.
- Determining acceptable levels of personnel protection.
 - *How clean is clean?*
- Providing enhanced capabilities without impacting logistics.

"How dirty is clean?"

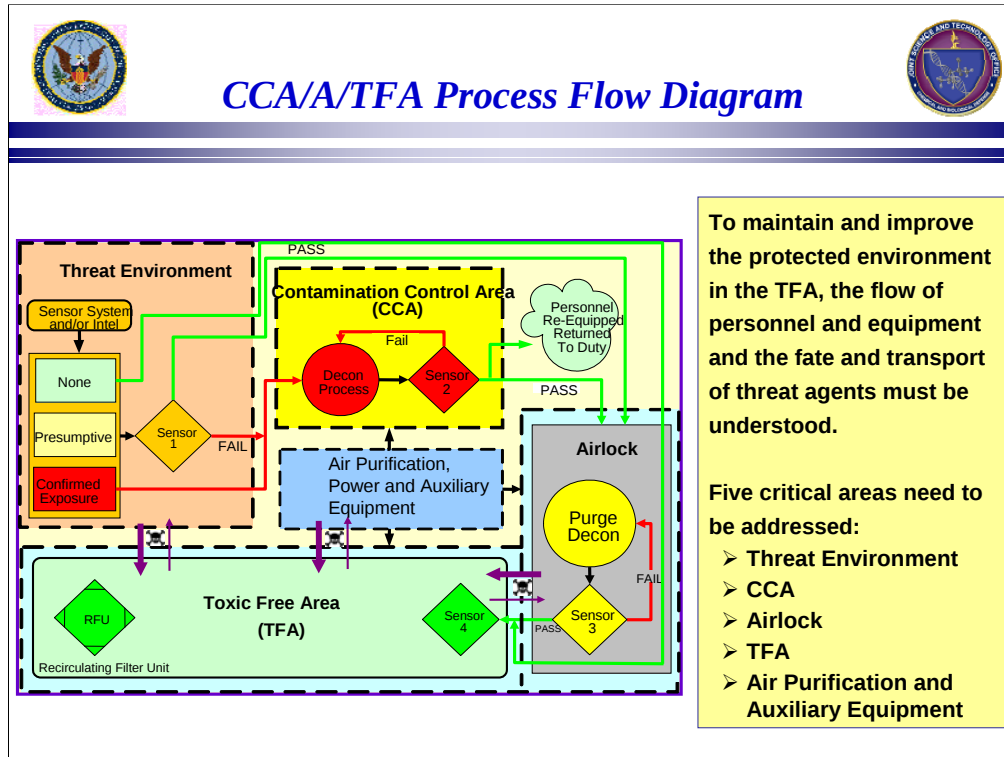
"You can check out any time you like but you can't come in."

One problem is that there is not one standard CCA/A/TFA system or process.

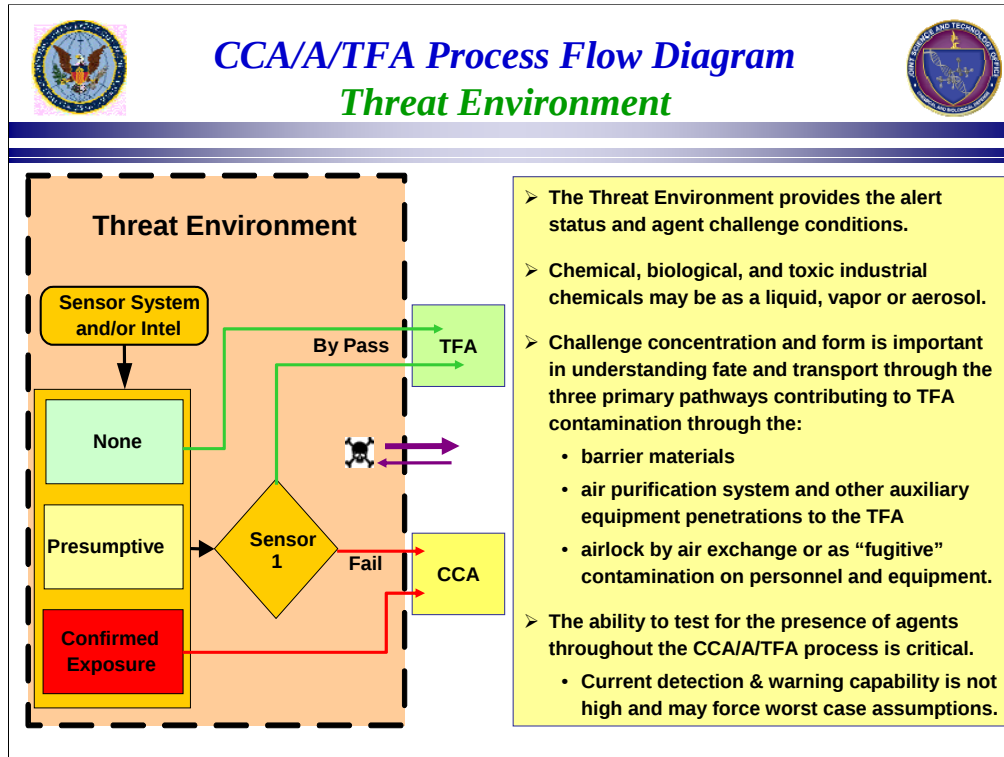
Also modeling contaminant transport

And the complex question of "How clean is clean?"

Or from our perspective: "How dirty is clean?" and a worse case conclusion of: To paraphrase "Eagles – Hotel California" "You can check out any time you like but you can't come in."



Goal was to model flow of personnel and transport of contaminants through the system that is broken into five areas



The Threat Environment provides challenge and alert levels

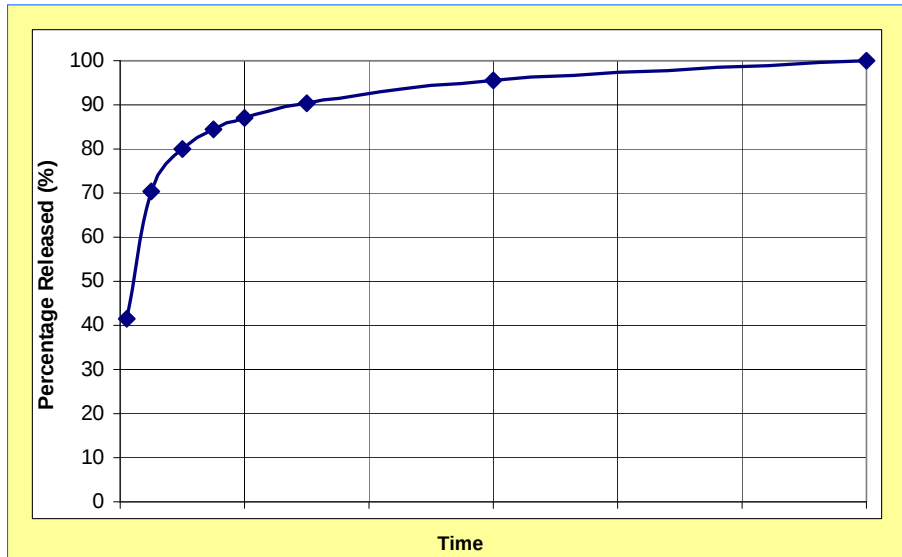
CBRN TIC/TIM as liquid, vapor, aerosol

Three primary paths into TFA

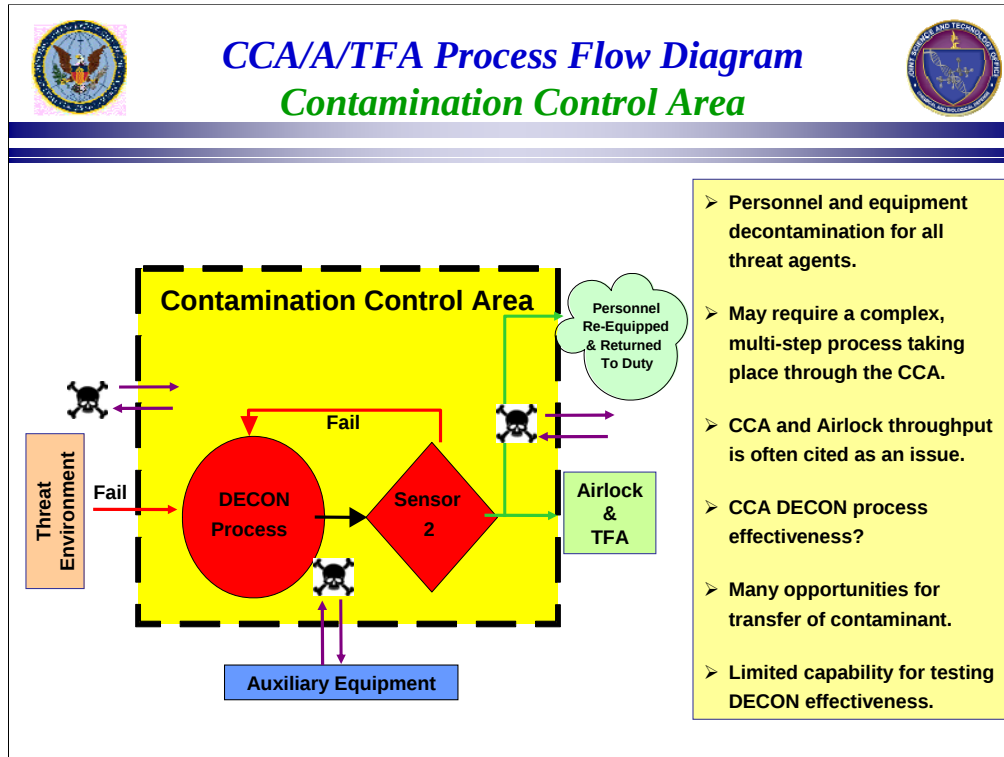
Lack of monitoring may risk TFA contamination or force worst case assumption (DECON everyone)



Rate of Agent Desorption

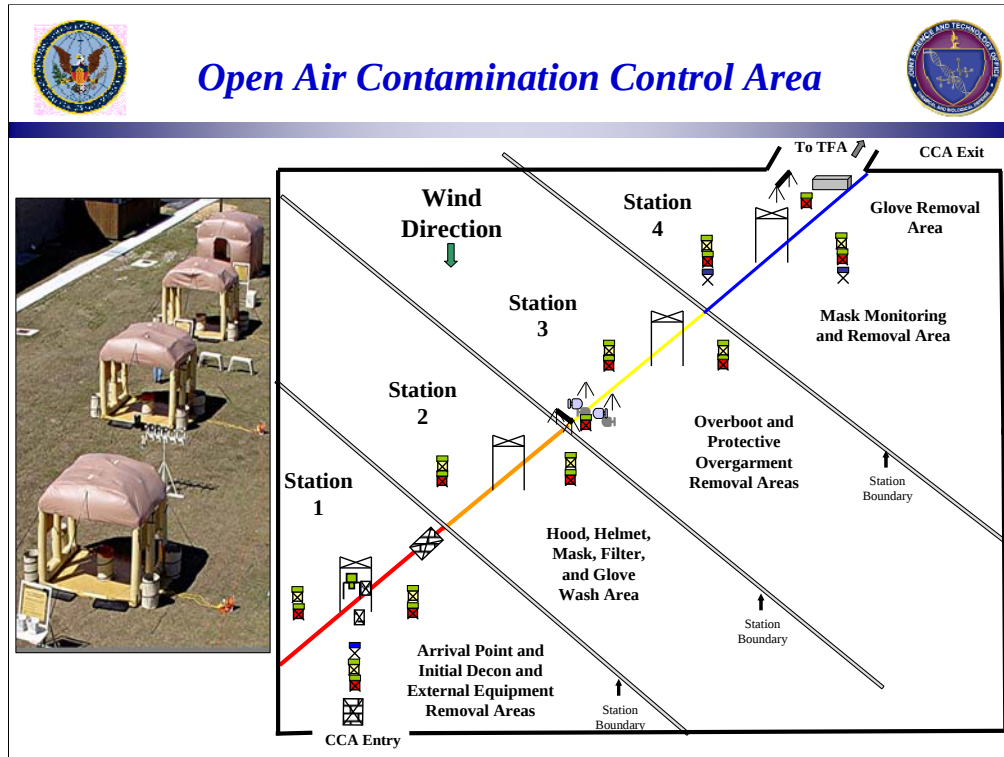


**Part of our required data was to understand
Adsorption/Desorption and Deposition/Re-
Aerosolization**



As alluded earlier having monitoring technology for assessing need to decontaminate would be advantageous as this is the most time consuming step (bottleneck) and where much contaminant transfer occurs.

Those questions of “How clean is clean?” and “How dirty is clean “?



An Open air CCA

The JECF CDD requires ingress/egress in a contaminated environment and may have limited CCA capabilities



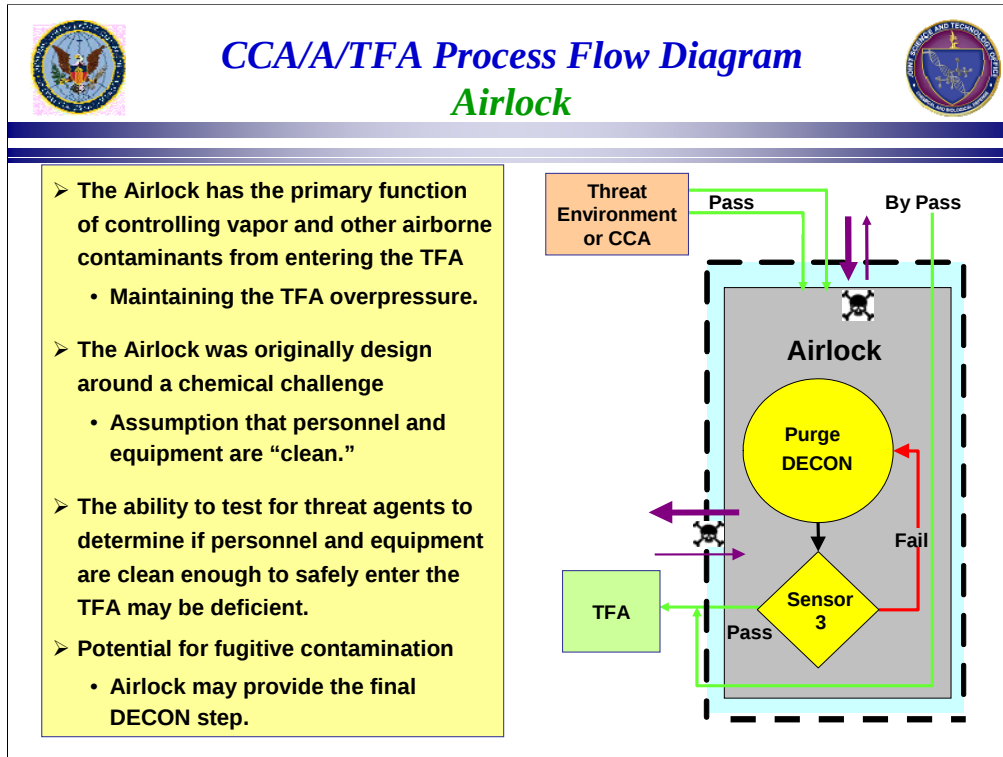
Swedish Demonstration
Toxic Trip 2005, Zaragoza Air Base, Spain



**CW Agent Contamination Test Cabinet
Aircrew Processing System**

- Infrared heaters that rapidly heat the enclosure to ~70°C
- 90 second processing/sample time
- CW agent detector (AP2C monitor)

**An approach for assessing whether to DECON
or not (CCA Triage).**



Airlocks maintain over-pressure and control transport of airborne contaminants.

“How dirty is clean?”

Airlock importance and need for enhancements increasing as JECF CDD may require final doffing and DECON in airlock

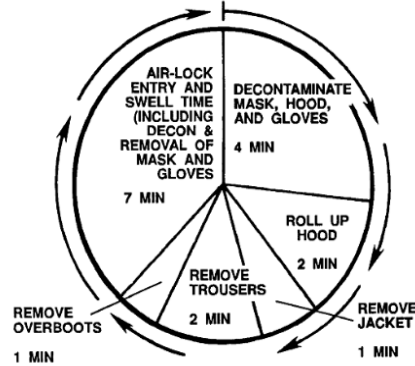


Entry Process from Army FM 3-4

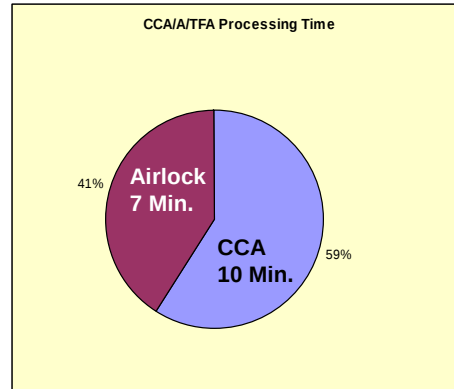


U.S. Army Field Manual 3-4 recommends that commanders estimate 17 minutes for each person to complete the CCA/A/TFA process.

Table 6-5. Entry process times.



Entry Process from Field Manual 3-4



Airlock Process to provide three-log purge of airborne contaminants

The Contamination Control Area and Airlock process takes about 17 minutes

This may be optimistic, especially for the CCA processing of air crews



Airlocks



M28
Protective
Entrance



CBPSS
endwall
with
integral
litter and
ambulatory
airlocks



Bump-Through-Door Airlock

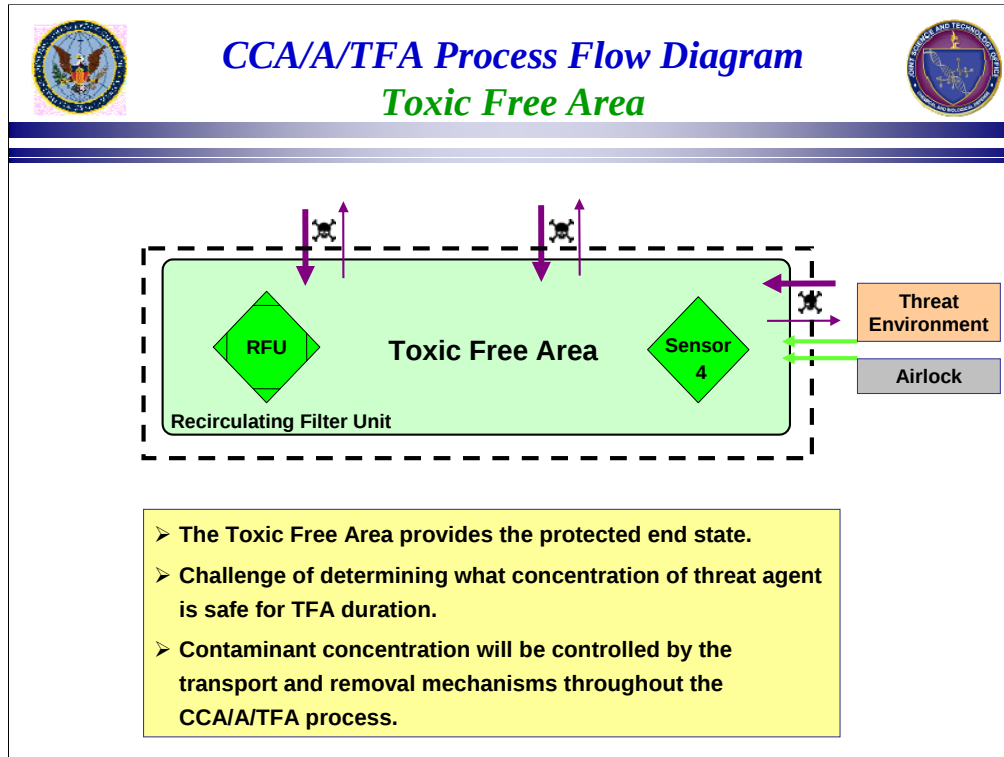


BTDA (side view) with FFA 580 installed

Some examples of single person, litter patient, and multi-person airlocks.

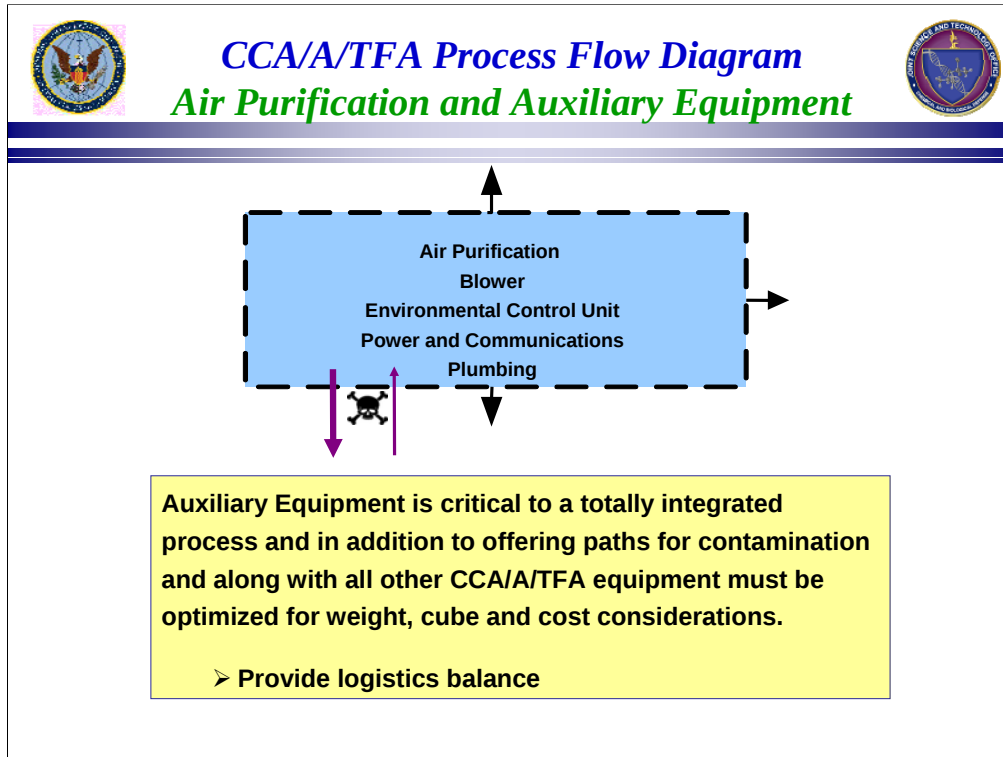
One issue is the volume and the rule of thumb requiring six air exchanges to provide a 3-log reduction in airborne contamination

The BTDA is logistically burdensome



The issue in the TFA is contaminant concentration and duration of stay with respect to current toxicity standards and low level exposure studies.

Use knowledge to mitigate exposure.



The air purification systems is critical source and sink for contamination as well as any other penetration to the TFA.



CCA/A/TFA Process Analysis



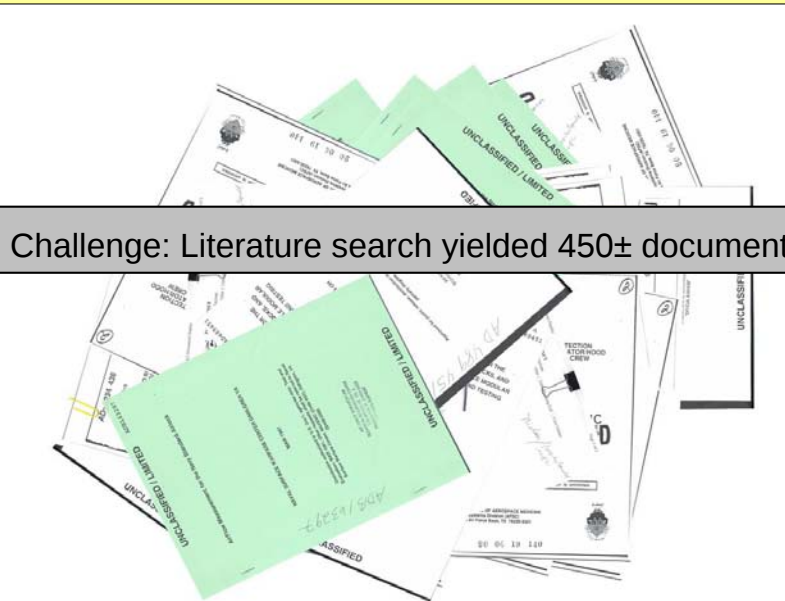
Benefits

- Comprehensive knowledge of CCA/A/TFA processing will enable researchers to develop enhance systems.
- These enhanced systems will allow the most expeditious transition from an unprotected state or from individual protection into collective protection while maintaining highest protection factor in the toxic free area.

The analysis focusing on identifying “weak links” will help direct system improvements.



CCA-A-TFA Literature Review Process



Challenge: Literature search yielded 450± documents

First objective was to gather information by PI from each service performing literature search and review



CCA-A-TFA Literature Review Process



Literature review is the cornerstone on which everything else will be built – will be used to:

- Analyze parameters, boundaries, and limitations of existing CCA-A-TFA systems and processes
- Provide input to overarching model which will be one of the main outputs of this project
- Provide input to technical report

To make review data useful - so that modelers and report writers won't have to re-read 450± documents, we must provide sufficient detail to:

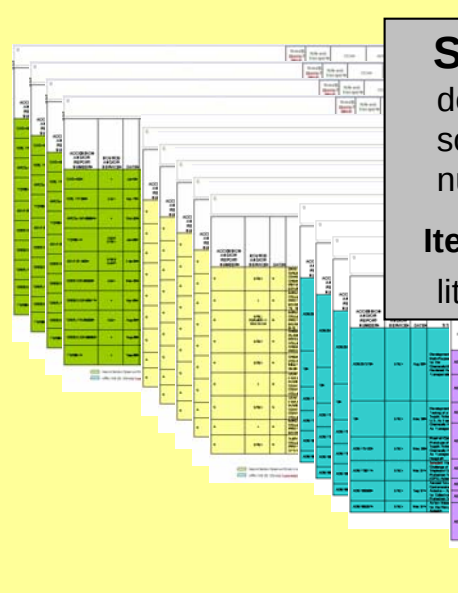
- Let modelers and reviewers know if the document contains useful data
- Provide solid data points in review comments
- A clear trail back to the relevant data in the documents

The knowledge from review was basis for modeling and reference source for final report

To be more useful the information was arranged in an spreadsheet by key terms



CCA-A-TFA Literature Review Process



Solution: Organized list of documents into consolidated table; sort-able by organization, report number, date, title, author, etc.

Iterative Process standardized our literature review inputs

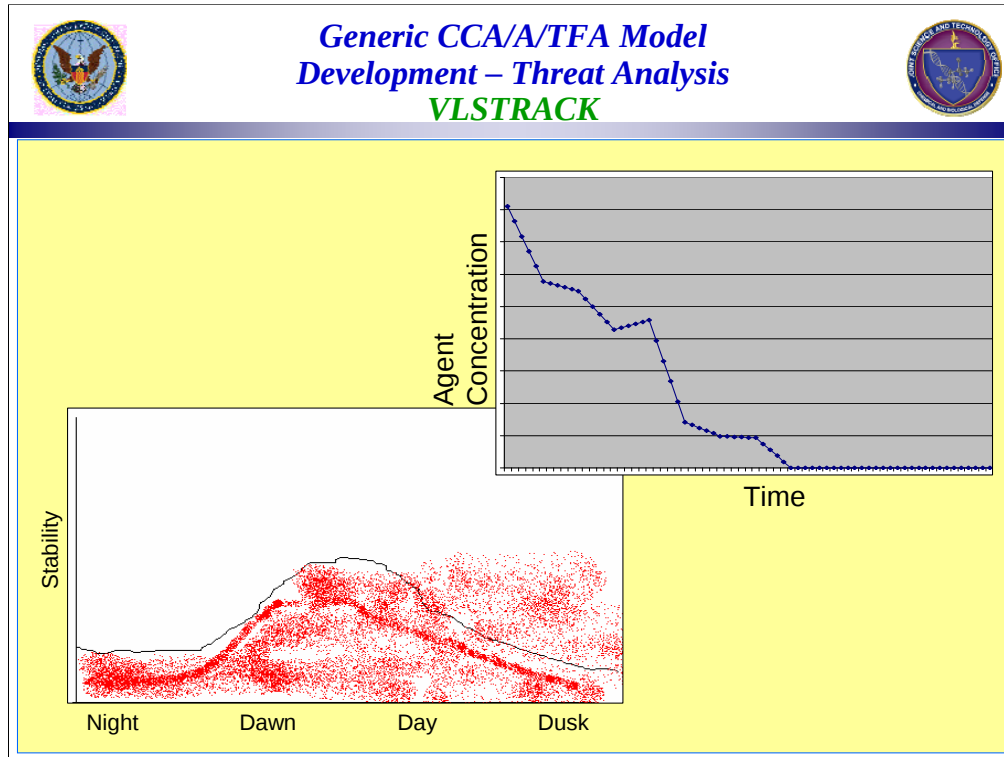
Product was a spreadsheet database with review comments



CCA-A-TFA Literature Review Process

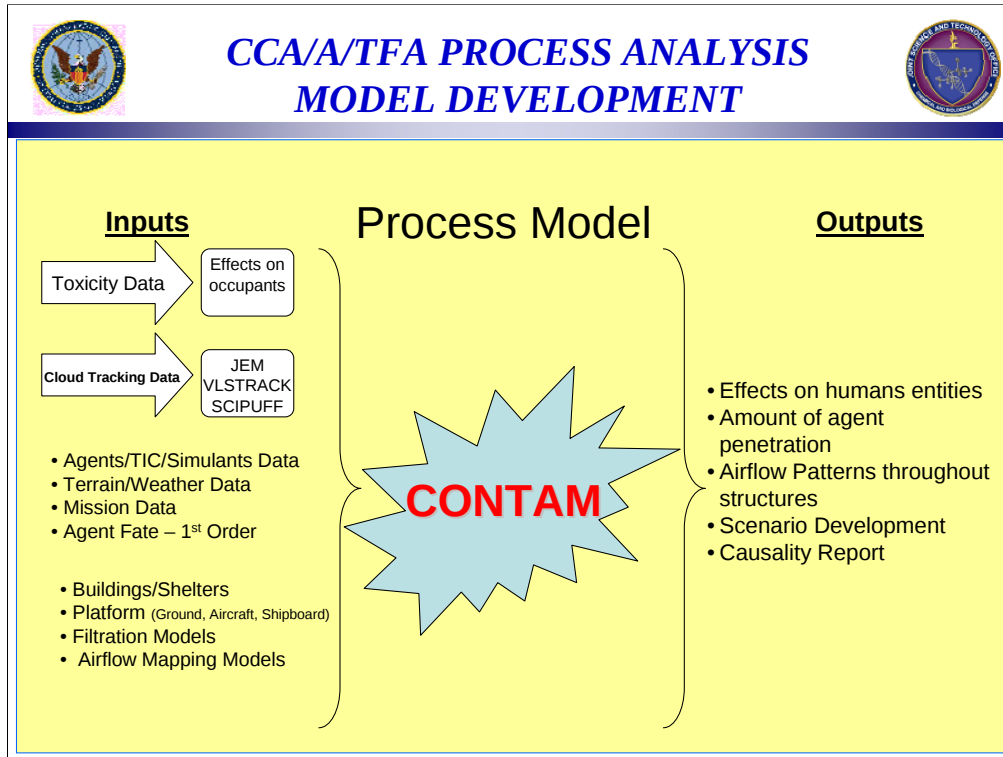


ID	ACCESSION- AND/OR-REPORT- NUMBER	SOURCE- AND/OR- SERVICE	DATE	TITLE	AUTHOR(S)	ABSTRACT / CRITICAL-REVIEW-COMMENTS	Page # Para #	Elec-Copy/Hand-Copy
278R	ADB237273R	DTICR	Aug 00R	Development of a Multi-Purpose Airlock for the Chemically/Biologically-Hardened Air-Transportable Hospital	Blewett, William K	AFRLMLQL Note: Test and Eval parameters and data which may be useful to modelers. Pages 23—29 of PDF. Tables 1—3 have hard data.¶ Conclusions: Fan-Pressurization-Testing —with leakage rate of airlock makeup flow greater than 400 cfm required for pressurization to 0.3 twg.¶ Conclusions: Purge-Testing —With makeup air flow rate of 400 cfm, overpressure of 0.3 twg, and 60 hz, Airlock achieves three-log reduction in aerosol concentration in less than 3 minutes. With no makeup air flow, the airlock achieves three-log reduction in 3.6 minutes.¶ Conclusion: Static Vapor-Challenge-Testing —Operating in the static mode (no entries and exits), the airlock provides protection factor well above the 6,667 required for collective protection shelters.¶ Appendix A pages 39-83 of PDF has many engineering drawings—may be useful for CONOPS or modeling.¶ Appendix B pages 85-122 is Draft Operation and Maintenance manual—probably useful for CONOPS work.¶	Pages 23-29, 39-83, and 85-122 of PDF.¶	ER
279R	13R	DTICR	May 96R	Development and Testing of a Medical Supply Airlock for the U.S. Air Force Chemically-Hardened Air-Transportable Plant	Ramos, Gabriel A.; Reeves, Dennis W.; Blewett, William K; Anca, Victor J; Jones, Daryl W	AFRLMLQL Note: Vapor-Challenge—Test & Eval data for Purge Rate, Protection Factor, Exit/Entry procedures. Beginning ~ Page 13 of PDF. Report addresses vapor-challenge during purge test and time required to reduce aerosol concentration in medical airlock—reduce vapor-challenge by 99.9% within 1-hour—max allowed purge time 3 hours. Tables 2, 3, 4, 5, and 6 contain data on direct and indirect challenge levels—airflow rate (200cfm) overpressure (0.24 twg), entry/exit purge time, etc.¶	Pages 13-19, 23, and 24 of PDF.¶	ER
280R	ADB175182R	DTICR	May 93R	Proof-of-Concept Prototype of a Medical Supply Airlock for the Chemically-Hardened Air-Transportable Hospital	Jones, Daryl W; Blewett, William K; Ramos, Gabriel A; Reeves, Dennis W	¶	¶	¶



Next task was to develop Threat challenge information

VLSTRACK was modeling tool used



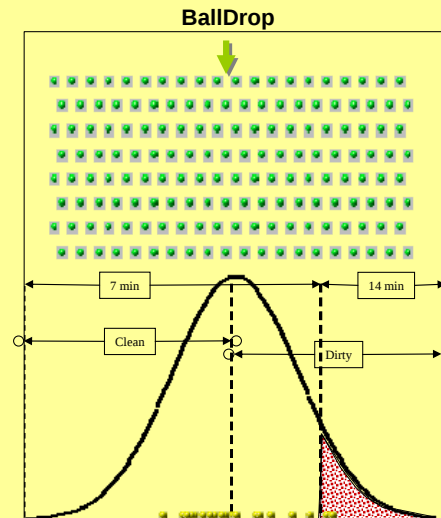
For modeling through the system CONTAM was used



Determining Who is “Dirty”



- BallDrop application for statistically/randomly determining who would make it through the CCA process “dirty”
- In this example – two are detectably dirty, seven are dirty but not detectable, 21 are clean



We used a random process to assign how dirty each model person was.



Order of Entry for Thirty Individuals



Contaminated

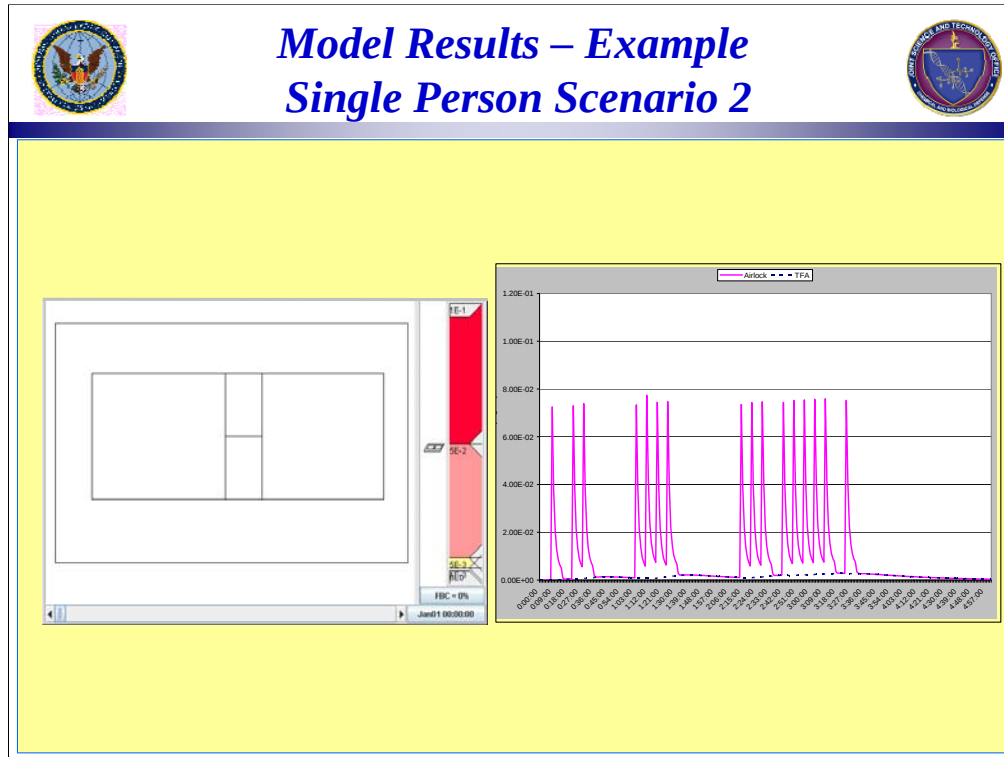
1-Purge

2-Purge

Scenario 2-S	Scenario 4-S	Scenario 6-S	Scenario 2-M	Scenario 4-M	Scenario 6-M	
1	1	1	1	1	1	1
1	1	1	1	1	1	2
1	1	1	1	1	1	3
1	1	1	1	1	1	4
1	1	1	1	1	1	5
1	1	1	1	1	1	6
1	1	1	1	1	1	7
1	1	1	1	1	1	8
1	1	1	1	1	1	9
1	1	1	1	1	1	10
1	1	1	1	1	1	11
1	1	1	1	1	1	12
1	1	1	1	1	1	13
1	1	1	1	1	1	14
1	1	1	1	1	1	15
1	1	1	1	1	1	16
1	1	1	1	1	1	17
1	1	1	1	1	1	18
1	1	1	1	1	1	19
1	1	1	1	1	1	20
1	1	1	1	1	1	21
1	1	1	1	1	1	22
1	1	1	1	1	1	23
1	1	1	1	1	1	24
1	1	1	1	1	1	25
1	1	1	1	1	1	26
1	1	1	1	1	1	27
1	1	1	1	1	1	28
1	1	1	1	1	1	29
1	1	1	1	1	1	30

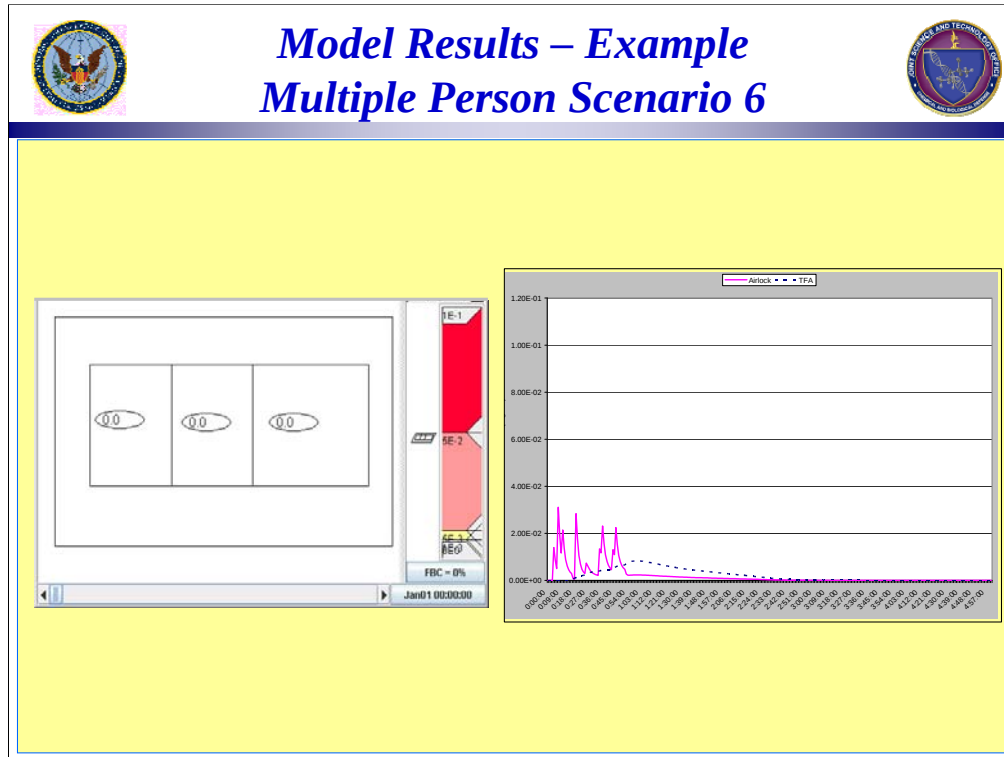
Note: S means single person airlock and M means multiple person airlock

These are some of the scenarios and illustrates how order of entry could cause “log jams”



On left animation shows contamination concentration in CCA/A/TFA and graph on right shows concentration spikes from individuals processing through single person airlock over time.

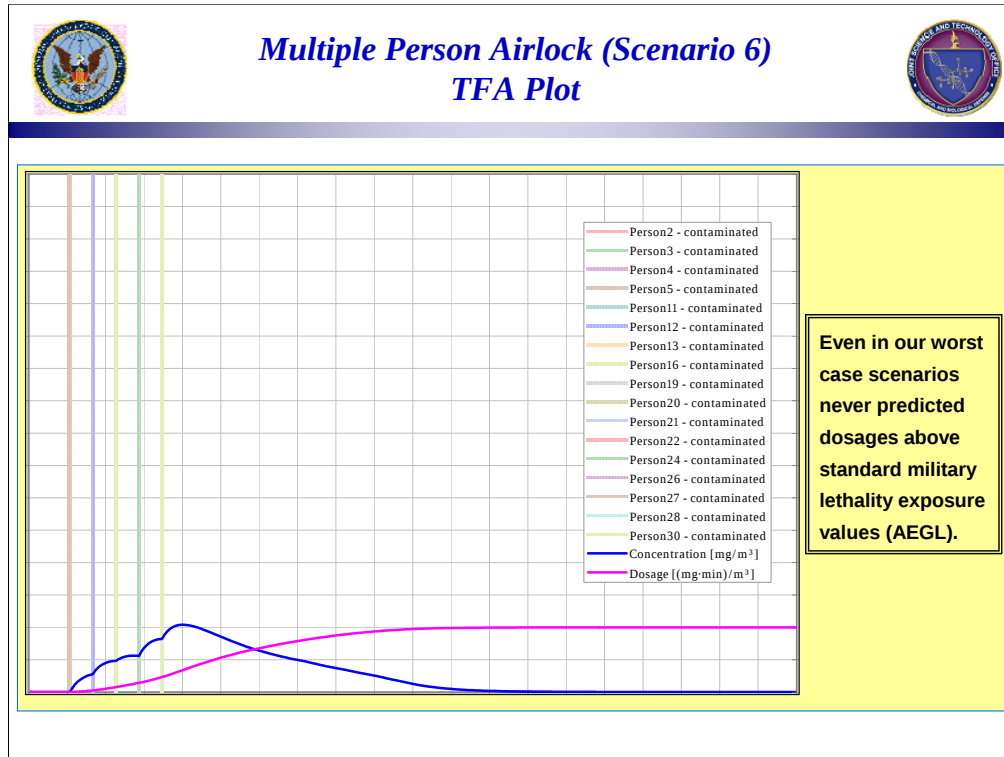
Single person airlock maintains low concentrations in TFA but required almost four hours to process 30 individuals.



Same type of slide but now individuals processing through multi-person airlock

Yielded lower airlock spike concentrations but slightly higher concentrations in TFA.

However, the multi-person airlock processed all 30 individuals in less than one hour



Graph of contaminated individuals arrival time and TFA concentration and dosage.

Didn't exceed Acute Exposure Guideline Limits (AEGL).



CCA/A/TFA Process Analysis



Conclusion

- Multiple person airlocks provided best performance.
- More model runs and fidelity is needed taking into account dynamic processes versus our initial runs that were limited scenarios often at constant or static rates.
- Associated project with DSTL Porton Down will perform further modeling and analysis of CCA/A/TFA process.
- Project assessing biological particle mitigation proposed.

Multi-person airlocks performed best but have logistical burden

Initial modeling provides good basis for future efforts to provide complete understanding of CCA/A/TFA Process



Thank You!