



**An Overview of Risk-Based Explosives Safety Siting
for
The 2018 International Explosives Safety Symposium & Exposition**

Michael Oesterle, PhD, PE

Ruby Domingo

NAVAFAC EXWC, Port Hueneme, CA

Jon Chrostowski

Ryan Schnalzer

ACTA, Torrance, CA

Introduction



- **Problem:**

- Explosives storage and handling facilities require site plan approval from Department of Defense (DoD) Explosives Safety Board (DDESB) to operate
- Quantity-Distance (QD) violations can be mitigated through risk acceptance by the component Military Service
- Quantitative information on hazards and consequences is needed by officials who accept risk for explosive facilities not meeting QD criteria.

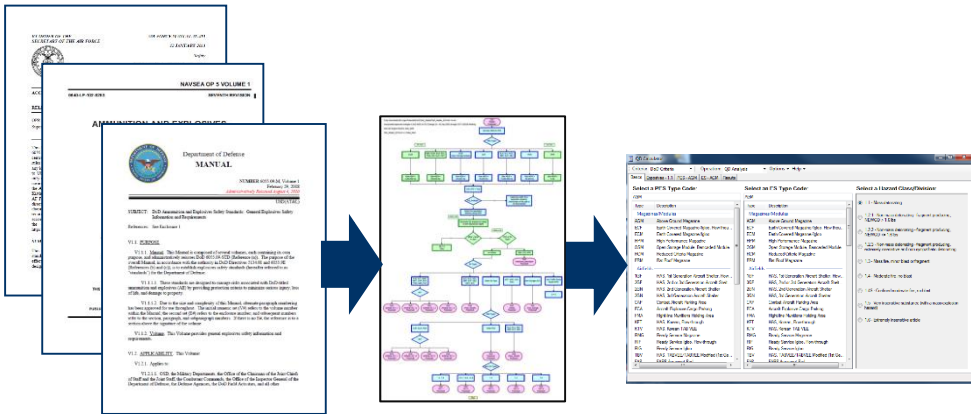
- **Solution:**

- Make use of Explosives Safety Siting (ESS) software, which is a GIS based automated site planning tool that is used DoD-wide for generation of site plan packages
- Incorporate hazard-consequence analysis tools into ESS:
 - Tier 1- ASAP-X based on DoD 6055.09M consequences
 - Tier 2a- HAZX based on DDESB TP-14 revision 4 algorithms
 - Tier 2b- DDESB Risk Based Explosives Safety Analysis based on DDESB TP-14 revision 4 algorithms using numerical event probabilities and acceptance criteria (i.e. SAFER)

- **Introduction**
- **Background**
- **Technical Approach**
- **Verification Results**
- **RBESS Demonstration**
- **Conclusions and Path Forward**

Background- What is ESS?

- DoD sponsored software developed for use by all DoD services.
- Software developed and maintained by NAVFAC EXWC on behalf of the DDESB
- Used for:
 - Automated calculation and display of explosives safety quantity distance (ESQD) arcs
 - Automated and standardized Site Plan Package development
 - Automated and standardized Potential Explosion Site (PES) data



Background- Tier 1 ASAP-X

- Consequences are based on damage descriptions for hazard zones in 6055.09-M
- Simple input consisting of cost and number of occupants
- Consequences based on ES location within hazard zone
- ESS QD engine used in implementation to calculate hazard zones

PES NAME:		DESCRIPTION:	
HAZARD DIVISION	NEW (LBS)	Is the PES an open pad, ECM, or Other?	ECM
1.1	70000		Yes
1.2.1		Is the ECM 25 ft or larger and a loading density less than 0.028 lbs/cubic feet?	No
1.2.2			
1.2.3			
1.2.3 MCE		Is the ECM Undefined?	No
1.2.3 MCE (xx)			
1.3			
1.4			

NEW in Pounds Distance in Feet Bldg Cost is a Generic Value An ES Name must be entered for every ES being evaluated					
ES INPUT DATA FOR					
ES Name	Dist from PES	Personnel at ES	Bldg Cost	ECM Orientation	On Base
ES_21	250	10	100		
ES_22	400	10	100		
ES_23	500	10	100		
ES_24	700	10	100		
ES_25	1000	10	100		
ES_26	1500	10	100		
ES_27	2000	10	100		

GPS Data Input Table							
Degrees	Minutes	Seconds	Direction	Degrees	Minutes	Seconds	Direction
PES							

GPS Data Input Table							
Degrees	Minutes	Seconds	Direction	Degrees	Minutes	Seconds	Direction
ES Information							

EARTH COVERED MAGAZINE ZONE OUTPUT FOR

ECM FRONT DISTA	ECM REAR DISTA	ECM SIDE DISTA	ZONE	FATAL	BUILDING DAMAGE LOSS	INJURIE	% FATAL	% BLDG DAMA	% INJURI
247	247	247	1 (K6)						
371	371	371	2 (K9)	10	100		100%	100%	
453	453	453	3 (K11)	9	100	1	90%	100%	10%
742	495	659	4 (K18)	10	150	6	50%	75%	30%
989	989	989	5 (PTRD)						
1,449	1,449	1,449	6 (IBD)	1	20	1	5%	15%	5%
TOTAL PEOPLE AFFECTED				60					
TOTAL FATALITIES				20					
% FATALITIES				50%					
TOTAL INJURIES				8					
% INJURIES				13%					
TOTAL BUILDING COSTS				600					
TOTAL BLDG DAMAGE LOSS				\$379					
% BUILDING DAMAGE LOSS				63%					
TOTAL ES: AFFECTED				6					

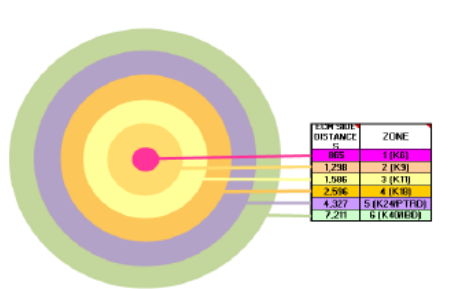
ON BASE DATA FOR									
ECM FRONT DISTA	ECM REAR DISTA	ECM SIDE DISTA	ZONE	FATAL	BUILDING DAMAGE	INJURIES	% FATAL	% BLDG	% INJURI
247	247	247	1 (K6)						
371	371	371	2 (K9)	10	100		100%	100%	
453	453	453	3 (K11)	9	100	1	90%	100%	10%
742	495	659	4 (K18)	10	150	6	50%	75%	30%
989	989	989	5 (PTRD)						
1,449	1,449	1,449	6 (IBD)	1	20	1	5%	15%	5%
TOTAL PEOPLE AFFECTED				60					
TOTAL FATALITIES				20					
% FATALITIES				50%					
TOTAL INJURIES				8					
% INJURIES				13%					
TOTAL BUILDING COSTS				600					
TOTAL BLDG DAMAGE LOSS				\$379					
% BUILDING DAMAGE LOSS				63%					
TOTAL ES: AFFECTED				6					

OFF BASE DATA FOR									
FRONT DISTA	ECM REAR DISTA	ECM SIDE DISTA	ZONE	FATAL	BUILDING DAMAGE	INJURIES	% FATAL	% BLDG	% INJURI
247	247	247	1 (K6)						
371	371	371	2 (K9)						
453	453	453	3 (K11)						
742	495	659	4 (K18)						
989	989	989	5 (PTRD)						
1,449	1,449	1,449	6 (IBD)						
TOTAL PEOPLE AFFECTED				0					
TOTAL FATALITIES									
% FATALITIES									
TOTAL INJURIES									
% INJURIES									
TOTAL BUILDING COSTS				0					
TOTAL BLDG DAMAGE LOSS									
% BUILDING DAMAGE LOSS									
TOTAL ES: AFFECTED				0					

ES OUTPUT DATA

ES Name	Distance from PES	On Base	Zone	Personnel at ES	Fatalities	Injuries	Building Cost	Building Damage Loss
ES_21	250		2 (K9)	10	10.0	0.0	100	100.0
ES_22	400		3 (K11)	10	9.0	1.0	100	100.0
ES_23	500		4 (K18)	10	7.0	2.3	100	91.9
ES_24	700		4 (K18)	10	2.9	2.1	100	57.3
ES_25	1000		6 (IBD)	10	0.2	0.4	100	16.3
ES_26	1500		6 (IBD)	10	0.1	0.2	100	8.4
ES_27	2000		6 (IBD)	10			100	

EARTH COVERED MAGAZINE ZONE OUTPUT FOR ECM 1



Fatalities:

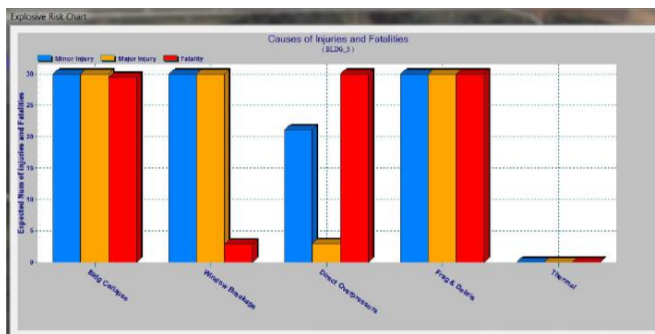
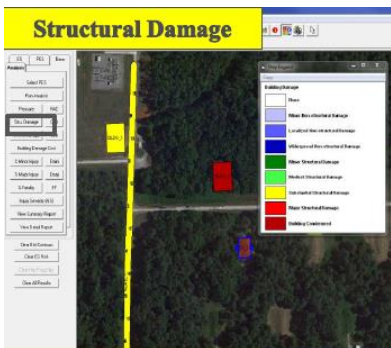
- Zone 1 = 100%
- Zone 2 = 90% - (0.1(K9-ES distance)/(K9-K6)+.90)
- Zone 3 = 80% - (0.1(K11-ES distance)/(K11-K9)+. 80)
- Zone 4 = 20% - (0.6(K18-ES distance)/(K18-K11)+.20)
- Zone 5 = 2% - (0.18(PTRD-ES distance)/PTRD-K18)+.02)
- Zone 6 = 1% - (0.01(IBD-ES distance)/(IBD-PTRD)+0.01)

Building Damage:

- Zones 1, 2 and 3 = 100%
- Zone 4 = 50% - (0.5(K18-ES distance)/(K18-K11)+0.5)
- Zone 5 = 20% - (0.3(PTRD-ES distance)/PTRD-K18)+0.2)
- Zone 6 = 5% - (0.15(IBD-ES distance)/(IBD-PTRD)+0.05)

Background- Tier 2a HAZX

- Defines accident probabilities in qualitative terms
- Translates consequences into severity categories
- Consequence algorithms based on DDESB TP-14, Rev. 4



Maximum Probable Loss (MPL) (given accident occurs)				
Receptor Type	No. of People	Equip/Fac Value (\$)	Fatalities	Major Injuries
Buildings	90	\$1,500,000	39.66	61.17
Moving Vehicles	2.1	\$15,623	0.25	0.52
Open Areas	0	\$0	0	0
Total	92	\$1,515,623	39.91	61.69

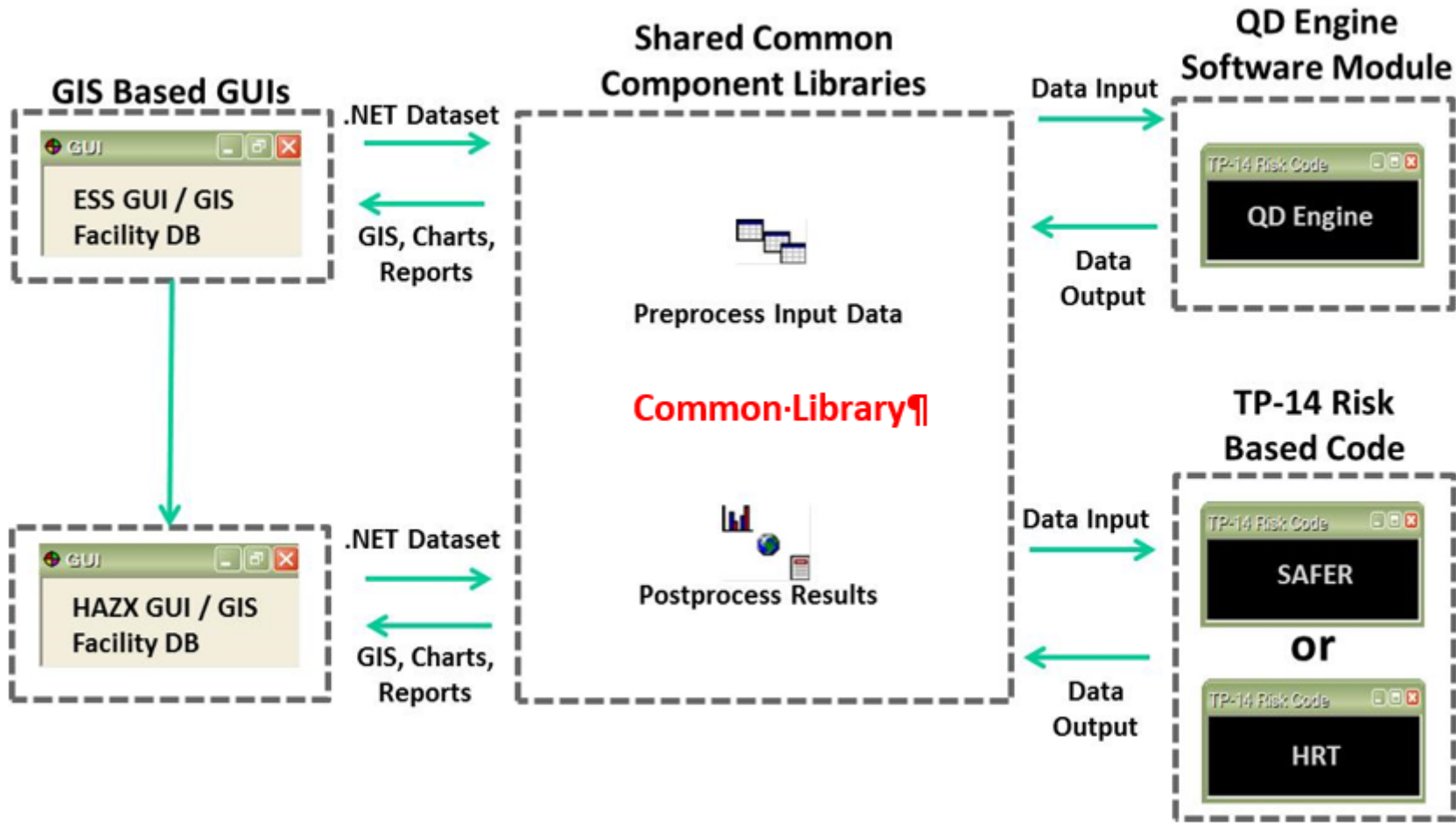
Severity	Probability				
	A - Possible	B - Seldom	C - Unlikely	D - Improbable	E - Practically Impossible
I - Catastrophic	F(1)	E(1)	H(2)	H(2)	M(3)
II - Critical	E(1)	H(2)	H(2)	M(3)	L(4)
III - Marginal	H(2)	M(3)	M(3)	L(4)	L(5)
IV - Negligible	M(3)	L(4)	L(4)	L(5)	L(5)

Description	Symbol	RAC	Color
Extremely High	E	1	Red
High	H	2	Orange
Moderate	M	3	Yellow
Low	L	4	Light Blue
Low	L	5	Dark Blue

ES Name : BLDG_3
Probability : Practically
Severity : Catastrophic
RAC : M(3)

- PES Input Requirements:
 - Facility Information
 - Height
 - Structure Type
 - Replacement Cost
 - Occupants
 - PES Activity
- ES Input Requirements:
 - Facility Information
 - Height
 - Structure Type
 - Roof Type
 - Window
 - Replacement Cost
 - Building
 - Windows
 - Occupants
 - Traffic Information
 - Barricade Polygons

RBESS System Design

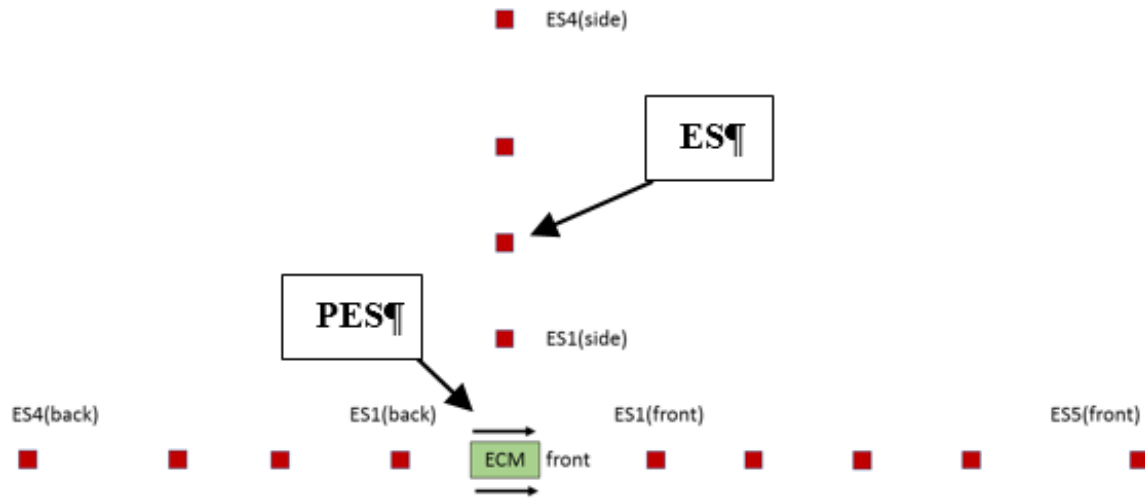


RBESS Verification



- **Focus of verification was to demonstrate that RBESS was implemented as intended**
- **Phase I concentrated of comparing Tier 1 results for ASAP-X, HAZX (Tier 1) and RBESS**
- **Phase II focused on comparing Tier 2a results between HAZX and RBESS**
- **Each phase consisted of multiple scenarios that varied:**
 - NEW
 - PES type and size
 - ES location
 - PES orientation for ECM

Phase I Verification Scenarios

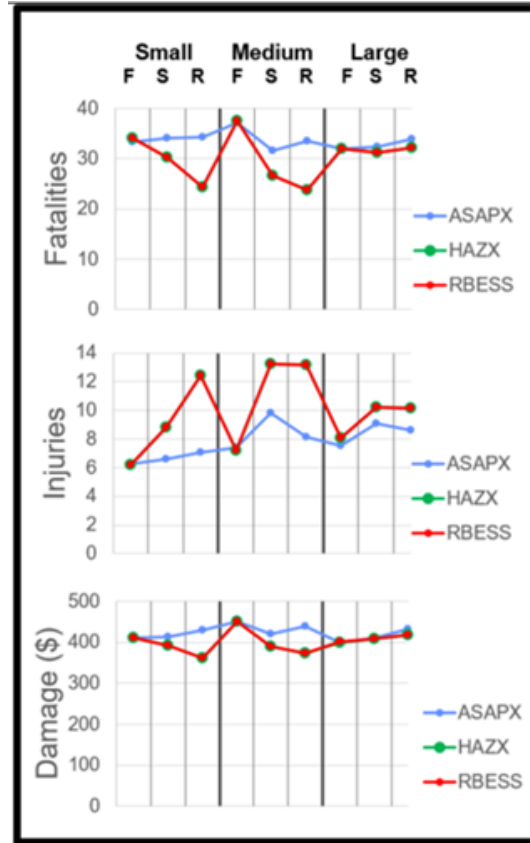


PES Type	Charge	ID	PES Orientation	IMD-B	ILD-B	IMD_U	ILD-U	PTR	IBD	> IBD
				ES 1	ES 2	ES 3	ES 4	ES 5	ES 6	ES 7
ECM	Small (1000 lb)	S1	Front	50	75	100	150	600	1000	1400
		S2	Side	40	65	95	140	500	1050	1300
		S3	Rear	30	70	105	115	400	850	1255
	Medium (70,000 lb)	S4	Front	200	300	400	500	800	1400	1600
		S5	Side	230	350	450	650	700	1300	1500
		S6	Rear	150	325	425	480	700	1000	1255
	Large (500,000 lb)	S7	Front	450	700	800	1300	2000	3800	4500
		S8	Side	400	600	750	1400	1600	3000	5000
		S9	Rear	475	500	870	1250	1500	2500	4000
Open	Small (500 lb)	S10	Front	40	60	80	120	400	900	1300
	Medium (30,000 lb)	S11	Front	150	250	300	500	650	1000	1400
Undefined	Medium (20,00 lb)	S12	Front	100	225	275	450	700	1200	1255
	Large (100,000 lb)	S13	Front	250	400	500	700	1000	1500	2000

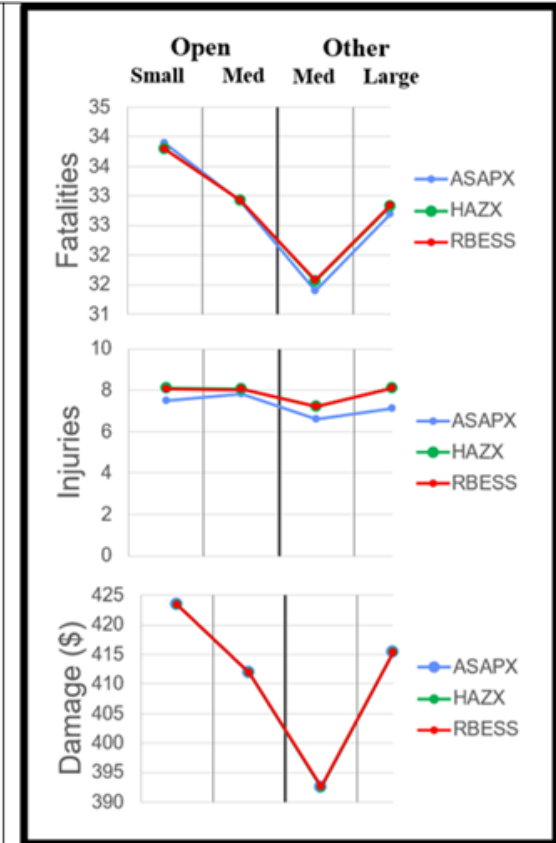
Phase I Verification Results



- **Nearly full agreement between HAZX and RBESS**
 - Common Library implement properly
- **Disagreement between ASAP-X and RBESS/HAZX for ECMs**
 - Hazard zone calculated with QDE in RBESS/HAZX
 - Hazard zone calculated with simplified QD engine in ASAP-X
- **Disagreement between ASAP-X and RBESS/HAZX for Injuries**
 - Interpolation scheme for ASAP-X is not consistent for all hazard zone due to different rounding rules



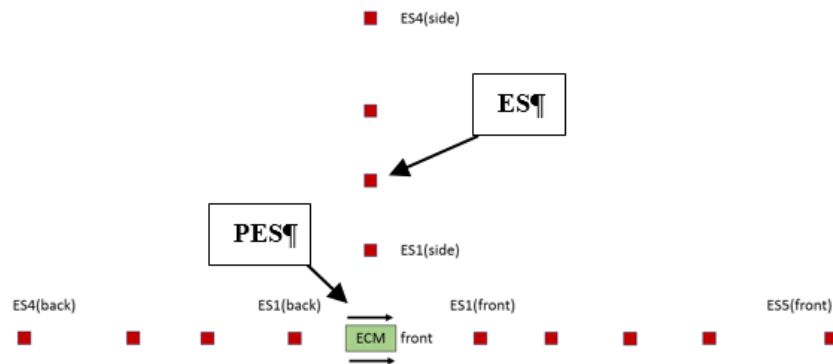
A. ECM-type PES Scenarios



B. Open- and Other-type PES Scenarios

Phase II Verification Scenarios

- 100 runs performed to test PES, NEW, and ES parameters
- Runs also used to test functionality
- Problem setup identical to Phase I runs
- Runs compared results between RBESS and HAZZ
- Runs included effects of barricades and roads



PES/NEW Parameters						
PES Category	PES Type	Soil Type	Activity Type	NEW	Hazard Division	Weapon Type
Aboveground Structure (AGS)	Small	Concrete	Destruction	S (< 1000 lb)	1.1	AIM-7 Missile
	Med	Loose Soil	Maint/Assembly	M (> 1000 lb)	1.2.1	Bulk/Lt Case
	Large	None (Ships)	Operations	L (> 100,000 lb)	1.2.2	M107
Earth Covered Magazine (ECM)	Small Steel Arch	Rock/Hard Clay	Storage		1.2.3	MK-82
	Small RC Arch		Testing		1.3	MK-83
	Med Steel Arch		Transportation		1.4	MK-84
	Med RC Arch				1.5	Unknown
	Large Steel Arch				1.6	MK1 (1.2.1)
Hardened AC Structure (HAS)	HAC					
Hollow Clay Tile	Hollow Clay Tile					
ISO Container	ISO Container					
Open	Open					
Operating Building (Concrete)	Small					
	Medium					
Steel PEMB	Steel PEMB					
Ship	Small					
	Medium					
	Large					

KEY

Considered in Phase 1

Recommended to be included

Not likely to be included

ES Parameters					
ES Category	ES Building Type	ES Roof Type	Exposure Type	Glass	% Glass
Mod Build/Trailer	Mod Build/Trailer	14" Reinforced Concrete	None	Annealed	Low (0-10%)
Open	Open	4" Reinforced Concrete	IBD	Tempered	Med (11-25%)
Vehicle	Vehicle	5/8" Gypsum Board	PTRD	Dual Pane	High (25-40%)
Reinforced Concrete	Small (Office/Comm)	3/8" Plywood + 2x10 joists	ILD		
	Medium (Office/Comm)	Light Steel Panel (22 gauge)	IMD		
	Large Tilt Up (Comm)	Lightweight Con and Steel Deck	On Base Rd		
Reinforced Masonry	Small (Office/Comm)	Medium Steel Panel (18 gauge)	Asset Presrv		
	Medium (Office/Comm)	Steel (Automobile)			
Steel PEMB	Small (Office/Storage)	Unknown			
	Medium (Office/Comm)	Wood Panelized (1/2" Plywd)			
Stud Wall (Wood Frame)	Small Wood Frame (Residence)				
	Med Wood Frame (Residence)				
	Medium Steel Stud				
Unreinforced Masonry	Small (Office)				
	Medium (Office)				
	Large (Office)				

KEY

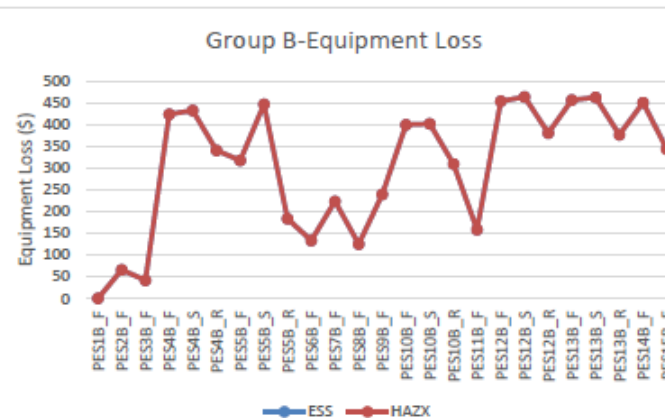
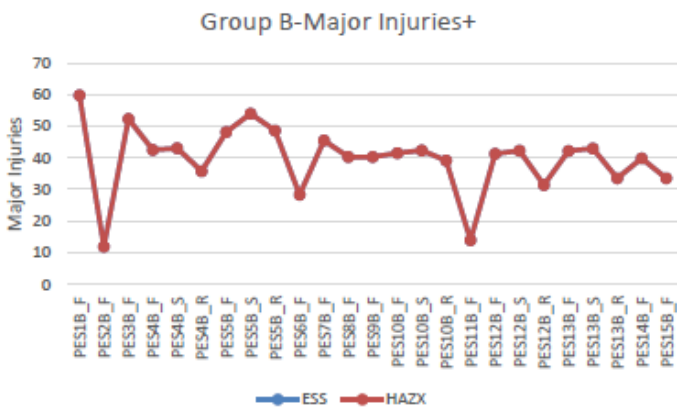
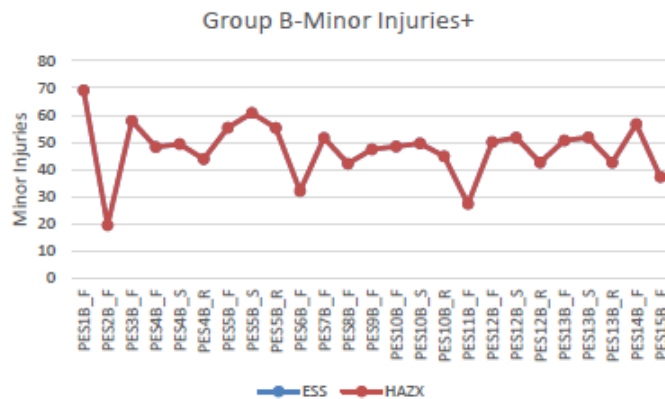
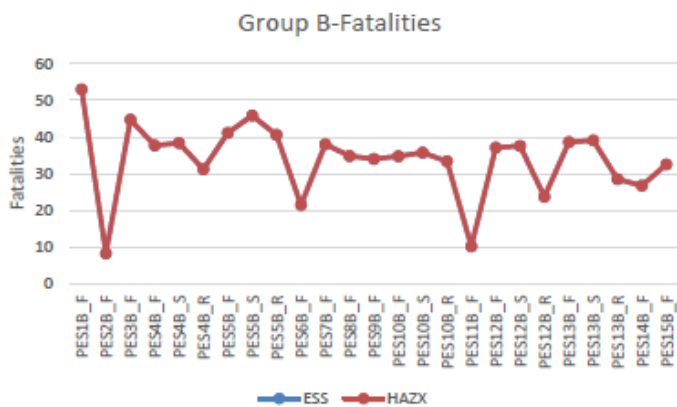
Considered in Phase 1

Recommended to be included

Not likely to be included

Phase II Verification Results

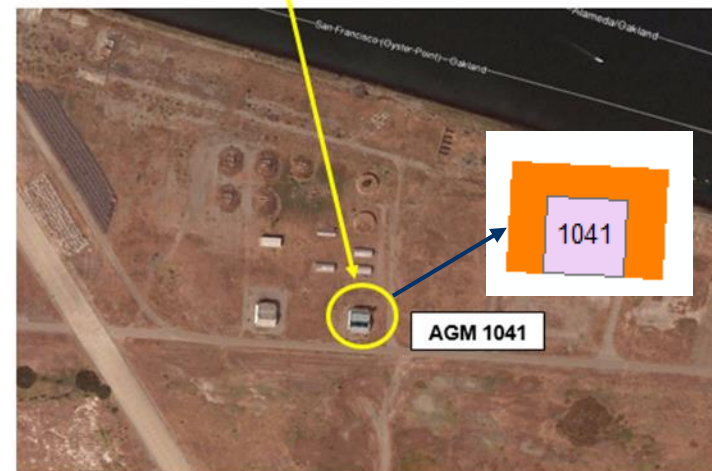
- Complete agreement between RBESS and HAZX
- RBESS calculated a higher expected value loss than HAZX by a factor of 10 for all roads, but issue was corrected
- RBESS functioned as expected



RBESS Demonstration



- Demonstration of Tier 1 and Tier 2a follows
- Alameda Naval Air Station used for example
- Barricade was included



RBESS Tier 1 AGM 1041 Project



The screenshot displays the RBESS software interface. The main window shows a map with several labeled areas: **ES's**, **ECMs**, **ES's**, **Tanks**, **Parking Lot**, **Dock**, **Airfield**, **AGM 1041**, and **EOL**. A context menu is open over the 'ES's' label, listing various analysis options. The 'Risk-based Analysis' option is selected, and a sub-menu is visible with 'Tier 1: Run New Analysis' highlighted. A yellow box labeled 'Click' points to this option. The map also shows various numbered points and structures, including 'Weapons CRd' and 'Airfield Perimeter'.

ES's

- Spatial Analysis
- Analyze Installation
- Analyze Facilities Selected from List
- Analyze Facilities Selected from Map
- Edit and Analyze Single Facility
- Analyze and Site for DQ
- Delete Analysis
- Reset Analysis
- Risk-based Analysis
 - Tier 1: Run New Analysis
 - Tier 1: Review Analysis Results
 - Tier 2A: Run New Analysis
 - Tier 2A: Review Analysis Results
 - MRAS Analysis
- Arc Analysis Results
- Analysis Errors
- Analysis Reports
- Violations
- Mitigation
- DQ Results
- Advanced Analysis
- Local Eval Zones
- Air Force Commander's Risk Assessment Report
- Weapons Safety Report

Click

Tanks

Parking Lot

Dock

ECMs

ES's

Airfield

AGM 1041

EOL

RBESS Tier 1 Demonstration



PES Selection Screen

Tier 1 Analysis: PES Filter

From ESS DB

Facility Filter: Columns Batch

Facility Number	Name	Type Code	PES_ID	Number of Scenarios	RPU_ID	Criteria Code
1010	Ammo Struc Inst	AGM	37			navy
1013	Ammo Prod Struc	EOL	439			navy
1026	Ammo Struc Inst	AGM	45			navy
1036	ES Related	AGM	51			navy
1041	Ammo Struc Inst	AGM	56	1		navy
1042	Ammo Struc Inst	AGM	57			navy
1045	Igloo Str Inst	ECM	60			navy
1046	Igloo Str Inst	ECM	61			navy
1047	Igloo Str Inst	ECM	62			navy
1048	Igloo Str Inst	ECM	63			navy
1049	Igloo Str Inst	ECM	64	1		navy
1051	Ammo Struc Inst	EOL	66			navy
1061	Igloo Str Inst	ECM	72			navy
1062	Igloo Str Inst	ECM	73			navy
1063	Igloo Str Inst	ECM	76			navy
1064	Igloo Str Inst	ECM	77			navy
1065	Igloo Str Inst	AGM	78			navy
1066	Igloo Str Inst	ECM	435			navy
1067	Igloo Str Inst	ECM	436			navy
1068	Ready Service ...	RSL	438			navy
1069	Ready Service ...	RSL	440			navy
1080	Special Weapo...	EOL	443			navy
25001	ECM Small	ECM	815	1		navy

40 rows found.

Click

OK Cancel

Scenario Selector Screen

Scenario Selector

Facility Filter: Columns Batch

Scn_ID	Scenario_Name	Facility_Number	Facility_Name	Date_Created	Notes
20	Risk Analysis for PES 1041	1041	Ammo Struc Inst	12/26/2017 6:06 PM	

New Scenario Delete Scenario

Select Cancel

1 rows found.

Click

RBESS Tier 1 Scenario Setup Screen (Scenario Tab)



Tier1: Risk-Based Analysis Scenario Setup

Scenarios Close

Scenario PES Non-Transient ES

Scenario Details

Scenario ID: 20 **From ESS DB**

Selected PES: 1041 | Ammo Struc Inst | AGM

Analysis Name: Risk Analysis for PES 1041

Date Created: 12/26/2017 6:06:13 PM

Notes:

Add text to define scenario

Instructions:

1. Edit Analysis Name (optional).
2. Add notes in the Notes Box (optional).
3. Click 'Next' button to continue

Instruction Panel

< Back Next >

Save Information > Run QD > Run Scenario

RBESS Tier 1 Scenario Setup Screen (PES Tab - IBD Distance & Hazard Zone Distances Sub-Tabs)



Tier1: Risk-Based Analysis Scenario Setup

Scenario: PES Non-Transient ES

From ESS DB if available

PES Detail
 PES Type: Other # People: 9
 PES ESS Name: 1041 | Ammo Struc Inst | AGM Replacement Cost: 159000
 PES ESS Description: HIGH EXPLOSIVE MAGAZINE

Explosive Detail

IBD Distance Hazard Zone Distance

H/C/D	IBD (ft)	ESS Database NEW	Scenario NEW
1.1	1250	6000	6000
1.2.1	971	4800	4800
1.2.2	316	3500	3500
1.2.3	168	16000	16000
1.3	171	17000	17000
1.4	100	500000	500000

Baseline H/C/D: 1.1 Changes to Baseline H/C/D require QD to be re-run.
 Auto Select

User can edit

From ESS DB

Auto Select determines which HD has largest IBD

Instructions:

1. Fill out the information for PES Detail: # People and Replacement Cost are required.
2. Select one of the options to determine PES volume and enter the Height.
3. In Explosive Detail, update NEW where necessary (only cells in yellow can be updated).
4. Click on the 'Save Information' button.
5. Then, click on the 'Run QD' button, this will calculate the Hazard Zone Distances and load ES sites in the Non-Transient ES tab.

Instruction Panel

After Run QD:

1. Click on Hazard Zone Distances to review distances.
2. Click on 'Next' to review ES in Non-Transient ES tab.

Click on "Save Info" then on "Run QD"

< Back Next > Save Information > Run QD > Run Scenario

Tier1: Risk-Based Analysis Scenario Setup

Scenario: PES Non-Transient ES

PES Detail
 PES Type: Other # People: 9
 PES ESS Name: 1041 | Ammo Struc Inst | AGM Replacement Cost: 159000
 PES ESS Description: HIGH EXPLOSIVE MAGAZINE

Explosive Detail

IBD Distance Hazard Zone Distance

	1 (K6)	2 (K9)	3 (K11)	4 (K18)	5 (K24/PTRD)	6 (K40/IBD)
Front	109	164	200	327	750	1250
Left	109	164	200	327	750	1250
Right	109	164	200	327	750	1250
Rear	109	164	200	327	750	1250

Baseline H/C/D: 1.1 Changes to Baseline H/C/D require QD to be re-run.
 Auto Select

Instructions:

1. Fill out the information for PES Detail: # People and Replacement Cost are required.
2. Select one of the options to determine PES volume and enter the Height.
3. In Explosive Detail, update NEW where necessary (only cells in yellow can be updated).
4. Click on the 'Save Information' button.
5. Then, click on the 'Run QD' button, this will calculate the Hazard Zone Distances and load ES sites in the Non-Transient ES tab.

Instruction Panel

After Run QD:

1. Click on Hazard Zone Distances to review distances.
2. Click on 'Next' to review ES in Non-Transient ES tab.

Once "Run QD" is clicked, the hazard zones can be displayed on the Hazard Zone Distance tab. Also, the Non-Transient ES Tab will be populated

< Back Next > Save Information > Run QD > Run Scenario

RBESS Tier 1 Scenario Setup Screen (Non-Transient ES Tab)



User can edit the radius within which ES's will be evaluated: a factor on IBD

User can select which ES's within evaluation zone will be included in analysis

Tier1: Risk-Based Analysis Scenario Setup

Include in Scenario: RBESS Eval Zone: 1.2 Additional Options: [?] Scenarios Close

Scenario PES Non-Transient ES

Select ES for RBESS Analysis **From ESS DB** (listed below from current ESS Spatial Analysis Zone):

All facilities within evaluation zone
All facilities within evaluation zone
All facilities in violation (mitigated or not)
Only facilities in violation and not mitigated

	Facility #	Desc	Max # of People	Height (ft)	Total Cost	On Base	Exposure Type
01	1036	HIGH EXPLOSIVE MAGAZINE	10	15	400000	<input checked="" type="checkbox"/>	IMD(U)
02	1037	GENERAL STORAGE SHED (Demolished)	10	15	400000	<input checked="" type="checkbox"/>	ILD(U)
03	1038	GENERAL STORAGE SHED	10	15	400000	<input checked="" type="checkbox"/>	IBD
04	1039	GENERAL STORAGE SHED	10	15	400000	<input checked="" type="checkbox"/>	IBD
05	1040	GENERAL STORAGE SHED	10	15	400000	<input checked="" type="checkbox"/>	IBD
06	1042	HIGH EXPLOSIVE MAGAZINE	10	15	159000	<input checked="" type="checkbox"/>	IMD(U)
07	1043	DEMOLISHED WATER TANK	10	15	400000	<input checked="" type="checkbox"/>	IBD
08	1044	DEMOLISHED WATER TANK	10	15	400000	<input checked="" type="checkbox"/>	IBD
09	1045	HIGH EXPLOSIVE MAGAZINE	10	15	123600	<input checked="" type="checkbox"/>	IMD(B)
10	1046	HIGH EXPLOSIVE MAGAZINE	10	15	123600	<input checked="" type="checkbox"/>	IMD(B)
11	1047	HIGH EXPLOSIVE MAGAZINE	10	15	123600	<input checked="" type="checkbox"/>	IMD(B)
12	1048	12x17 Box ECM	10	15	123600	<input checked="" type="checkbox"/>	IMD(B)
13	1049	12x17 Box ECM	10	15	123600	<input checked="" type="checkbox"/>	IMD(B)
14	1050	INERT STOREHOUSE	10	15	400000	<input checked="" type="checkbox"/>	IBD
15	1052	ADMINISTRATIVE OFFICE (Demolished)	10	15	400000	<input checked="" type="checkbox"/>	IBD
16	1053	Guard Shack	10	15	400000	<input checked="" type="checkbox"/>	IBD
17	1054	GATE / SENTRY HOUSE	10	15	400000	<input checked="" type="checkbox"/>	IBD
18	1080	SPECIAL WEAPONS SHOP	10	15	400000	<input checked="" type="checkbox"/>	IBD

From ESS DB

Instruction Panel

Instructions:

1. Review Non-Transient ES to be included in scenario.
2. Update information where necessary (only cells in yellow can be edited)
3. Click on 'Save Information'
4. Click on 'Run Scenario'

Optional:

Use the 'Next' and 'Back' buttons to review information on the Non-Transient ES and PES tabs.

Set ratio for RBESS Eval Zone (default is 1.2).

In Additional Option, select option for ES (Exposed Sites).

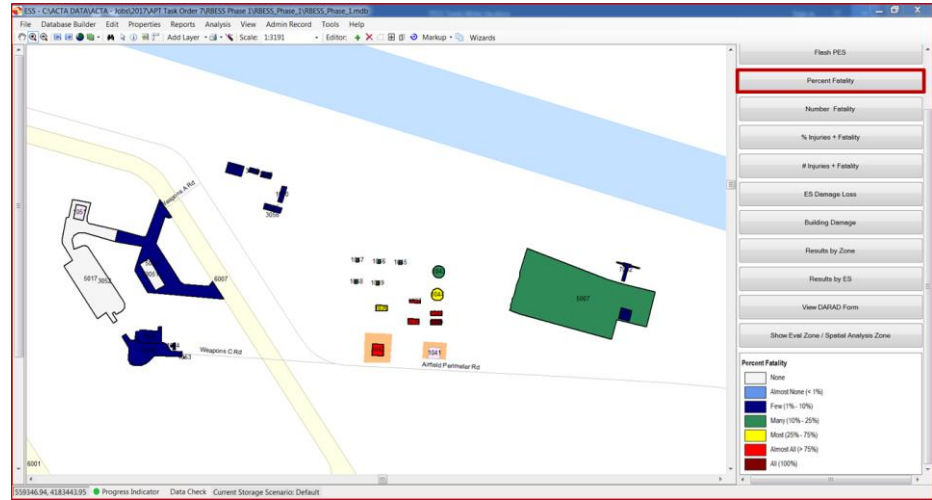
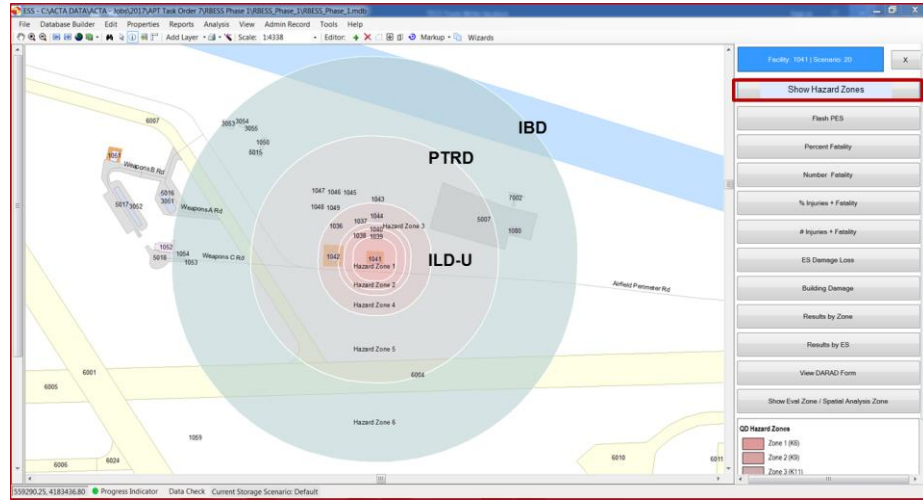
If either of the options listed above are updated, click the 'Save Information' button, then the 'Run Scenario' button.

When done, click on "Run Scenario"

Back Next Save Information Run QD Run Scenario

If data are available from ESS DB, the ES attributes will be filled in; otherwise, default values are displayed. User can also edit the values

RBESS Tier 1 Analysis Results



ES Name	Distance from PES	Zone	Personnel at ES	Building Cost	Inv #Fats	Fatalities	Building Damage Loss
1037	293.7	4 (K13)	10	\$400,000.00	3,306	5,482	\$315,404.43
1038	268.2	4 (K13)	10	\$400,000.00	9,861	7,702	\$590,062.44
1039	113.7	2 (K9)	10	\$400,000.00	10,000	9,913	\$400,000.00
1040	101.7	1 (K6)	10	\$400,000.00	10,000	10,000	\$400,000.00
1041	147.3	2 (K9)	10	\$400,000.00	10,000	9,353	\$400,000.00
1042	287.4	4 (K13)	10	\$150,000.00	9,767	7,651	\$124,273.28
1043	321.7	4 (K13)	10	\$400,000.00	6,168	2,252	\$208,454.80
1044	216.1	4 (K13)	10	\$400,000.00	8,483	7,240	\$374,862.47
1045	401.1	5 (K24PTRD)	10	\$123,600.00	5,053	1,854	\$55,295.87
1046	448.8	5 (K24PTRD)	10	\$123,600.00	4,482	1,494	\$51,379.58
1047	508.5	5 (K24PTRD)	10	\$123,600.00	3,680	1,227	\$45,889.87
1048	440.1	5 (K24PTRD)	10	\$123,600.00	4,555	1,518	\$51,880.87
1049	367.0	5 (K24PTRD)	10	\$123,600.00	5,467	1,829	\$58,274.87
1050	959.2	6 (K40IBD)	10	\$400,000.00	4,480	0,165	\$55,948.08
1052	1,235.5	6 (K40IBD)	10	\$400,000.00	0,309	0,103	\$21,722.30
1053	1,121.3	6 (K40IBD)	10	\$400,000.00	0,377	0,126	\$35,430.05
1054	1,163.3	6 (K40IBD)	10	\$400,000.00	0,349	0,116	\$33,802.96
1080	833.4	6 (K40IBD)	10	\$400,000.00	0,050	0,183	\$69,936.27
3083	1,171.5	6 (K40IBD)	10	\$400,000.00	0,347	0,116	\$29,355.52
3054	1,121.1	6 (K40IBD)	10	\$400,000.00	0,377	0,126	\$35,444.73
3055	1,068.0	6 (K40IBD)	10	\$400,000.00	0,410	0,137	\$42,004.42
3056	823.3	6 (K40IBD)	10	\$400,000.00	0,496	0,165	\$59,157.33
5007	361.4	5 (K24PTRD)	10	\$400,000.00	5,559	1,853	\$180,202.38
5015	920.3	6 (K40IBD)	10	\$400,000.00	0,496	0,165	\$59,157.33
5016	972.1	6 (K40IBD)	10	\$400,000.00	0,466	0,155	\$53,279.91
5018	1,136.2	6 (K40IBD)	10	\$400,000.00	0,360	0,123	\$33,586.92
7002	891.3	6 (K40IBD)	10	\$400,000.00	0,515	0,172	\$62,863.02
Total			270	\$9,177,000.00	107,893	70,975	\$3,683,629.48

AMMUNITION AND EXPLOSIVES WORKSHEET

Deviation #: 1041 Effective Date: 29b. PES Function: 30. PES # People: 9

31. PES Equip/Fac (Value) \$: \$159,000.00 32. Required Blast Distance: 727 33. Required Fragment Distance: 1250

34a. Hazard Division: 1.2.1; NEW: 6,000 34b. Hazard Division: 1.2.1; NEW: 4,800 34c. Hazard Division: 1.2.2; NEW: 3,500

34d. Hazard Division: 1.2.3; NEW: 16,000 34e. Hazard Division: 1.3; NEW: 8,000 34f. Hazard Division: 1.4; NEW/MEQ: 17,000

35a. QD area exceed the installation boundary? YES NO Are other Services affected? YES NO Was coordination as necessary made? YES NO 35c. If YES, provide site plan 35d. If YES, provide site plan 35e. If YES, provide site plan **Only ES's w/ QD Violations are shown**

35b. Is this deviation associated with a hybrid or risk-base safety submission? 35c. If YES, provide site plan

INFORMATION ON THE EXPOSED SITES (ES)

FACILITY	DISTANCE THAT REQUIRED		# PEOPLE	EQUIP/FAC (VALUE) \$	EXPOSURE TYPE	ONOFF INSTALLATION	At Required Distance		At Requested Distances		Violations		
	REQ	ACTUAL					FATALITIES	INJURIES	EQUIP/FAC (LOSS) \$	EQUIP/FAC (LOSS) \$			
1037	307	363	10	400,000.00	IBD	ON	0	4	189,968.11	11	31,060.44	YES [2]	
1038	129	113.7	10	400,000.00	IBD	ON	0	0	0.00	9.91	6.81	400,000.00	YES [2]
1039	129	101.7	10	400,000.00	IBD	ON	0	0	0.00	10	6	400,000.00	YES [2]
1040	129	147.3	10	400,000.00	IBD	ON	0	0	0.00	8.13	6.7	400,000.00	YES [2]
1043	129	331.7	10	400,000.00	IBD	ON	0	0	0.00	1.25	3.63	388,448.00	YES [2]
1044	129	316.1	10	400,000.00	IBD	ON	0	0	0.00	7.24	3.15	374,862.47	YES [2]
1050	129	993.3	10	400,000.00	IBD	ON	0	0	0.00	0.38	0.12	31,944.00	YES [2]
1052	129	1,261.5	10	400,000.00	IBD	ON	0	0	0.00	0.13	0.10	31,020.28	YES [2]
1053	129	1,103.3	10	400,000.00	IBD	ON	0	0	0.00	0.13	0.10	31,440.00	YES [2]
1054	129	1,148.8	10	400,000.00	IBD	ON	0	0	0.00	0.12	0.10	33,802.96	YES [2]
1080	129	833.4	10	400,000.00	IBD	ON	0	0	0.00	0.18	0.17	48,914.00	YES [2]
7002	129	891.3	10	400,000.00	IBD	ON	0	0	0.00	0.17	0.14	42,863.02	YES [2]

EXPECTED POTENTIAL CONSEQUENCES

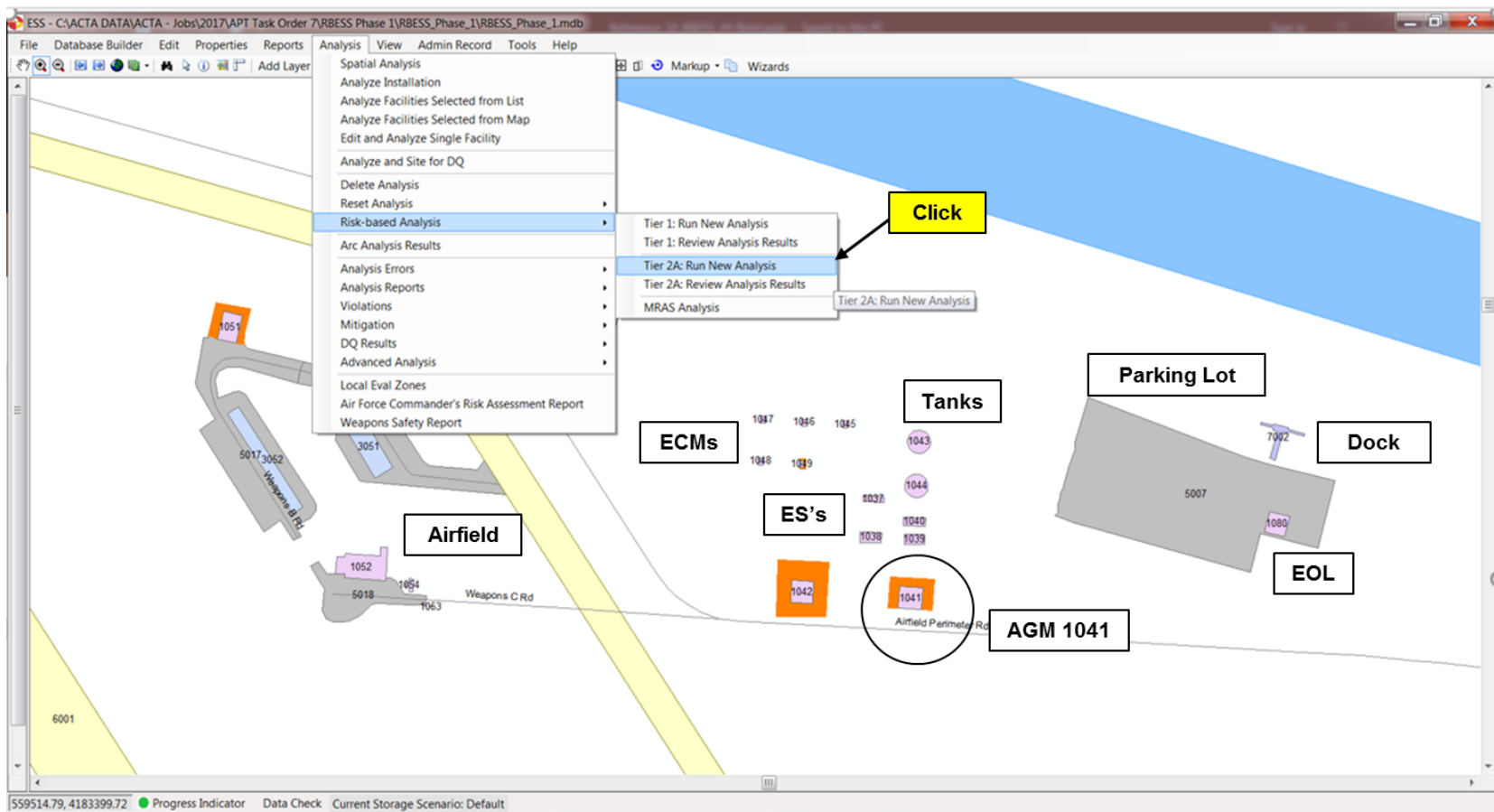
37. Potential Explosion Site:	a. Fatalities:	9	b. Injuries:	10	c. Equip/Fac:	\$ 159,000.00
38. Potential Losses for Exposed Sites (ES) Meeting Criteria:	a. Fatalities:	2	b. Injuries:	4	c. Equip/Fac:	\$ 199,968.11
39. Potential Loss Being Accepted for Deviating from Approved Standards:	a. Fatalities:	47.27	b. Injuries:	10.77	c. Equip/Fac:	\$ 2,448,948.30
40. Total Potential Loss (#):	a. Fatalities:	58.27	b. Injuries:	14.77	c. Equip/Fac:	\$ 2,807,916.43

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RBESS Tier 2a AGM 1041 Project



- The same project developed for Tier 1 can be used to do a Tier 2a analysis
- Simply select: run a Tier 2a analysis
- Selecting a PES & scenario are identical to Tier 1 (so not shown)



RBESS Tier 2a Scenario Setup Screen (PES Tab & Explosives Tab)



- For Tier 2a, the PES activity type determines the P(event) that is used to develop a Risk Matrix [P(e) vs. Severity]

Tier 2A: Risk-Based Analysis Scenario Setup

Scenario: **PES** | Explosives | Non-Transient ES | Transient ES | Barricades

PES Details

PES Description: HIGH EXPLOSIVE MAGAZINE
 PES Category: Aboveground brick structure (AGBS)
 PES Type: Small AGBS
 Soil Type: Concrete
 Headwell Type: Undefined Headwell
 # ISO Containers: Not Applicable

Reduce Fragment Size due to Load Density:

Instructions:

- Review and update the information.
- Click on the 'Save Information' button.
- Then, click on the 'Next' button.

From ESS DB if available

Instruction Panel

Floor Area Options

PES Volume (changes require QD to be run)

Use Calculated Floor Area from ESS Map Use Internal Length and Width from Facility Enter Length and Width

Height (ft): 25 | Area (sqft) 270.5

Event Probability

Activity Category: Maintenance Inspection, Assembly, Disassembl

Activities: Functional tests not requiring voltage across firing circuits

Mishap Likelihood: **Seldom**

Description: Infrequent occurrences

P(e) determined from Activity Type

Click on "Save Info"

< Back | Next > | Save Information | Run QD | Run Scenario

Tier 2A: Risk-Based Analysis Scenario Setup

Scenario: PES | **Explosives** | Non-Transient ES | Transient ES | Barricades

Explosive Settings:

HC/D	IBD (ft)	ESS Database	Scenario NEW (lb)	Weapons Type	Weapons Description
1.1	1250	6000	6000	Unknown	Robust or thick-skinned bomb (MK-62)
1.2.1	971	4800	4800	M1 (105 mm) projectile	Robust or thick-skinned 105 mm projectile
1.2.2	316	3500	3500	MK2 (40 mm) projectile	Robust or thick-skinned 40 mm projectile
1.2.3	168	16000	16000	MK82 bomb (1 round d...	Robust or thick-skinned bomb
1.3	171	17000	17000	Bulk propellant	Bulk propellant
1.4	100	100	100	W/A	Not applicable

Baseline HC/D: 1.1 | Changes to Baseline HC/D require QD to be re-run.

Auto Select

TP14 Weapon Type

ESS DB

User can edit

Auto Select determines which HD has largest IBD

Instruction Panel

Instructions:

- Review Explosive setting and update where necessary (only cells in yellow can be edited)
- Select a different Baseline HC/D by unchecking 'Auto Select' and select desired HC/D from dropdown (optional)
- Click the 'Save Information'
- Click the 'Run QD'
- After QD has finished, click on 'Next' to continue

Click on "Save Info" then on "Run QD"

< Back | Next > | Save Information | Run QD | Run Scenario

RBESS Tier 2a Scenario Setup Screen (Non-Transient & Transient ES Tab)



User can enter TP14 ES attributes or accept defaults

Tier 2A: Risk-Based Analysis Scenario Setup

Include in Scenario: RBESS Eval Zone: 1.2 Additional Options: All facilities within evaluation zone Update ?

Scenario PES Explosives Non-Transient ES Transient ES Barricades

Select ES for RBESS Analysis (30 of 58 total ES's are listed below from current ESS Spatial Analysis Zone)

Exp Grp	Facility #	Desc	Height (ft)	Class %	Total Cost	Window Cost%	On Base	Exposure Type	Structure Category	Structure Type	Roof Type	Window Type
01	1036	HIGH EXPLOSIVE M...	15	10	400	2.5	✓	IMD(U)	Steel PEMB	Mediu...	Light st...	Anne...
02	1037	GENERAL STORAGE	15	10	400	2.5	✓	ILD(U)	Steel PEMB	Mediu...	Light st...	Anne...
03	1038	GENERAL STORAGE	15	10	400	2.5	✓	IBD	Steel PEMB	Mediu...	Light st...	Anne...
04	1039	GENERAL STORAGE	15	10	400	2.5	✓	IBD	Steel PEMB	Mediu...	Light st...	Anne...
05	1040	GENERAL STORAGE	15	10	400	2.5	✓	IBD	Steel PEMB	Mediu...	Light st...	Anne...
06	1042	HIGH EXPLOSIVE M...	15	10	159	2.5	✓	IMD(U)	Steel PEMB	Mediu...	Light st...	Anne...
07	1043	DEMOLISHED WATE...	15	10	400	2.5	✓	IBD	Steel PEMB	Mediu...	Light st...	Anne...
08	1044	DEMOLISHED WATE...	15	10	400	2.5	✓	IBD	Steel PEMB	Mediu...	Light st...	Anne...
09	1045	HIGH EXPLOSIVE M...	15	10	123	2.5	✓	IMD(B)	Steel PEMB	Mediu...	Light st...	Anne...
10	1046	HIGH EXPLOSIVE M...	15	10	123	2.5	✓	IMD(B)	Steel PEMB	Mediu...	Light st...	Anne...
11	1047	HIGH EXPLOSIVE M...	15	10	123	2.5	✓	IMD(B)	Steel PEMB	Mediu...	Light st...	Anne...
12	1048	12x17 Box ECM	15	10	123	2.5	✓	IMD(B)	Steel PEMB	Mediu...	Light st...	Anne...
13	1049	12x17 Box ECM	15	10	123	2.5	✓	IMD(B)	Steel PEMB	Mediu...	Light st...	Anne...
14	1050	INERT STOREHOUSE	15	10	100	2.5	✓	IBD	Steel PEMB	Mediu...	Light st...	Anne...
15	1052	ADMINISTRATIVE O...	15	10	100	2.5	✓	IBD	Steel PEMB	Mediu...	Light st...	Anne...
16	1053	Guard Shack	15	10	400	2.5	✓	IBD	Steel PEMB	Mediu...	Light st...	Anne...
17	1054	GATE / SENTRY HO...	15	10	100	2.5	✓	IBD	Steel PEMB	Mediu...	Light st...	Anne...
18	1080	SPECIAL WEAPONS	15	10	400	2.5	✓	IBD	Steel PEMB	Mediu...	Light st...	Anne...
19	3051	OPEN AMMUNITION	15	10	400	2.5	✓	None	Steel PEMB	Mediu...	Light st...	Anne...

Instructions:

1. Review Non-Transient ES to be included in scenario.
- optional - Set ratio for RBESS Eval Zone (default is set to 1.2)
- optional - Additional Options, filter ES option
- Must click on 'Update' if changes made to RBESS Eval Zone or Additional Options
2. Update ES information where necessary (only cells in yellow can be edited)
3. Click on 'Save Information'
4. Click on 'Next' to continue

Instruction Panel

Back Next Save Information Run QD Run Scenario

Roads, runways, shipping lanes can be defined at the Tier 2a level

Tier 2A: Risk-Based Analysis Scenario Setup

Include in Scenario: RBESS Eval Zone: 1.2 Additional Options: All facilities within evaluation zone Update ?

Scenario PES Explosives Non-Transient ES Transient ES Barricades

Select ES for RBESS Analysis (7 of 33 total ES's are listed below from current ESS Spatial Analysis Zone):

Exp Grp	Facility #	Desc	On Base	Vehicle Interval (ft)	Vehicle Count	Vehic Leng (ft)	Vehic Width (ft)	Vehic Height (ft)	Vehicle Cost	Vehicle Window Cost%	Glass %	On Base	Exposure Type	Window Type
1	6004	RUNWAY / ...	✓	500	7	12	5	4.5	20000	1.5	25	✓	PTRD	Tem...
2	6007	TAXIWAY / ...	✓	500	4	12	5	4.5	20000	1.5	25	✓	PTRD	Tem...
3	Chrp_p_JSC	Channel	✓	500	30	12	5	4.5	20000	1.5	25	✓	PTRD	Tem...
4	Rd_NTR_57	Airfield Park...	✓	500	26	12	5	4.5	20000	1.5	25	✓	PTRD	Tem...
5	Rd_NTR_63	Weapons A...	✓	500	1	12	5	4.5	20000	1.5	25	✓	PTRD	Tem...
6	Rd_NTR_64	Weapons B...	✓	500	1	12	5	4.5	20000	1.5	25	✓	PTRD	Tem...
7	Rd_NTR_65	Weapons C...	✓	500	1	12	5	4.5	20000	1.5	25	✓	PTRD	Tem...

Instructions:

1. Review Transient ES to be included in scenario.
- optional - Set ratio for RBESS Eval Zone (default is set to 1.2)
- optional - Additional Options, filter ES option
- Must click on 'Update' if changes made to RBESS Eval Zone or Additional Options.
2. Update ES information where necessary (only cells in yellow can be edited)
3. Click on 'Save Information'
4. Click on 'Next' to continue

Optional:

Use the 'Next' and 'Back' buttons to review information on the Non-Transient ES, Transient ES, and Barricades tabs.

Back Next Save Information Run QD Run Scenario

RBESS Tier 2a Scenario Setup Screen (Barricade Tab)



TP14 barricades, berms, etc. that can block PES debris/fragment throw can be defined at the Tier 2a level

Tier 2A: Risk-Based Analysis Scenario Setup

Include in Scenario: RBESS Eval Zone: 1.2 Additional Options: All facilities within evaluation zone Update ?

Scenarios Close

Scenario PES Explosives Non-Transient ES Transient ES **Barricades**

	<input type="checkbox"/>	Height (ft)	Layer
1	<input checked="" type="checkbox"/>	10	Access Control Area
2	<input checked="" type="checkbox"/>	10	Access Control Area
3	<input checked="" type="checkbox"/>	25	Access Control Area
4	<input type="checkbox"/>	10	Access Control Area

4 rows found.

Click

< Back Next > Save Information > Run QD > Run Scenario

RBESS Tier 2a Results



Tier 2a has numerous displays and reports including the Risk Matrix shown below. Consequences are available for each ES and a DARAD form can be generated

The screenshot displays the RBESS software interface. A central dialog box titled "Explosive Risk Matrix" is open, showing a risk assessment table. The table has columns for Severity (I - Catastrophic, II - Critical, III - Moderate, IV - Negligible) and Risk Assessment Method (A - Frequent, B - Likely, C - Occasional, D - Seldom, E - Unlikely). The cells contain risk levels (EH, H, M, L) and counts in parentheses. A dashed box highlights the cell for IV - Negligible under D - Seldom, which contains L(4). Below the table is a legend for Description, Symbol, RAC, and Color. To the right of the table, it indicates "Matrix for: Total Risks", "Probability: Seldom", "Severity: Negligible", and "RAC: L(4)". A note at the bottom states "Note: based on injuries and \$ loss".

The right-hand sidebar contains several buttons for generating reports and views. The button "View Facility Risk Matrix" is highlighted with a red box. Other buttons include "Flash PES", "Show Pressure", "RAC (#Inj/%Dam)", "RAC (#Inj/\$Loss)", "Structural Damage", "Str Dam Loss (\$)", "Window Breakage", "Win Brk Loss (\$)", "Building (Str + Win) Loss (\$)", "% Minor Inj Greater", "Emini", "% Major Inj Greater", "Emaji", "% Fatality", "Efat", "Injury Severity (AIS)", "Report By ES", "View ES Consequences", "View ES Risk Matrix", "View Facility Risk Matrix", "View DARAD Form", "View MPL Summary Form", "View ES Risk Results Form", "View All Results", and "Show Eval Zone / Spatial Analysis Zone".

Conclusions



- **RBESS Tier 1 and Tier 2a modes have been implemented in ESS.**
- **Output for both Tier 1 and Tier 2a RBESS include color-coded maps that display information on replacement cost, fatalities, and injuries.**
- **Output also displays consequence information for individual ES's as well as summary information for all the ES's affected by the PES.**
- **Both tiers of RBESS automatically populate the Department of Army (DA) Form 7632 which is known as the Deviation Approval and Risk Acceptance Document (DARAD).**
- **RBESS has been validated through comparisons with ASAP-X and HAZX for Tier 1 and 2a and has been shown to generate the expected results.**
- **RBESS is being released in ESS v6.1.4 and will be available to ESS users in the near future.**

Questions?