INDORAMA VENTURES

Module 8 Facility & Occupied Building Siting

Last Revised – June 2024

PS Bootcamp Modules

- ✓ **Module 1: Introduction**
- ✓ **Module 2: Hazard Identification**
- ✓ **Module 3: Risk Matrix**
- ✓ **Module 4: Safeguards Concept**
- ✓ **Module 5: Explosion/Fire Protection**
- ✓ **Module 6: Management of Change**
- ✓ **Module 7: Incident Investigation**
- ✓ **Module 8: Facility Siting**

Agenda

Facility Siting Worst Case Event Examples

- West Fertilizer Ammonium Nitrate Explosion, West Texas
- BP Amoco Refinery, Texas City
- Phillips 66, Pasadena, Texas

Facility Siting Guidance

Facility Siting Analysis Methodology

Portable Blast Resistant Modules

Facility Siting Results and How to Use Them

Siting Changes and PSM Support

Objectives

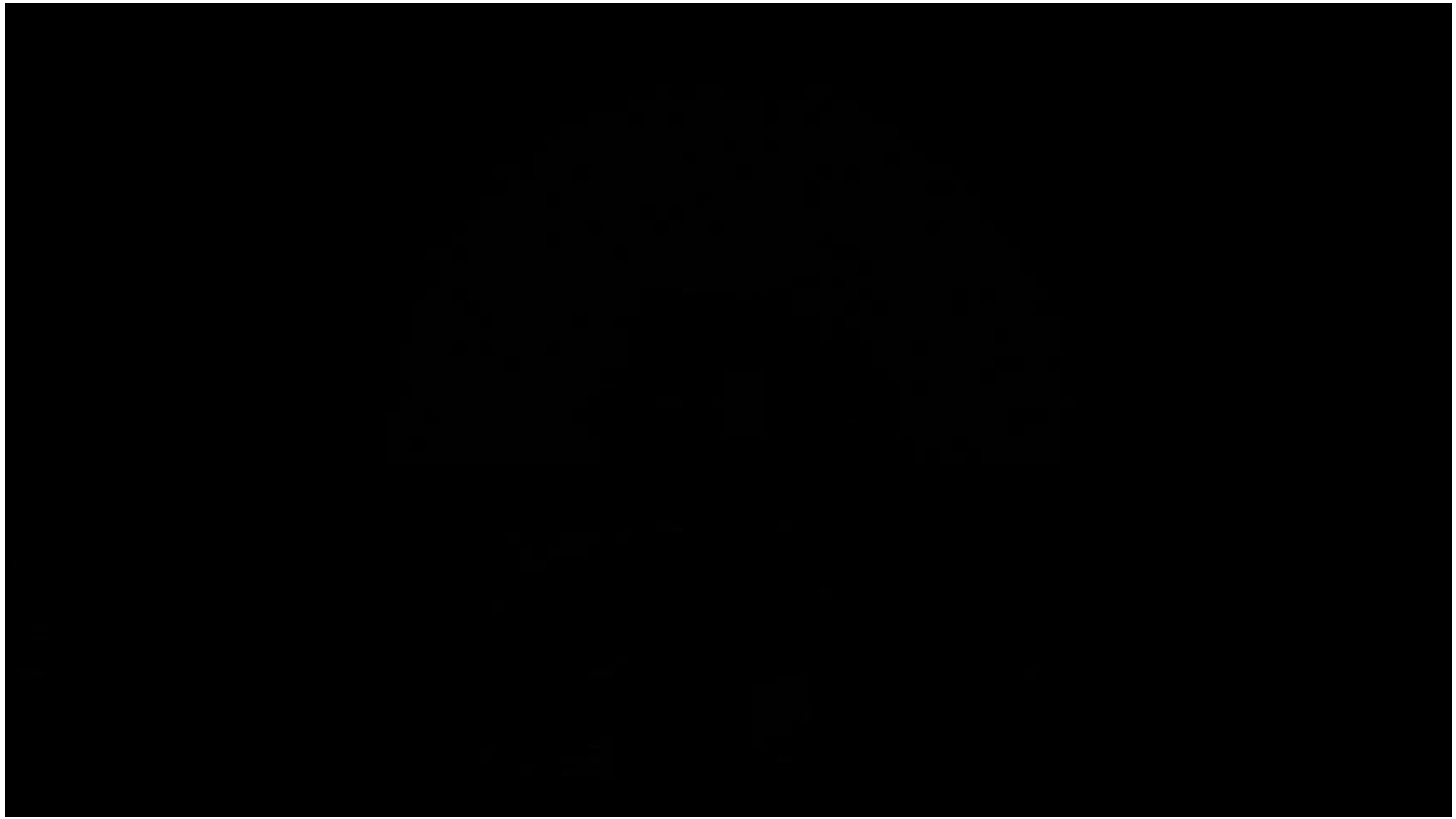
- Understand Hazards and Risks associated with the location of process plant buildings intended for occupancy and the related standards
- Familiarization with Indorama's formal methodology for the assessment of Facility Siting risks (IVL EHS-407)
- Familiarization with Blast Resistant Modules
- Understand how Facility Siting Study Results can be used in PHAs, LOPAs and MOCs
- Understand when and why PSM should be involved with changes to Occupied Buildings and location of Temporary Buildings

Facility Siting Worst Case Event Examples

West Fertilizer Ammonium Nitrate Explosion - West Texas

Date:	**April 17, 2013**
Facility:	**Fertilizer Plant**
Hazard:	**Detonation of ammonium nitrate**
Losses:	**15 Deaths, 200 injuries. Significant off-site impacts.**
Situation:	**External fire initiated detonation of solid ammonium nitrate being stored at facility.**
Event:	**Fuel quantity and blast energy still under investigation.**
Cause:	**External fire.**

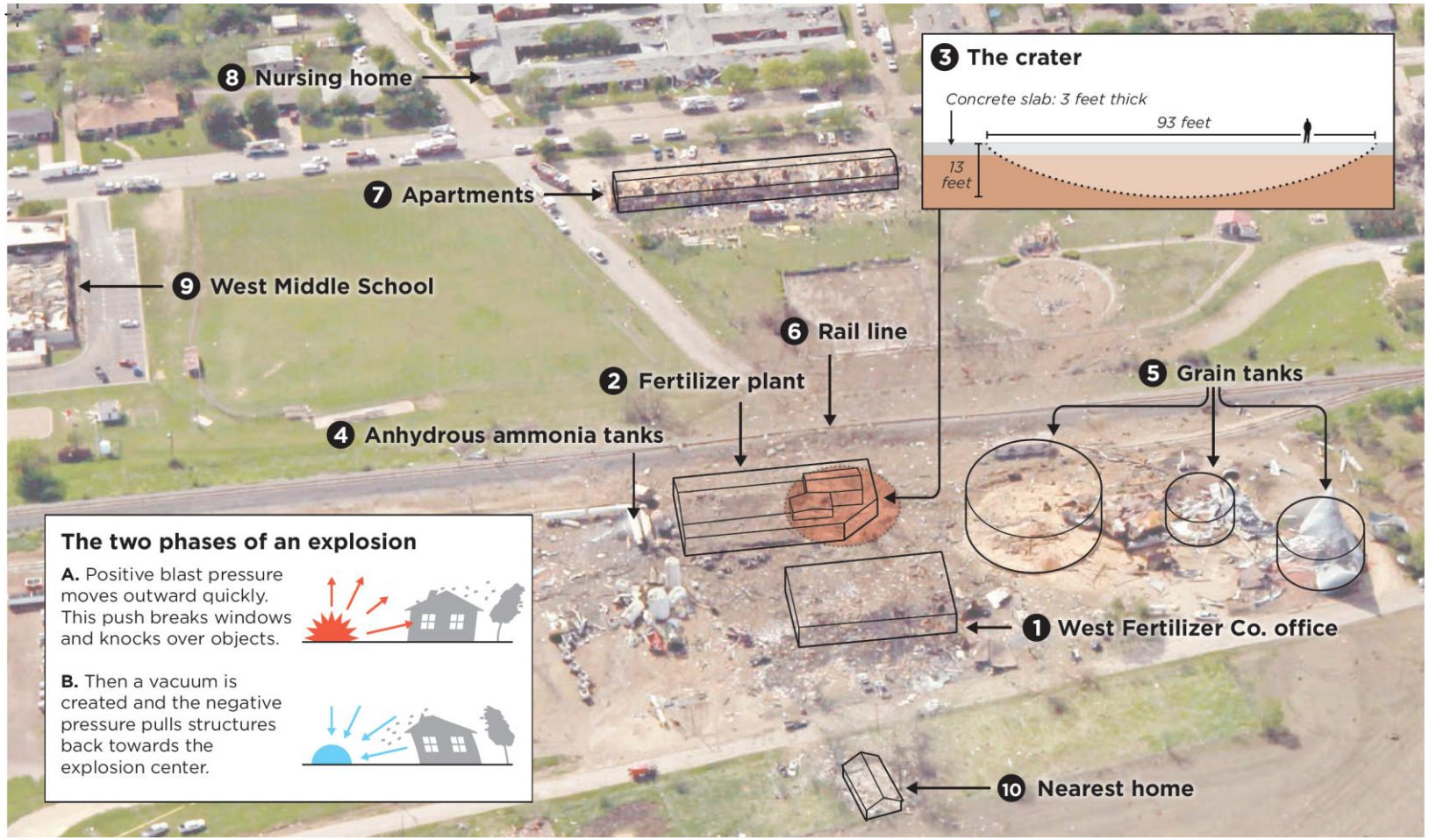
Ammonium Nitrate Explosion



West Fertilizer, After…

West Fertilizer, Before

West Fertilizer, After…



BP Amoco Refinery - Texas City

Date: March 23, 2005

Facility: Texas City refinery isomerization unit.

Hazard: Unconfined vapor cloud explosion, VCE

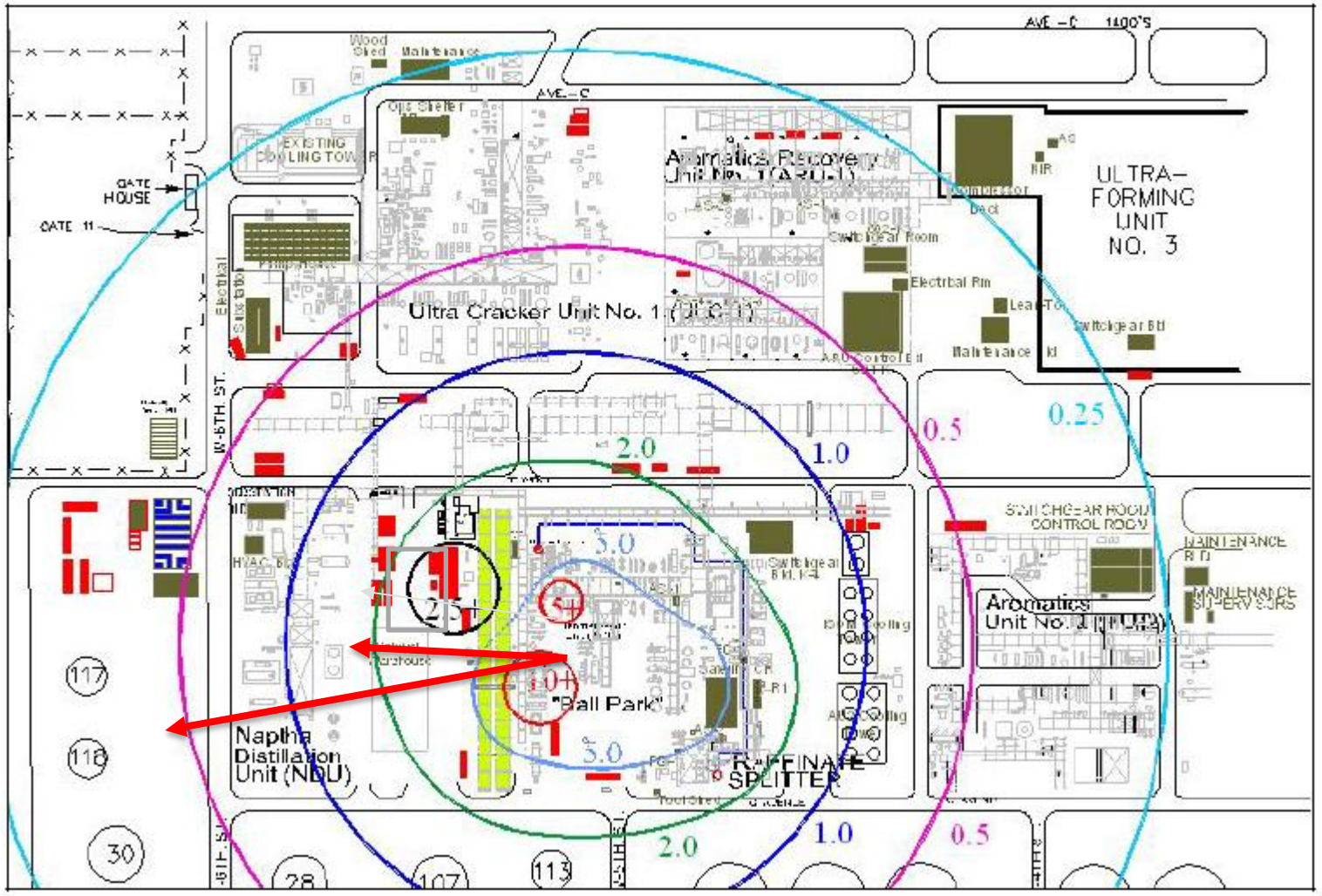
Losses: 15 Deaths, 170 injuries, damage to facility.

Situation: Equipment overpressure resulting in loss of containment of hydrocarbon vapors and liquid.

Event: 7,600 gallons (28,700 liters, 18,800kg) of hot, flammable liquid mixture of hexanes, heptanes and octanes was released 120’ above-ground in 107 seconds before the relief valves closed.

Cause: Multiple administrative system failures. Cavalier corporate attitude regarding process safety.

BP Refinery - Overpressure Map



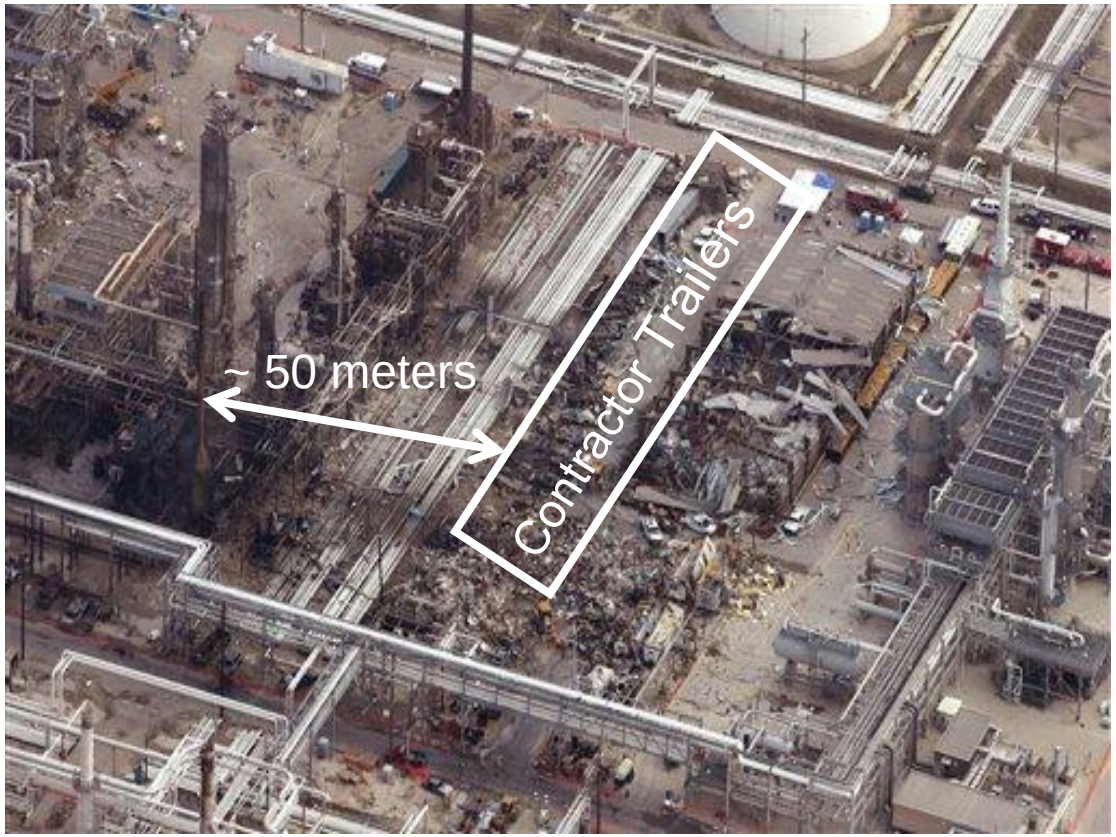
Assessment of Severity

Actual: No injuries or equipment damage

Potential : Fatalities and significant plant damage

Points of reference:

- BP Texas City, ~20k release



Picture of BP Texas City, Site of VCE

Phillips 66 - Pasadena, Texas

Date: October 23, 1989

Facility: Polyethylene Plant

Hazard: Unconfined Vapor Cloud (VCE)

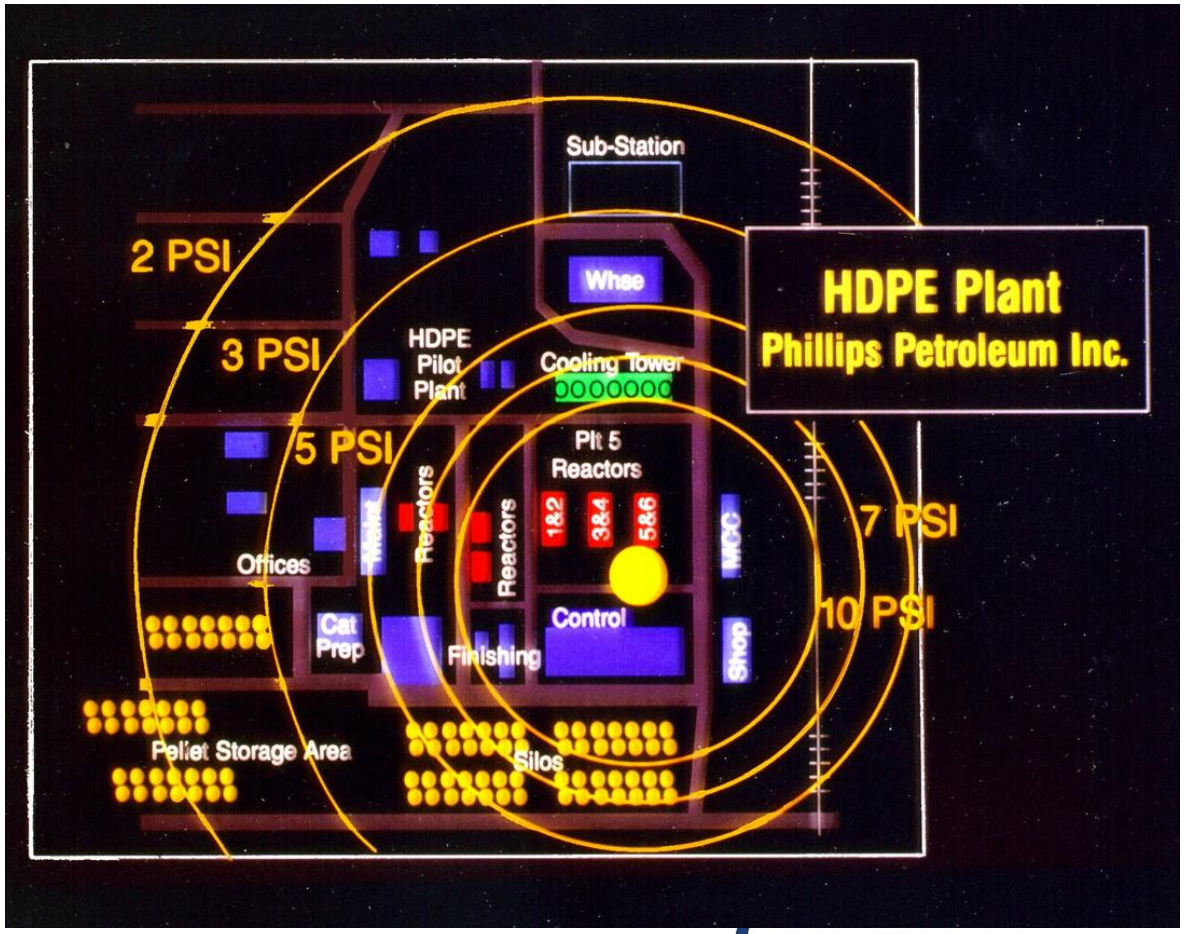
Losses: 23 Deaths
130 Injuries
over $ 1 Billion in Damage

Event: ~ 85K lbs. mixture of hydrogen, ethylene, hexene & isobutene was released through an open valve in about 2 min. (600 psig system pressure). A vapor cloud formed and was ignited as it traveled through the plant. Explosion equivalent to 2.4 tons of TNT.

Cause: Inadequate lock-out, tag-out procedure

Phillips 66, Pasadena, Texas

All 22 of those who died at the scene were within 250 ft of the point of release and 15 of them were within 150 ft



Facility Siting Guidance

What are OSHA Requirements?

OSHA PSM expects demonstration of "best practice," which is referred to as "Recognized And Generally Accepted Good Engineering Practice" (RAGAGEP).

> *". . . the violations from the top cited sub-element 1910.119 (d)(3)(ii), failure to document compliance with recognized and generally accepted good engineering practice (**RAGAGEP**) were analyzed. The predominant issues highlighted in the (d)(3)(ii) violations are **pressure relief devices** and **facility siting**. Twenty different refinery inspections resulted in citations for failure to document that relief valves comply with **RAGAGEP**."**

***Lisa A. Long, Michael L. Marshall, and James Lay, Update on OSHA's PSM National Emphasis Programs. Process Safety Progress, 2011. 30(4): p. 4**

Facility Siting References

API RP 752

- Management of Hazards Associated With Location of Process Plant Permanent Buildings
- Third Edition, December 01, 2009

API RP 753

- Management of Hazards Associated With Location of Process Plant Portable Buildings
- First Edition, June 01, 2007

API RP 756

- Management of Hazards Associated with Location of Process Plant Tents
- First Edition, September 01, 2014

API RPs 752, 753, and 756

Guiding Principles:

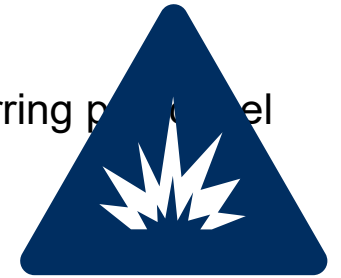
- Locate non-essential personnel **away** from process areas
- Minimize use of **occupied** buildings and tents near process areas
- **Manage** occupancy of buildings and tents near process areas
- Occupants of buildings and tents that are **intended for occupancy shall** be protected against potential hazards through design, construction, installation, modification and maintenance.
- Manage **use** of buildings **intended for occupancy** as an integral part of the design, construction, maintenance, and operation of a facility

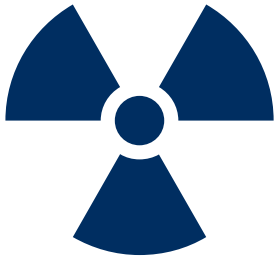
API RPs 752, 753, and 756

Occupied permanent or portable buildings and tents

- Only buildings and tents **intended for occupancy** shall be included
- A building or tent is 'intended for occupancy' if personnel are assigned to it or it is used for a recurring personnel function.

Reducing risk from potential explosion, fire, and toxic material release hazards





Facility Siting Analysis Methodology

Assessment Process

Facility Siting:

Is an analysis of the spatial relationship between where the **hazards are located** and where the **people congregate**.

A facility siting analysis is intended to **identify, assess, and manage the risk** associated with potential process safety related hazard event scenarios that could **negatively impact buildings and areas on site that are intended for occupancy**, process control or emergency response.

A 12-step assessment process is detailed in Attachment B of IVL EHS-407

Reference Figure 1: Facility Siting Process Flowchart

IVL EHS-407 Scope

Process related incident posing a risk of human injury, damage to property or damage to the environment.

Consequence-based screening assessment followed by risk-based assessment.

Focus increasingly complex modeling methods toward worst credible hazard scenarios for occupied areas.

Buildings and areas on site intended for occupancy, process control and emergency response.

IVL EHS-407 Scope

Table 2.2
Examples of Process-Related Incidents

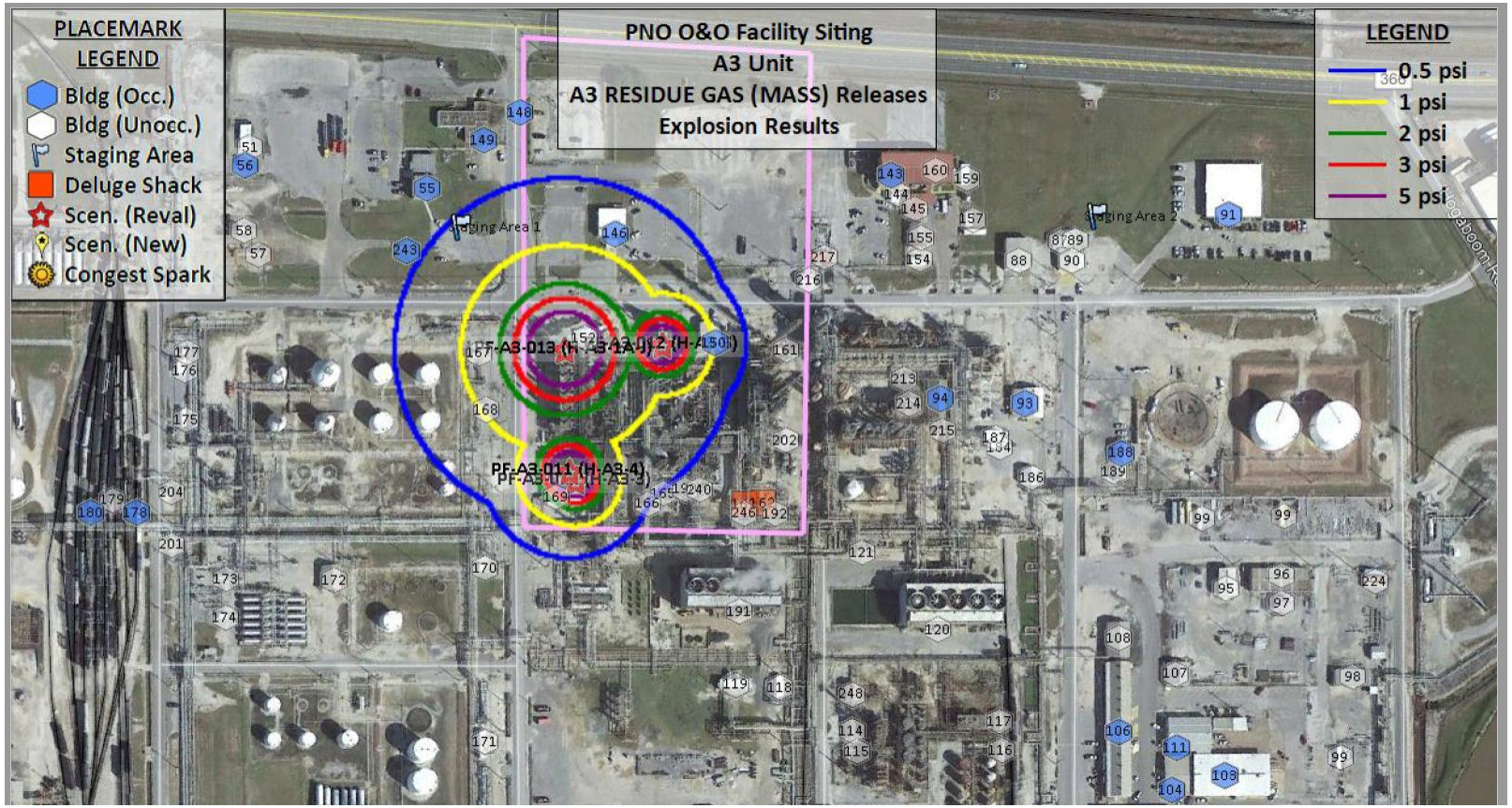
Hazard	Example	Comments
Physical overpressure	Vapor cloud explosion	Yes, see **Appendix E-3**.
	Dust explosion	None identified as possible
	Subsidence	None identified as credible
	Impact from missiles / debris	None identified as credible
	Extreme weather, tornado / hurricane or typhoon	Yes, reviewed during Step 8.

See Attachment H – Examples of Worst Credible Hazard Event Scenarios

IVL EHS-407 Scope

General			Chemical		
Area	Name	Release Mechanism	Name	CAS No.	Equip #
E4 and E7	PT-E4/E7-003_F-E4-1/F-E7-15_NH3	Ammonia release from gasket failure at Ammonia Storage Tank, F-E4-1/F-E7-15, 6" tank bottom gasket failure(hole size based on a quarter of the gasket), horizontal, Liquid leak @ ambient temp, quarter gasket failure from overheating tank, corrosion, or pump seal leak (equivalent 0.8660" dia), 10 min release	Ammonia - anhydrous	7664-41-7	F-E4-1/F-E7-15
E4 and E7	PT-E4/E7-002_Railcar_NH3	Ammonia liquid release from hose failure at tank car 2" unloading hose, horizontal Reference E7 55.09.2 & E4 1.17.1	Ammonia - anhydrous	7664-41-7	E4/E7
Utilities	PT-O-029_1 cylinder_Cl2	Chlorine release due to hose failure at 1-ton Cylinders manifold with one on line at any given time. 5/16" hose failure, horizontal BUILDING DEPENDENT ON SOURCE LEAK THE SITE HAS MULTIPLE COOLING TOWERS THE LEAK WOULD NEED TO BE CONSIDERED FOR EACH AREA	Chlorine	7782-50-5	1 ton Cl2 cylinder
F4 and F6	PFT-F4/F6-010_400 lb cylinder_EtCl	Ethyl Chloride release from 400lb cylinder POTENTIAL FOR INTERNAL CORROSION DUE TO WATER ACCUMULATION IN BOTTOM DRAIN PIPING OF EC STORAGE TANK F-F4-140 RESULTING IN A PIN HOLE LEAK IN THE VESSEL SHELL	Ethyl Chloride	75-00-3	ETHYL CHLORIDE TANK

IVL EHS-407 Scope



What does ‘Occupied’ mean?

EHS-407 A.9 Occupied Building Examples

A.9.1 Occupancy is more than transient or intermittent, e.g. more than 100 man-hours a month; and/or

A.9.2 There is a work station or chair present, or other evidence of a building acting as a base, or to which workers routinely return and are “static’ for a period; and/or

A.9.3 There is a cooking device, e.g. stove, microwave, hot plate, etc.; and/or

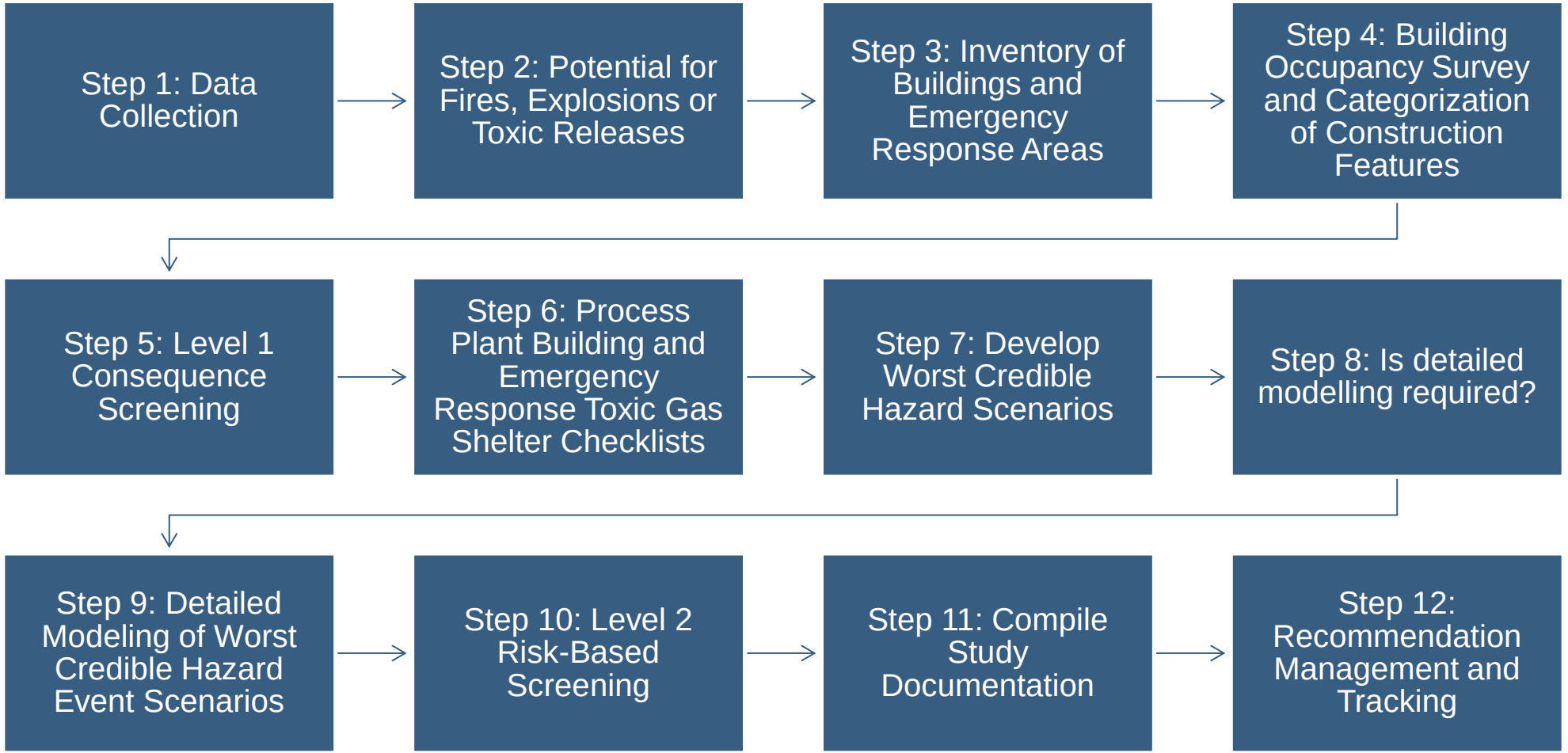
A.9.4 There is “tidal” usage, e.g. canteens, changing rooms, and visitors centre.

Also refer to API 752 (2009) for more examples and clarifications of occupied buildings.

Glossary

ALARP: As Low As Reasonably Practical	. . . think logical
BDL: Building Damage Level	. . . think probability of fatality
FS: Facility Siting	. . . think where people are
MCE: Maximum Credible Event	. . . think size of hole
RAGAGEP: Recognized and Generally Accepted Good Engineering Practice	. . . OSHA expects this
VCE: Vapor cloud explosion	. . . Texas City

Methodology



Typical Reports (EHS-407 B.4.11)

Facility Siting Assessment Reports should include the following sections:

- Executive summary with objective, methodology and key findings
- Recommendations with key issues identified
- Methodology and any alternative approaches used for the review
- Building List and Occupancy
- Hazard or contour maps illustrating the potential areas with flammable and toxic impacts
- Results for all occupied buildings, process control buildings, and emergency response buildings/areas being assessed with location of information in the report
- Conclusions with main findings
- Appendix with hazard identification and risk assessment table

Typical Reports (EHS-407 B.4.11)

The study evaluated the location of occupied buildings in relation to process areas that have the potential for accidental toxic releases, fires, and explosions. The facility siting team identified the worst credible hazard event scenarios at O&O, F5, and the Calabrian facility with the potential to impact buildings intended for occupancy at O&O. The team evaluated the potential impact of the scenarios on occupied permanent buildings using the siting criteria in Facility Siting Procedure EHS-407, the American Petroleum Institute (API) Recommended Practice 752 (RP 752), and the criteria in **Appendix E-2** of this report. The team evaluated the potential impact of the scenarios on occupied portable buildings according to API Recommended Practice 753 (RP 753). The team quantified the severity of the potential impacts to occupied buildings according to EHS-208 Risk Management Procedure and Matrix.

Typical Reports (EHS-407 B.4.11)

Rec Sort	Rec #	Risk Management Opportunities HAZOP
3: EHS-3, LOPA - 12.4.4	P1	1. CONSIDER IMPLEMENTING THE FOLLOWING SAFEGUARD IPLS IDENTIFIED (LOW CIRC FLOW THROUGH RX HEAT EXCHANGERS AND HIGH RX TEMPERATURE TRIPS) TO PREVENT AN OVERPRESSURE TO AN OCCUPIED BUILDING (THIS OPTION SELECTED AT MIM) OR REMOVE PERSONNEL FROM THE E6 PERMIT BUILDING (B1 TYPE BLDG), FROM THE E6 DRUMMING BLDG (B2 TYPE BLDG - #70) AND FROM THE BLDG 5 LOADING RACK (B1 TYPE BLDG - #73) : POTENTIAL 5 PSI IMPACT OR INSTALL A BRM FOR THE PERMIT BUILDING, THE DRUMMING BLDG AND A BRM FOR THE BLDG 5 LOADING RACK NOTE: WITH THE INSTALLATION OF THE NEW E6 COMFORT STATION THE E6 PERMIT BLDG HAS BEEN EVACUATED OF ALL PERSONNEL. AN MOC (M2015389-001) WAS INITIATED 4/25/15 TO DEMO THE PERMIT BLDG. 2020 Scribe note: BLDG 5 LOADING RACK (B1 TYPE BLDG - #73) is still occupied so RMO appears to remain open. Permit building is removed. Site preference is for all wood framed buildings to be removed. Bldg 5 Loading Rack building needs to be replaced with a metal frame building.

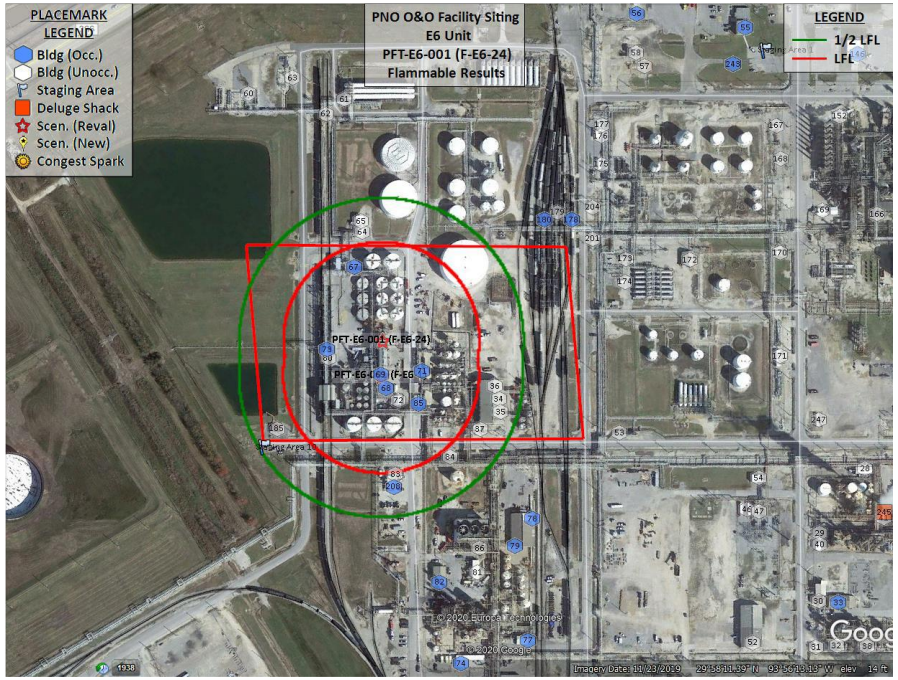
Typical Reports (EHS-407 B.4.11)

- 13.2.4	P3	3. 2020 FS Revalidation Team Consider evaluating risks to personnel in #25 B-F4-4 Control Room/Operator Shelter, #55 R&S Control Room, #93 B-T-25 G5 T&I building, #94 G1/G5 Operator Shelter, #103 Weld Shop, #104 B-T-29 CE&M Building, #106 Store House, #146 B-S-4 A3 Control Room, #149 B-S-3 Guard Office, and #150 B-S-4 A3 Control Room due to a VCE caused by Ethane/propane release from brittle fracture failure during repressurization of F-A3-103. This hazard results in complete destruction of each of these buildings. Gap currently closed by ALARM and SIL 2 SIF in PHA Xref (19) 5.13.1/4. A large number of scenarios impact the B-S-4 A3 Control Room and the 2020 FS Reval Team recommended upgrading the building to a BRM.

Typical Reports (EHS-407 B.4.11)

Building Number	Building Name / Use	Construction Features	Type	Occupancy (Hours)				Intended for Occupancy	Comments
				Essential		Non-Essential			
				Typical	Peak	Typical	Peak		
1	F6 Operator Shelter	Concrete Block Windows with Wire Mesh No Shelter in Place Pressurized HVAC	B3	1	9	0	0	N	API 752 4.2c
2	Building 12 (B-F6-5) Analyzer	Steel frame Steel siding	B2	1	8	0	0	N	API 752 4.2
3	Building 13 Storage	Steel frame Steel siding	B2	1	7	0	0	N	API 753 2.3
4	B-F6-7 & 8 (2 Buildings) PLC's	Steel frame Steel siding Window wire mesh	B2	4	16	0	0	N	API 752 4.2
5	Cat Storage Area (3 Bldgs) Trailer	Steel frame Steel siding Trailer with windows	B2	0	80	0	80	Y	API 752 4.2
6	Sub DD	Steel frame Steel siding Window with wire mesh	B2	3	4	0	0	N	API 752 4.2
7	Building 14 B-F6-3 Analyzer Building	Steel frame Steel siding	B2	7	21	0	0	N	API 752 4.2
8	Sub BB	Steel frame Steel siding Window with wire mesh and glazed	B2	3	4	0	0	N	API 752 4.2
9	Boom Track Loading Rack Shelter - North (Demoed/gone)	Steel frame Steel siding	B2	0	0	0	0	N	API 752 4.2
10	Boom Track Loading Rack Shelter - South	Wood frame with steel siding with windows	B1	91	154	0	0	Y	API 752 4.1
11	Instrument Shop	Steel Sheet metal Windows	B2	840	1120	2	2	Y	API 752 4.1

Typical Reports (EHS-407 B.4.11)



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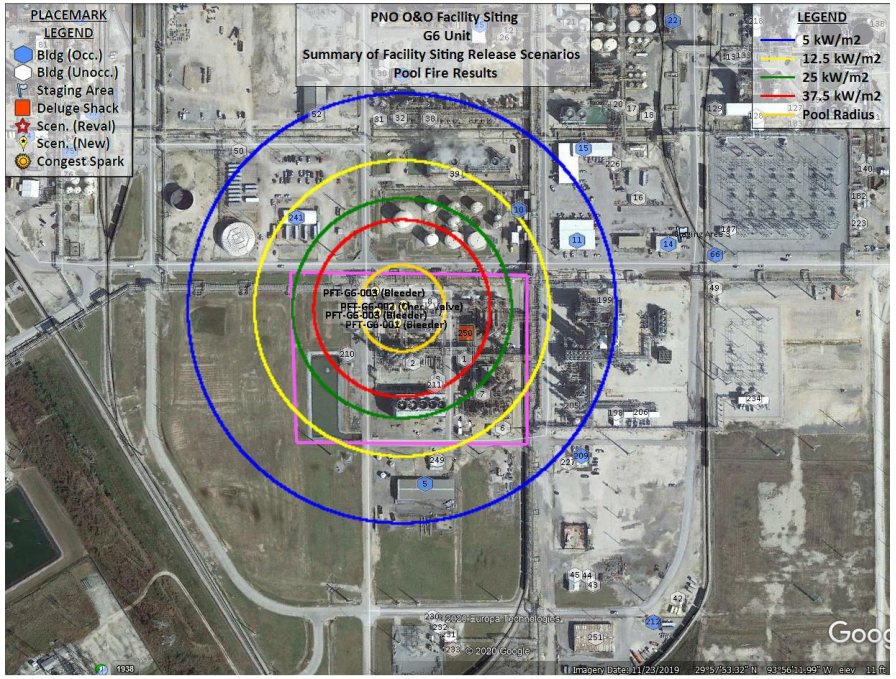

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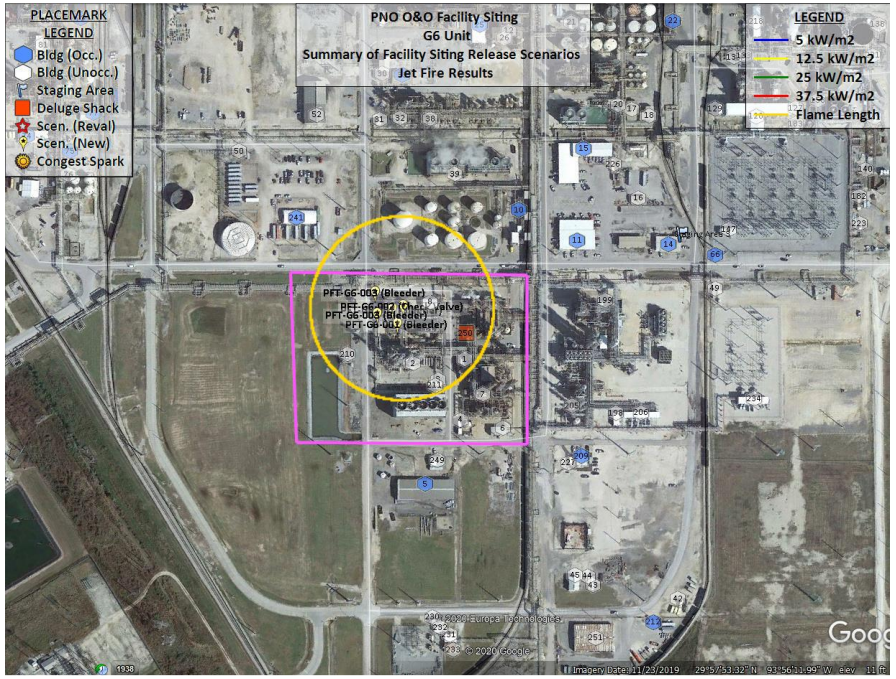

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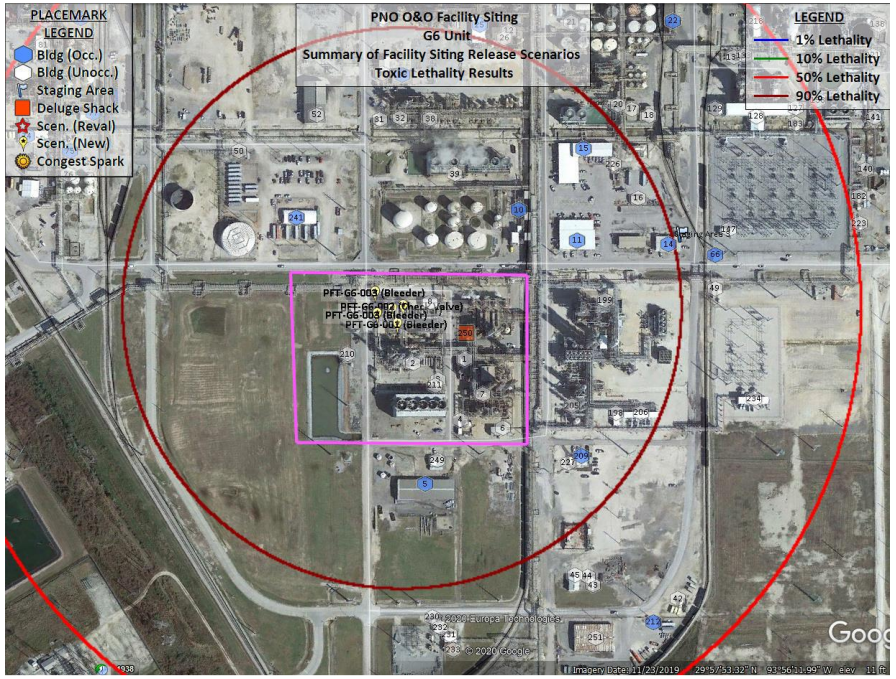

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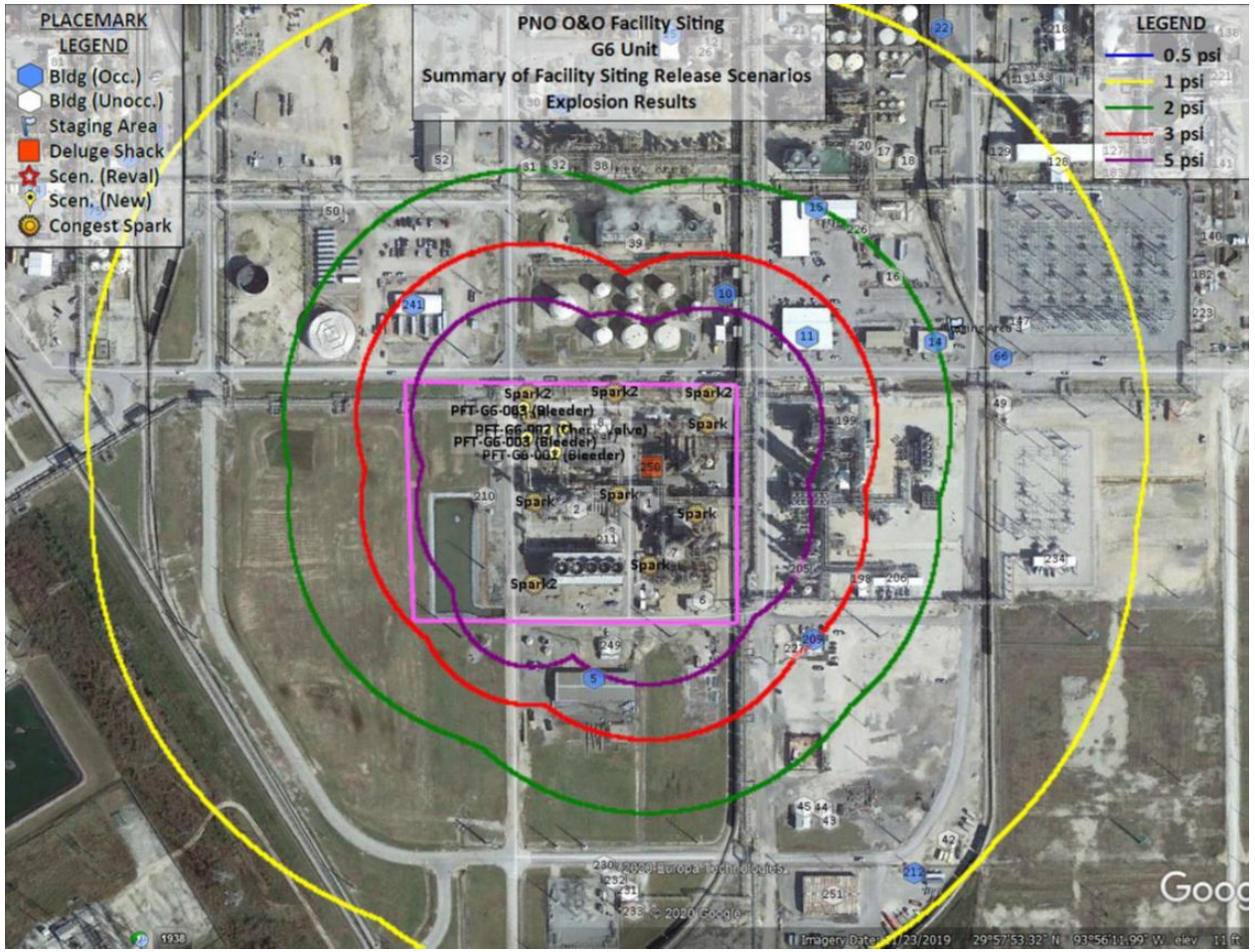


Typical Reports (EHS-407 B.4.11)

Hierarchy of Mitigation Measures [3]

Mitigation Measure		Example Measures
Passive	Eliminate hazard	Substitute with non-hazardous material/process conditions
	Prevent release (i.e. reduce the frequency of the scenario)	Upgrade metallurgy or design of equipment Reduce leak sources (eliminate flanges, drains, small-bore piping, etc. Rate equipment for maximum upset pressure
	Control size of the scenario	Minimize congestion Minimize confinement Utilize spill control dikes, curbs, etc. to limit the extent of pool fires and limit vapor dispersion from pools of flashing liquids Minimize release rate – provide process flow restrictions (either limiting pipe size or adding restricting orifices) to reduce the potential severity of a release from downstream equipment Reduce inventory of hazardous material (can reduce the duration of fire and gas release scenarios)
	Mitigate effect to building occupants	Relocate personnel (especially personnel that are not essential) Design or upgrade existing building to protect occupants from explosion, fire, or toxics Tightly seal windows and tight double doors (airlocks) to minimize toxic/flammable gas and smoke ingress
Active	Prevent release (i.e. reduce the frequency of the scenario)	Safety instrumented systems
	Control size of the scenario	Fire and gas/emergency shutdown systems (reducing quantity released) Fixed/automatic active firefighting systems
	Mitigate effect to building occupants	Issue occupants with personal protective equipment (PPE) for hazards HVAC air intake shut down on detection of flammable/toxic gas
Procedural	Prevent release (i.e. reduce the frequency of the scenario)	Mechanical integrity inspection Permits for hot work, lockout/tagout, line breaking, lifting, etc. Sampling to prevent contamination of reactive material
	Control size of the scenario	Manual active firefighting systems
	Mitigate effect to building occupants	Emergency response plan including, as appropriate: evacuation, escape routes, shelter-in-place, etc. Evacuate building occupants during start-up and planned shutdowns

Typical Reports (EHS-407 B.4.11)

List of Appendices

Going Forward

Regional guidance document will be updated to reflect learnings:

- MCE: Better source term selection
- Active management of portable/temporary occupied buildings
- Design requirements for shelter-in-place buildings
- Consistent safety concept for in-building fill hazard

Portable Blast Resistant Modules (BRMs)

Blast Resistant Modules (BRMs)

Portable BRMs are often utilized to house employees and contractors for various needs such as project work, outages, turnarounds, etc.

These temporary building can protect in the event of a blast, but also fire/smoke and in some cases, toxic releases.

BRM Placement

Ideal BRM Orientation

- ‘Short side’ to the process (less surface area, less impact)
- Doors away from/perpendicular to the process (ensures ability to escape)

Sliding Precautions/Appropriate Ground Surfaces for Sliding

- Level surface to allow BRM to slide in a blast
- Level surface behind BRM, ensures it does not roll or tip over
- No objects behind BRM that would prevent / stop sliding

For layered BRMS:

- Ensure enough distance between BRMS.
- Do not want BRMs to slide, make contact, and block doors – locking in personnel

PERFORM A PRE-PLACEMENT FIELD VISIT

Siting Pre-Evaluation

Hazards to Consider (Its not just about the blast)

- Overpressure (site for 200 ms duration)
- Thermal Radiation
- Toxicity (may need leak tightness)
- Pool & Jet Fire

Redline a plot plan with the following information:

- Orientation
- Doors, windows location
- HVAC Location

Provide following occupancy/unit status details:

- # Personnel by shift, including job roles (should be essential personnel only)
- Unit Status for duration BRM is on-site (BRMs should not be used during unit SU/SD activities)

Facility Siting Results and How to Use Them

How to use FS Results during PHA/LOPAs

Identify modeling scenarios that align with the PHA/LOPA scenario

Consider release hazard distances - flash fire, VCE overpressure, pool and jet fire radiant heat, toxic ERPG, IDLH, and lethality

Consider location of release and impacts to personnel and the environment

Set severities based on above information

Reference source of information in PHA/LOPA study

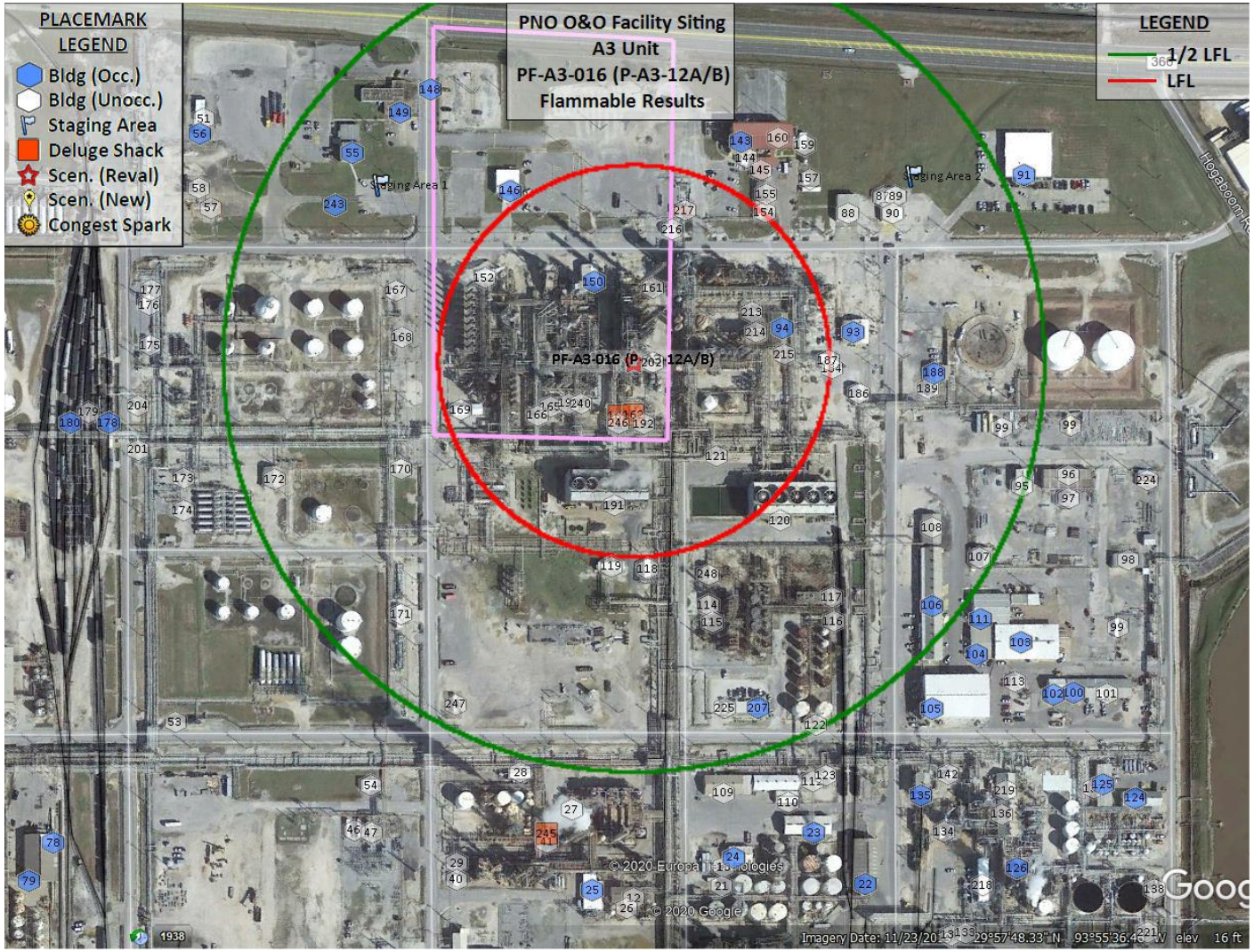
How to use FS Results during PHA/LOPAs

Area	Name	Release Mechanism	Chemical	Conditions
				Stability Class F
A3	PF-A3-016_P-A3-12A/B_Ethylene	Ethylene release from a Seal leak at pump, P-A3-12A/B, Inlet nozzle 6" 10% area = 1.9" diameter hole, inlet pressure 275 psig, inlet temperature -20F, Discharge pressure 450 psig, release pressure = inlet + 0.25* differential = 319 psig Confinement A3 400*60*12 = 288000 ft3 PHA XREF A3 TOWER SECTION PART 2 O:24 R:4 2.08.1	Ethylene	Temp 91.2 F Wind speed 3.0 m/s Stability Class D
				Temp 73.6 F Wind speed 1.5 m/s Stability Class F

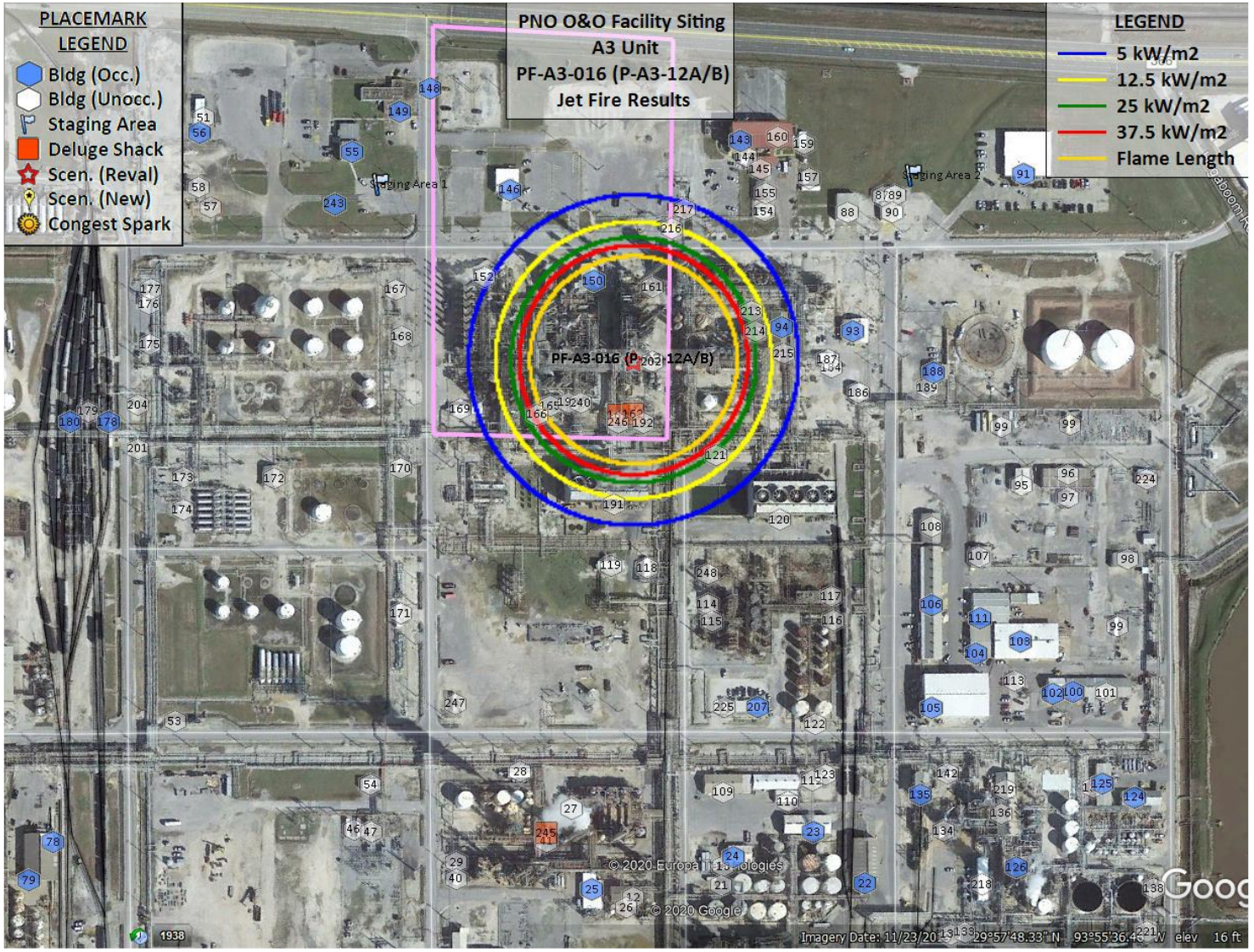
How to use FS Results during PHA/LOPAs

LFL %	Distances of Concern, ft										
	Flash Fire	Pool Radius	Late Pool Fire				Jet Fire				
			5kW/m2	12.5kW/m2	25kW/m2	37.5kW/m2	Flame Length	5kW/m2	12.5kW/m2	25kW/m2	37.5kW/m2
422	No Hazard	No Hazard	No Hazard	No Hazard	No Hazard	No Hazard	180	319	261	228	212
381	No Hazard	No Hazard	No Hazard	No Hazard	No Hazard	No Hazard	224	356	298	264	246

How to use FS Results during PHA/LOPAs



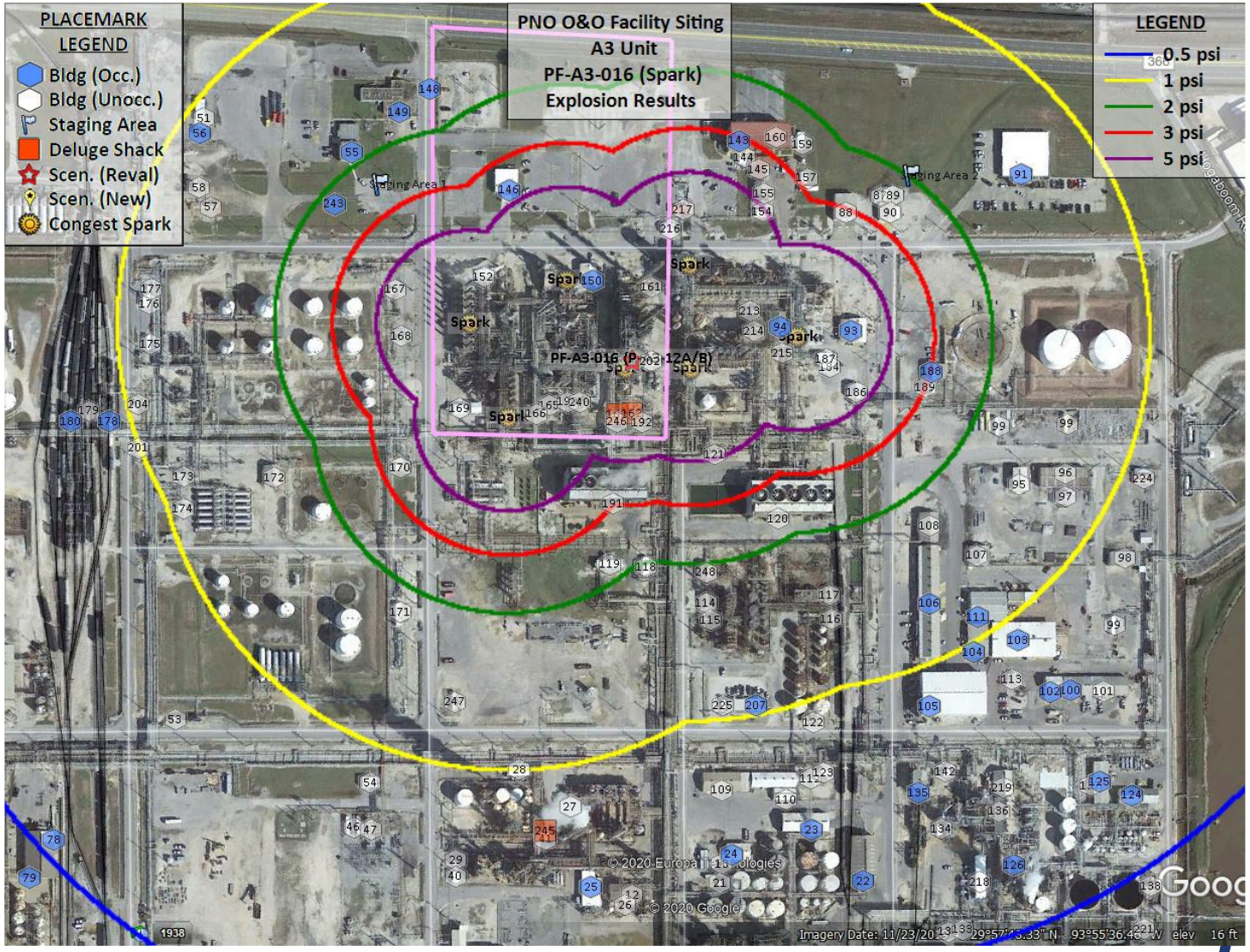
How to use FS Results during PHA/LOPAs



How to use FS Results during PHA/LOPAs

Model Used	Mass in cloud above LFL, lb	VCE Mass % above LFL	Distances of Concern, ft								
			VCE / BLEVE / TNT / PVB					Fireball			
			0.5 psi	1 psi	2 psi	3 psi	5 psi	5kW/m2	12.5kW/m2	25kW/m2	37.5kW/m2
BST	1305	100% or Greater VCE Mass	1225	679	376	264	179	798.5	477.5	284.7	174.6
	2590		1374	762	422	296	201	815.6	488.2	293.3	183.5

How to use FS Results during PHA/LOPAs



How to use FS Results during MOCs

Identify modeling scenarios that align with the following MOC types:

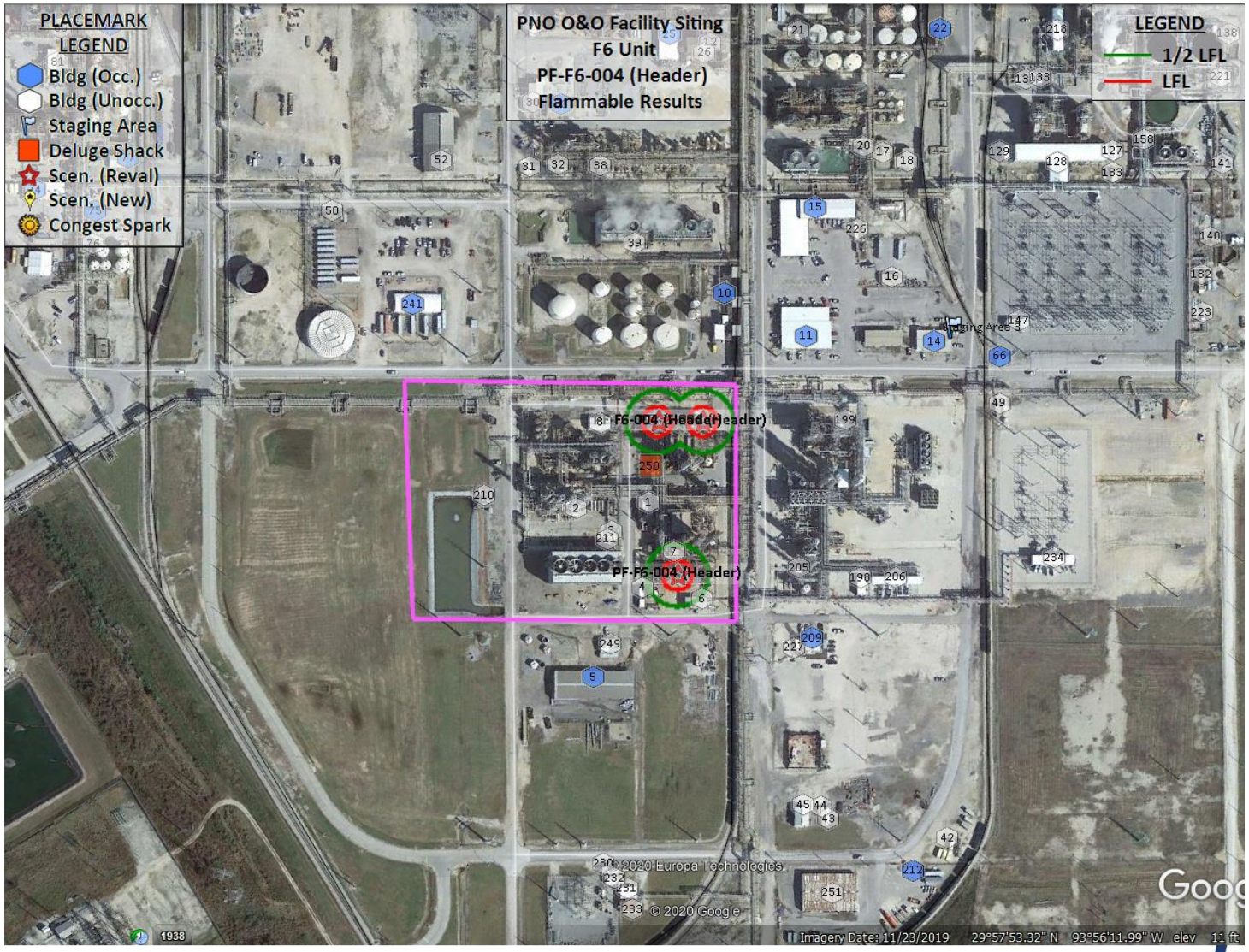
- Adding a new building that meets the definition of building intended for occupancy
- Assigning more personnel to an existing non-occupied building
- Changing the use type of a building that meets the definition of building intended for occupancy

Consider release hazard distances that impact building - flash fire, VCE overpressure, pool and jet fire radiant heat, toxic ERPG, IDLH, and Lethality.

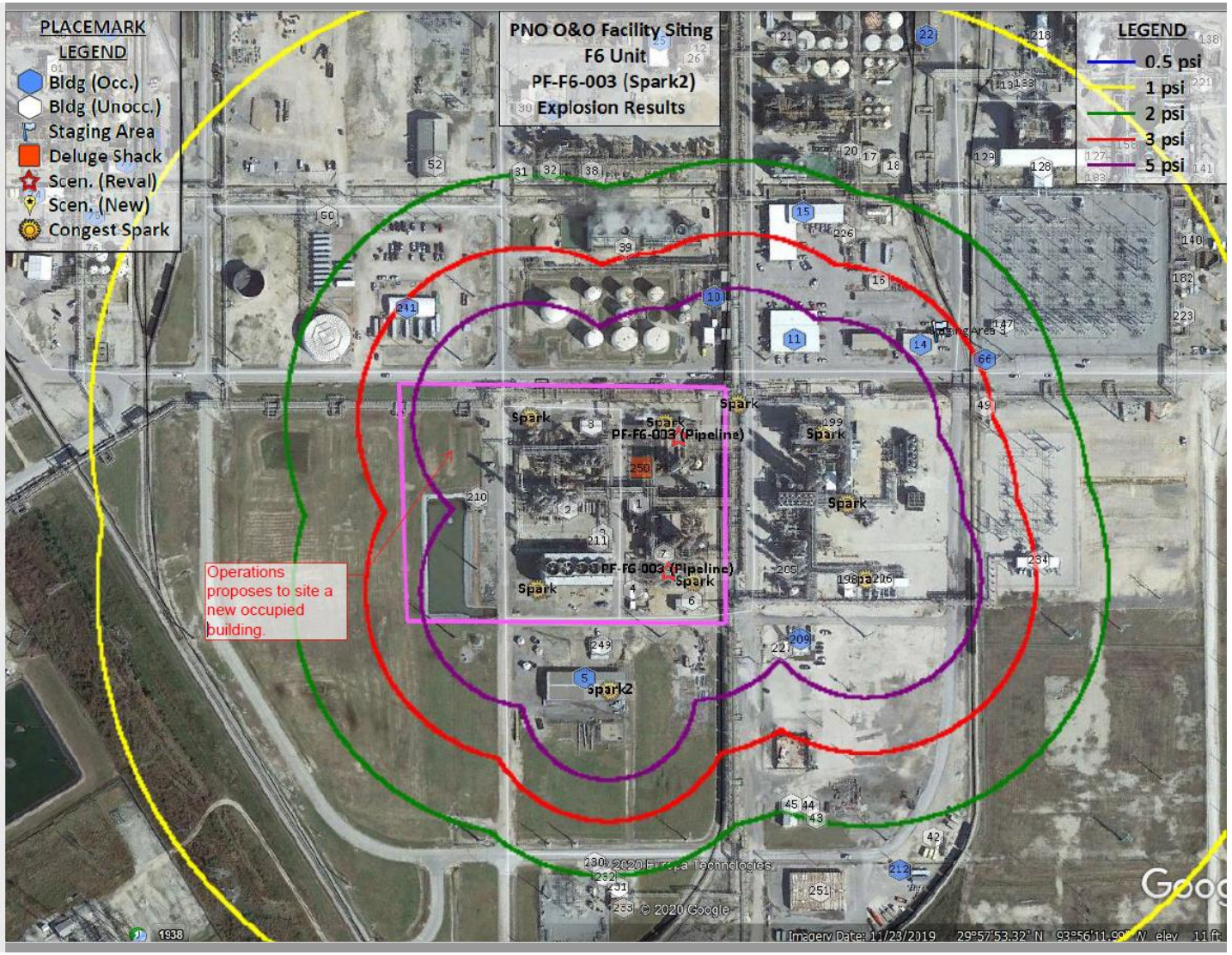
Ensure either through distance from hazard or building construction that personnel are adequately protected

Reference source of information in MOC

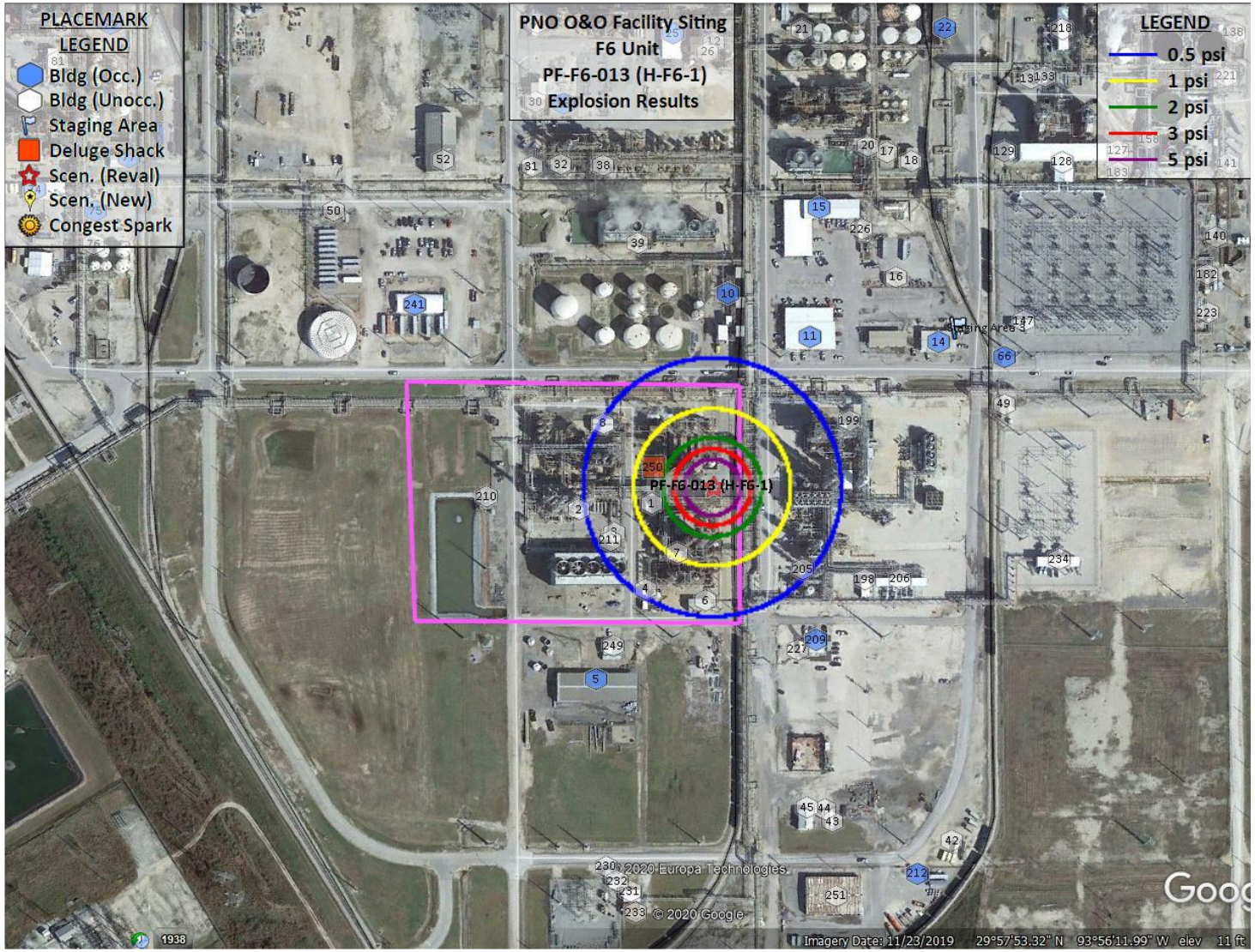
How to use FS Results during MOCs



How to use FS Results during MOCs



How to use FS Results during MOCs



Siting Changes and PSM Support

When to get PSM involved?

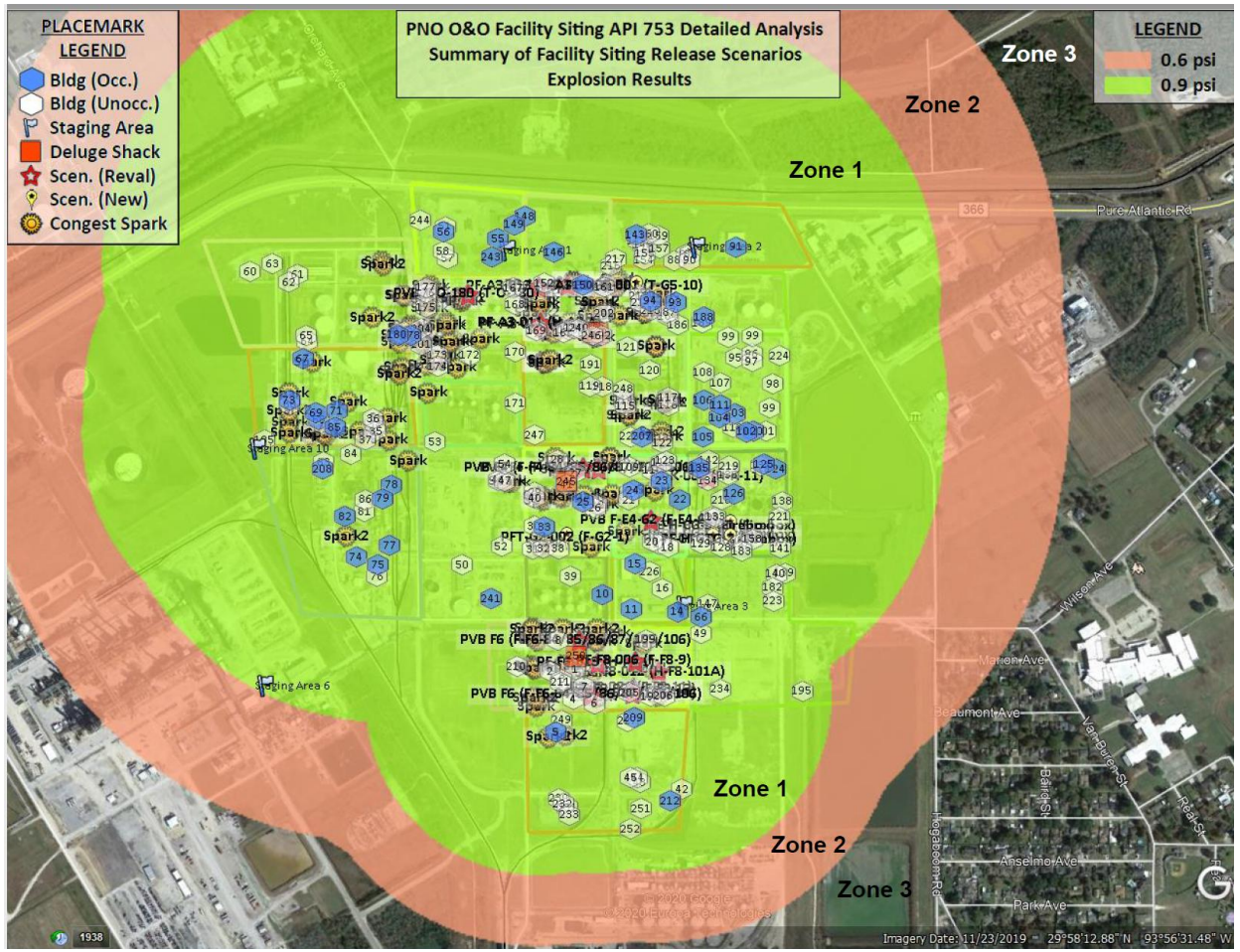
Anytime that one of the following occurs:

- Occupancy increases to a building
- Moving of personnel from one building to another
- Addition of Temporary Buildings (trailers, BRMs, tents, etc. – anything to house personnel in any kind of fashion)
- Addition of Permanent Buildings
- Addition of contractor trailers where they will occupy

Key Points

✓ Involve PSM early so a proper review and evaluation can be performed.
✓ In many cases, an MOC will also need to be conducted.
✓ Involve PSM **before** any changes are made.

When to get PSM involved?



Why does PSM need to be involved?

Occupancy changes will change the risk associated with that building and personnel in it. If we add headcount, the risk will increase – potentially to an unacceptable level per IVL standards.

Temporary buildings/tents have to be evaluated to our current facility siting study. This cannot be done by anyone other than PSM.

New permanent facilities generally do require civil analysis and a much more detailed facility siting analysis by experts. This is generally something that has to be outsourced.

Emergency Response Preparedness (for example, having enough SCBAs in control rooms for occupants).

Questions / Comments

Backup Slides

Step 1: Data Collection

- The Facility Siting Assessor compiles the current Process Safety Information (PSI) necessary to support the Assessment. This includes, but is not limited to:

Hazard identification information	Process data	Weather data	Building data
Equipment data	External sources data	Assembly area information	Layout data

Step 2: Potential for Fires, Explosions or Toxic Releases

Based on the chemical inventory data gathered in Step 1, determine if there is the potential for a fire, explosion or toxic hazard scenario using EHS-407 Attachment C.

CAS Number	CASK Chemical Name	Site Inventory (pounds)	NFPA 704 Classification[1]			Toxic Substance[2]	Flammable Substance[2]	US Ref. List Type[3]	Synonyms
			N_H	N_F	N_R				
7664-39-3	Hydrofluoric Acid (Conc. 50% or greater)		4	0	0	x		PSM/RMP	
1333-74-0	Hydrogen		0	4	0		x	RMP	
10035-10-6	Hydrogen Bromide		3	0	0	x		PSM	
7647-01-0	Hydrogen Chloride (Anhydrous)		3	0	1	x		PSM/RMP	
74-90-8	Hydrogen Cyanide		4	4	2	x	x	-	Hydrocyanic acid

Step 3: Inventory of Buildings and Emergency Response Areas

- Develop or update Facility's Building List and the role of each building is delineated.
- Role of each building on site is documented on the Building List.
- Cross-check Building List with the current site map.
- Temporary or portable buildings.
- Example Building List / Facility Siting Summary provided in EHS-407 Attachment D

Step 3			Step 4						Step 6		Step 7				Step 10			Step 11
BLDG NO	DESCRIPTION	ROLE	CONSTRUCTION FEATURES	TYPE	OCCUPANCY				FLAMMABLE IMPACT (Yes/No)	TOXIC IMPACT (Yes/No)	MODEL SCENARIO NUMBER	MODEL	SOURCE	SCENARIO	RISK MATRIX			RISK MANAGEMENT OPPORTUNITIES / RECOMMENDATIONS
					ESSENTIAL PERSONNEL		OTHER PERSONNEL								S	L	R	
					TYPICAL (HRS/WK)	PEAK (HRS/WK)	TYPICAL (HRS/WK)	PEAK (HRS/WK)										
1	Contractors workshops	Occupied Workshop	Steel frame/metal siding pre-engineered Combination brick/cinderblock/sheet metal/transite (currently scheduled to be removed) panels and roofs. 2 regular glass windows on N side by railroad tracks.	B2	6,500	6,500	6,500			YES	6.3	PHAST	TK 2 - Oleum 65 wt.%, Sulfur Trioxide	10 minute release of Oleum through a quarter of a 1/8 inch gasket on a 2-inch discharge flange or fitting downstream o of the transfer pump. (Pressure 3.5 kg/cm^2)	4	C	EHS-3	

Step 4: Building Occupancy Survey and Categorization of Construction Features

Perform an occupancy survey for each occupied building
Categorization of building type based on construction features.

Document information in Building List.

- Peak and normal occupancy on a weekly basis in hours for each building
- Differentiate between essential and non-essential personnel hours

Step 4: Building Occupancy Survey and Categorization of Construction Features

Occupancy survey for each occupied building.

Categorization of building type based on construction features.

Document information in Building List.

Table B-2
Building Categorization [1]

Building Type [1]	Construction Features [1,2]	Examples [2]
B1	Wood- Frame Trailer or Shack	Temporary Offices
B2	Steel-frame/metal siding pre-engineered building.	Workshops, warehouses. Industrial metal-clad buildings only. Brick-clad steel-frame buildings are Type B4
B3	Un-reinforced masonry bearing wall building	Administration building, cafeteria, substation. Single or multi-story. Roof is solely supported by the walls.
B4	Steel or concrete framed with unreinforced masonry infill or cladding	Same as B3 except the roof is supported by a frame, independent of the walls.
B5	Reinforced concrete or reinforced masonry shear wall building	Substantially designed building, but not specifically designed for blast.

1 "Management of Hazards Associated with Location of Process Plant Buildings, API Recommended Practice 752, November 2003, Appendix C

2 "Guidelines for Evaluating Process Plant Buildings for External Explosions and Fires", CCPS.

Step 5: Level 1 Consequence Screening

Level 1 Screening methodology presented is for performing a conservative worst-case consequence-based screening of hazard event scenarios and the potential impact(s) to occupied, process control and emergency response buildings/areas on site.

“Worst case” refers to a hazard event scenario (process related incident) where the maximum quantity of a hazardous chemical is released from a vessel or pipeline that results in the greatest distance to a specified endpoint.

- The basis for this scenario is very conservative and is always without active mitigation measures, but passive mitigation measures such as a bund or dike which reduce the consequence of the scenario, should be credited. (EHS-407 A.16)

Step 5A: Identification and Modeling of Worst-Case Hazard Scenarios

Identify potential worst case scenarios

Quantify the potential impact of each event scenario through modelling by a competent individual

Present results of modelling as contours on Facility map ("Hazard Map")

Table B-3
Examples of the hazards associated with process safety events

Hazard	Event
Physical overpressure and projectiles	▪ Vapour cloud explosion ▪ Dust explosion ▪ Mist (aerosol) explosion ▪ Vessel rupture ▪ Boiling Liquid Expanding Vapour Explosion
Thermal radiation	▪ Pool fire ▪ Jet fire ▪ Fireball ▪ Flare Stack ▪ Electrical Fire
Direct flame contact	▪ Flash fire
Toxic exposure	▪ Loss of containment giving release of toxic gas. ▪ Ingress of fumes into building ▪ Deliberate venting
Overpressures, Thermal Radiation, and/or Toxic Exposure	▪ Vehicle impact ▪ Land slide ▪ Flooding ▪ Subsidence ▪ Impact from missiles / debris ▪ Extreme weather, tornado / hurricane or typhoon

Steps 5B and 5C

Step 5B: Are Occupied Buildings or Areas impacted?

- Use the “Hazard Map(s)” developed in Step 5A
- Identify occupied buildings, process control buildings, or emergency response buildings / areas within flammable or toxic hazard zones.
  - Screen out buildings that are outside of the hazard zones.
  - Focus on processes / units with potential to impact occupied buildings and areas on site.

Step 5C: Are there safeguards to eliminate or reduce the severity?

- Are typically inherently safer management practices or passive mitigation systems. Examples would be:
  - Elimination
  - Relocation or reduction of inventory
  - Installation of a dike/bund.

Steps 6-9

Step 6: Process Plant Building and Emergency Response Toxic Gas Shelter Checklists

Step 7: Develop Worst Credible Hazard Scenarios

Step 8: Is detailed modeling required?

Step 9: Detailed Modeling of Worst Credible Hazard Event Scenarios

- Modeling results shall be presented as contours on Facility map.
- This format is conducive for evaluating impacts on buildings and Emergency Response Areas, as well as use as a “Hazard Map” for the site to address MOC issues in the future.

Scenario Selection: Worst Credible

Worst Credible: A hazard event scenario (process related incident) where the quantity and condition, e.g., pressure, temperature, composition, of a hazardous chemical released takes into account the process conditions and passive mitigation measures

Derived from PHAs and related process incident history

Examples include:

- Overfill of a tank at the maximum fill rate for a period of 10 minutes required for detection and isolation
- Pipe rupture of a compressed gas line as a result of corrosion under insulation
- Gasket leak on start-up following a maintenance turnaround

Step 10: Level 2 Risk-Based Screening

Step 10A: Assess Severity of Occupied Building Impacts

- Overpressure, Thermal Radiation and Toxic Gas

Step 10B: Establish Severity and Likelihood (Risk Ranking)

- Compare Severity and Frequency using Tables 1 and 2 in EHS-208 and plot on Figure 2 Risk Matrix
- A Quantitative Risk Assessment (QRA) may be necessary

Step 10C: Are the building design / location and risk acceptable?

Step 10D: Identify Risk Management Opportunities

Example Hazard Map

Steps 11 and 12

Step 11: Compile Study Documentation

Step 12: Recommendation Management and Tracking

- Facility Manager has responsibility to:
  - Ensure a process is in place to actively address the recommendations,
  - Develop related action plans, and
  - Track those plans to completion per IVL EHS-107, Management of Actions