



Refrigeration System Design - A Regulatory Overview



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Overview

- Background
- Process Safety Management (**PSM**)
 - 29 CFR 1910.119
- Risk Management Planning (**RMP**)
 - 40 CFR 68
- Enforcement Update



Background

- International & Domestic Catastrophic Events
 - Flixborough, England – 1974 vapor explosion at cyclohexane plant kills 28
 - Bophal, India – 1983 methyl isocyanate (MIC) leaked leaving 3,800 dead and approximately 11,000 with disabilities.
 - Pasadena, TX – 1989 a polyethylene reactor at refinery plant explodes killing 23 and injuring 130
 - Texas City, TX – 1947 ammonium nitrate explosion kills 552 and injures 3,000
 - Lake Charles, LA – 1967 isobutylene incident kills 7 and injures 13
 - Many Recent Domestic Events (3 to 7 fatalities)

Flixborough, UK



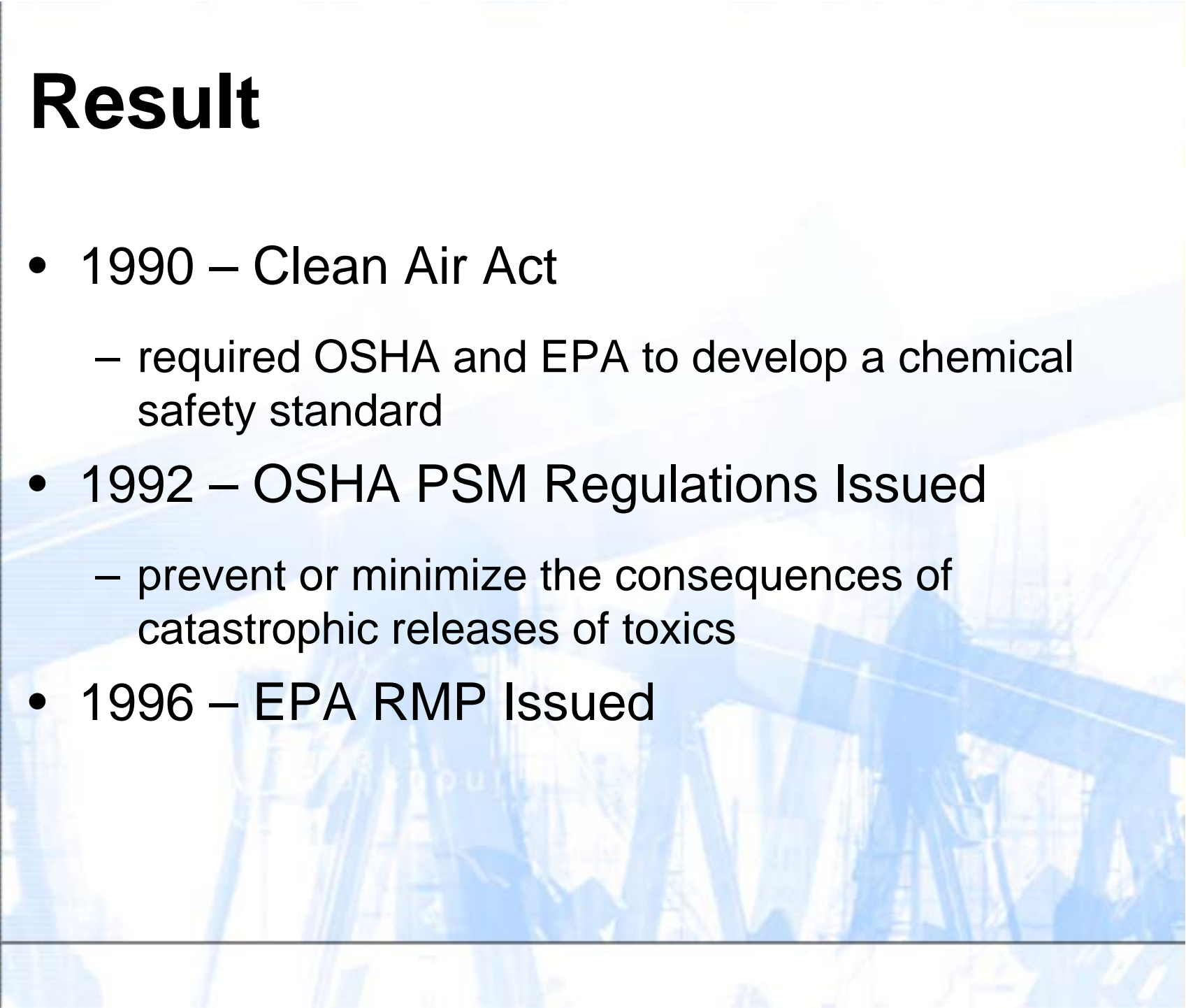


Refrigeration-Related Incidents

- Compressor housing blows off
 - Refrigeration manager killed; **170086433**
- Draining refrigerant oil from NH₃ refrigeration system oil traps
 - NH₃ release kills 2 employees on scissors lift; **014319784**
- Pressure vessel in an ammonia refriger. system ruptured under pressure. The explosion caused extensive physical damage.
 - 4 fatalities; **014511125**
- Oil separator on a two-stage ammonia refrigeration system became over pressurized and exploded
 - One killed, one hospitalized; **014503874**



Result

- 1990 – Clean Air Act
 - required OSHA and EPA to develop a chemical safety standard
 - 1992 – OSHA PSM Regulations Issued
 - prevent or minimize the consequences of catastrophic releases of toxics
 - 1996 – EPA RMP Issued
- 

Process Safety Management

OSHA

Occupational Safety & Health Administration
U.S. Department of Labor



- A performance-based standard
- Features a comprehensive management program
- Integrates
 - technology (including design)
 - operations & maintenance
 - management practices



PSM Features

- Applies to processes that utilize toxic/reactive substances above a threshold quantity (TQ)
 - anhydrous ammonia TQ=10,000 lb
- Process
 - any group of vessels **interconnected** or **separate** but located in close proximity
 - all equipment which could impact covered process would be considered part of single process
 - there are exceptions/exemptions

PSM Has 14 Elements





PSM Elements

- Employee participation (c)
- Process safety information (d)
 - chemical, technical, equipment
- Process hazard analysis (e)
 - systematic evaluation of hazards with continuous improvement
- Operating procedures (f)
 - startup, shutdown, emergency, temporary, ... includes operating limits



PSM Elements

- **Training (g)**
 - procedures (normal & emergency), hazards, specific tasks, safe practices
- **Contractors (h)**
 - employer & contractor requirements
- **Pre-startup safety review (i)**
 - insure construction in accordance with design, procedures, complete PHAs, training, etc.



PSM Elements

- **Mechanical Integrity (j)**
 - maintenance, Q/A, inspection/testing at proper frequencies, addresses equipment deficiencies
- **Hot work (k)**
- **Management of change (l)**
 - procedures, materials, technology, equipment and facilities
- **Incident investigation (m)**
 - investigates actual incidents or near-misses, lessons-learned, develop/resolve recommendations

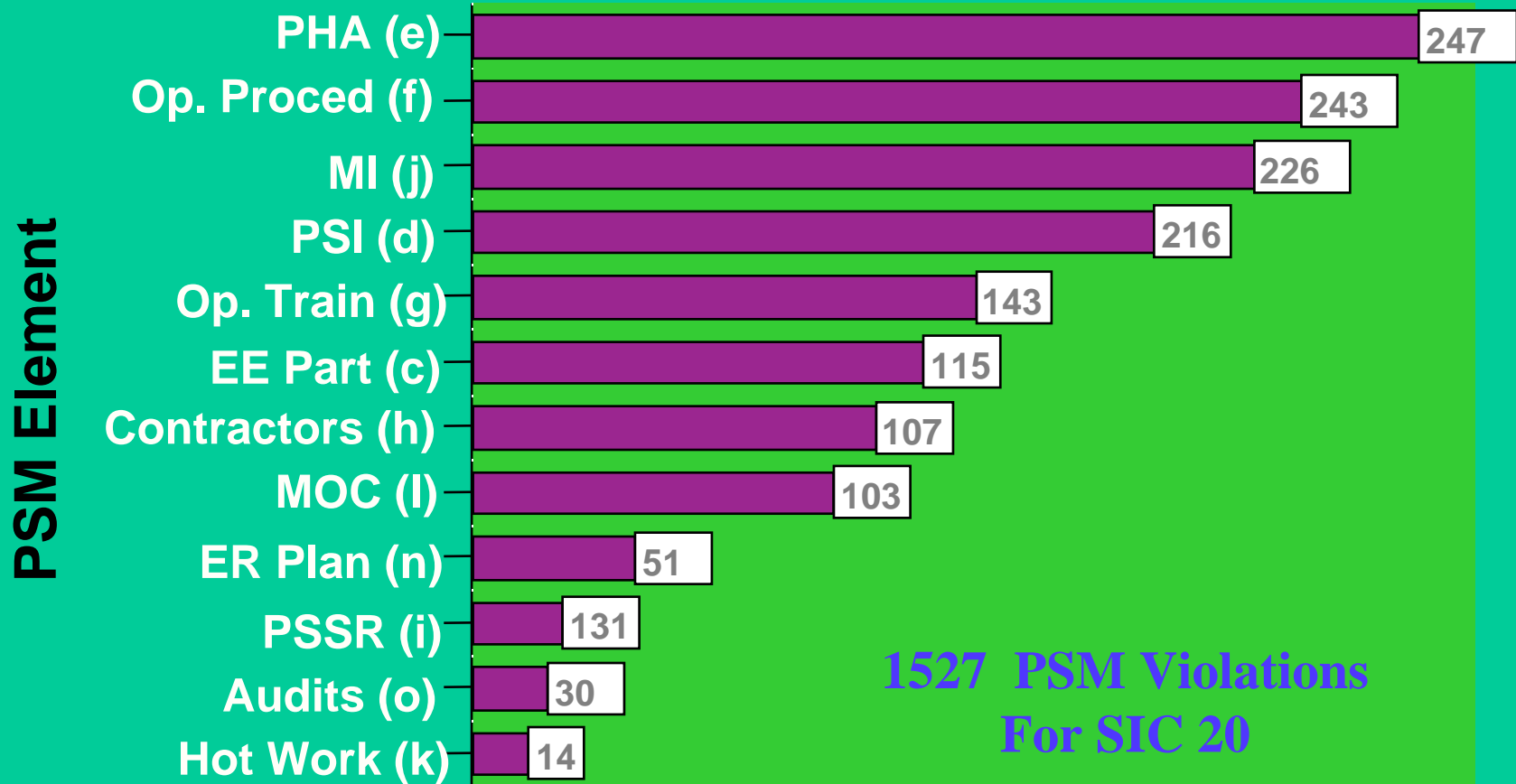


PSM Elements

- **Emergency planning & response (n)**
 - pre-planning, escape procedures, notification procedures, alarm system, training
- **Compliance audits (o)**
 - every 3 years, certifies standard compliance, verification, recommendations
- **Trade secrets (p)**
 - provides protection for trade secrets allows information to be “closely held”

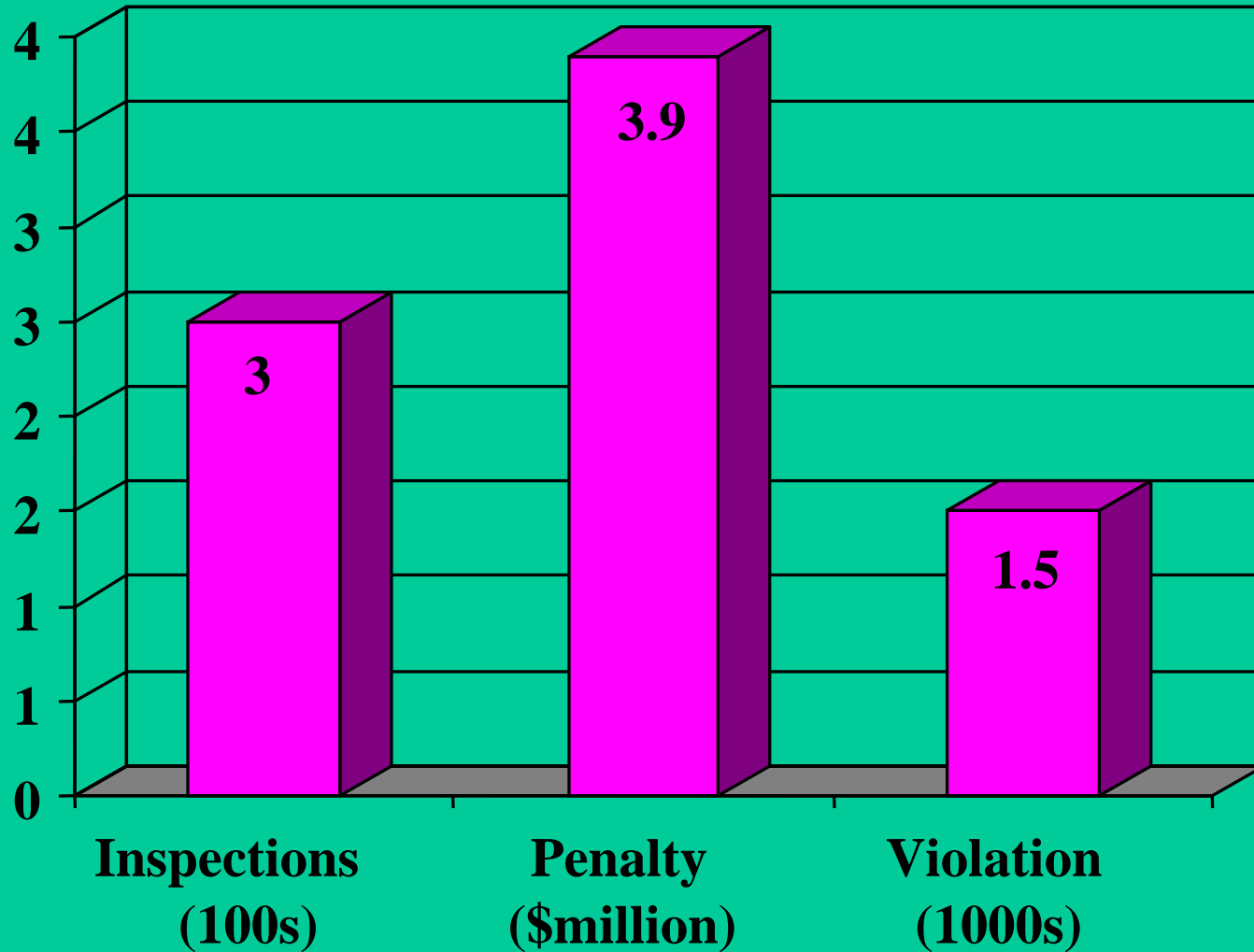
Frequency of PSM Violations

Number of Violations (May 92 - February 2001)



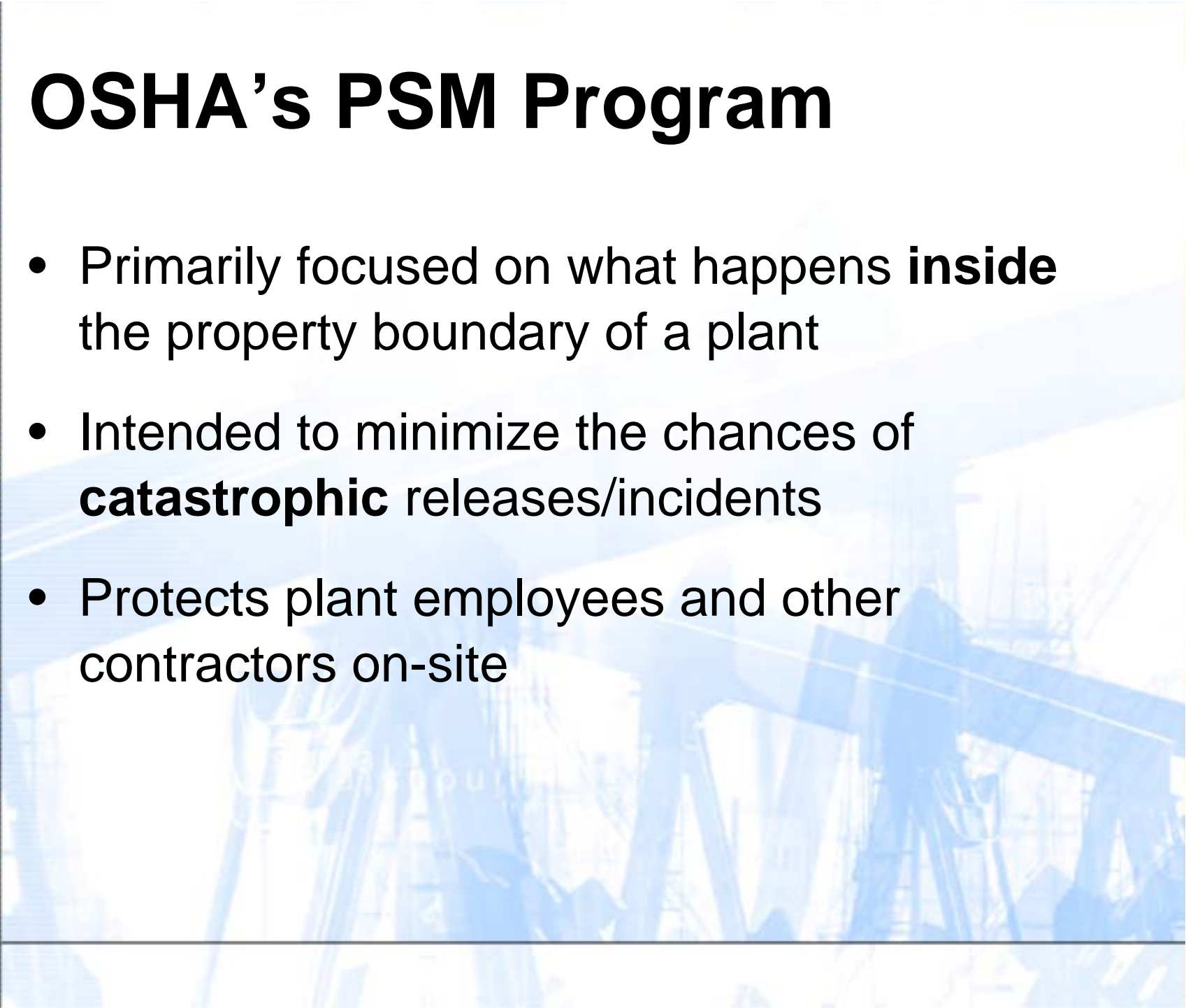
PSM Data for SIC 20 (Food & Kindred Products)

All PSM Inspections





OSHA's PSM Program

- Primarily focused on what happens **inside** the property boundary of a plant
 - Intended to minimize the chances of **catastrophic** releases/incidents
 - Protects plant employees and other contractors on-site
- 



Process Safety Management

- OSHA does have an active PSM Q/A program
 - unannounced inspections
 - SIC 20 is a focus area for inspections
- Areas of weakness in refrigeration-related PSM
 - programs with no implementation
 - mechanical integrity
 - management of change

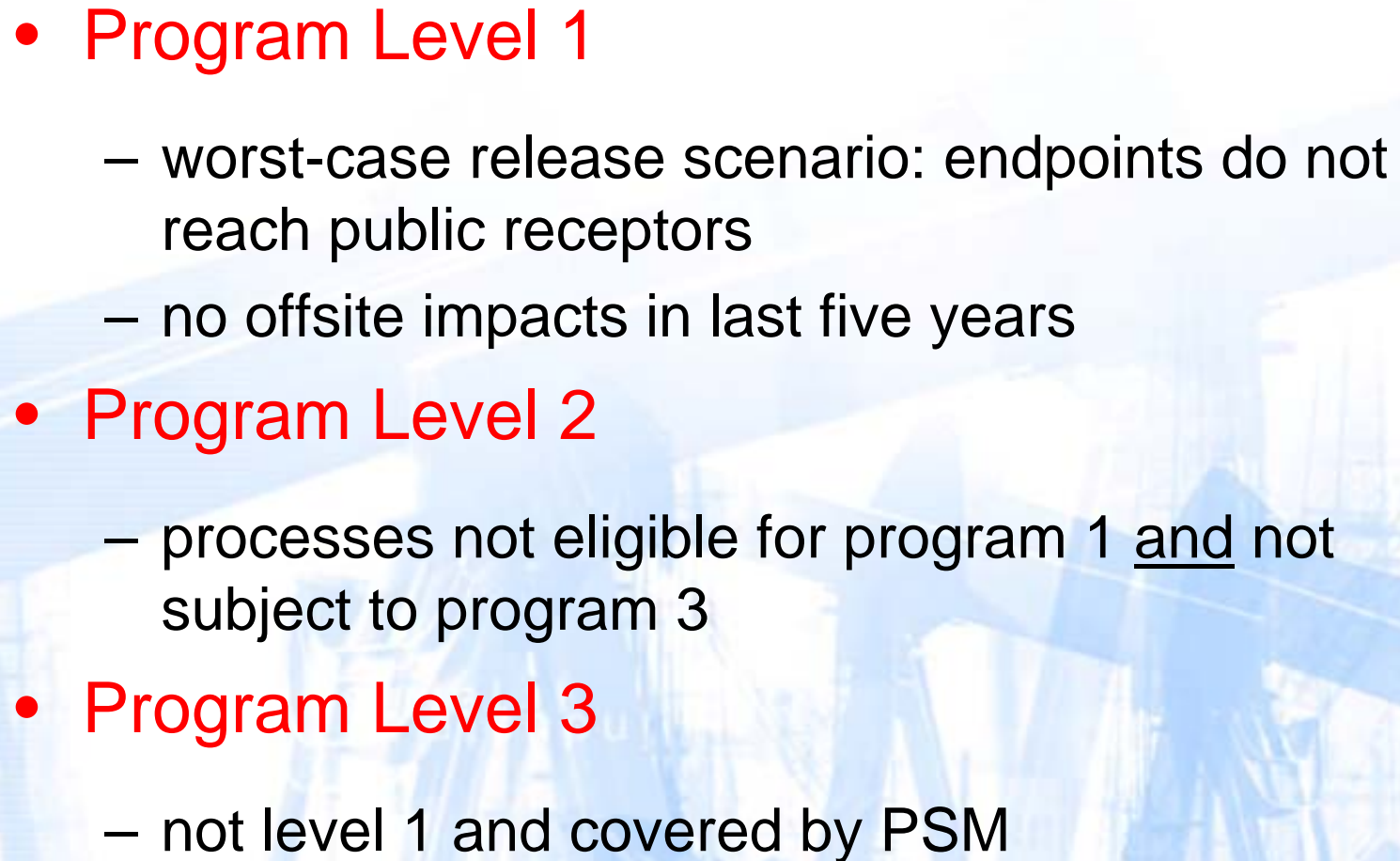
EPA's RMP



- Implement a risk management program
 - hazard assessment, release prevention program, emergency response program
- Three program levels
- Submit a risk management plan (“RMP”), including registration
- Update program and plan as required by rule, audit, or changes to process or chemicals.



RMP

- **Program Level 1**
 - worst-case release scenario: endpoints do not reach public receptors
 - no offsite impacts in last five years
 - **Program Level 2**
 - processes not eligible for program 1 and not subject to program 3
 - **Program Level 3**
 - not level 1 and covered by PSM
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RMP Program 3 Requirements

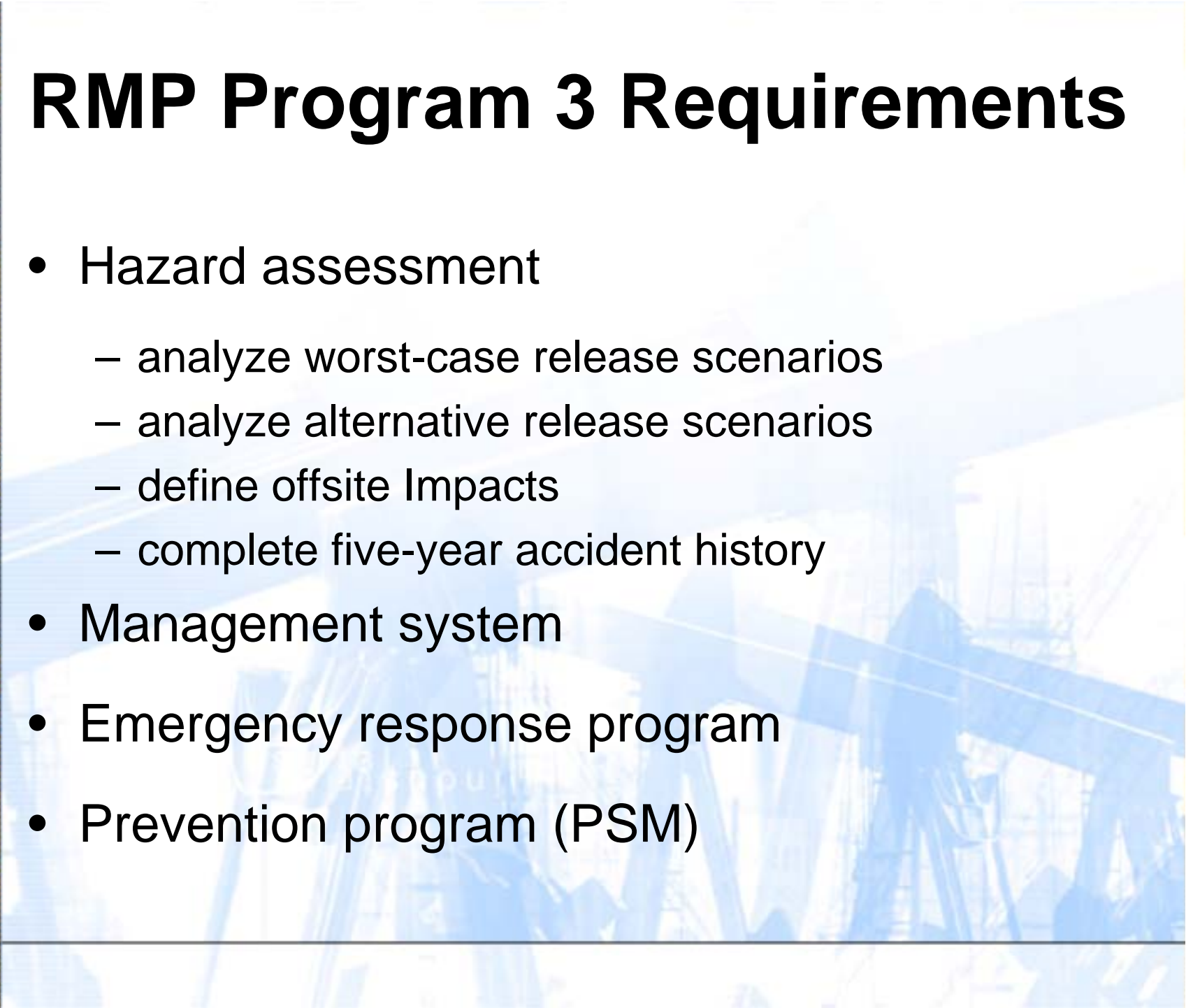
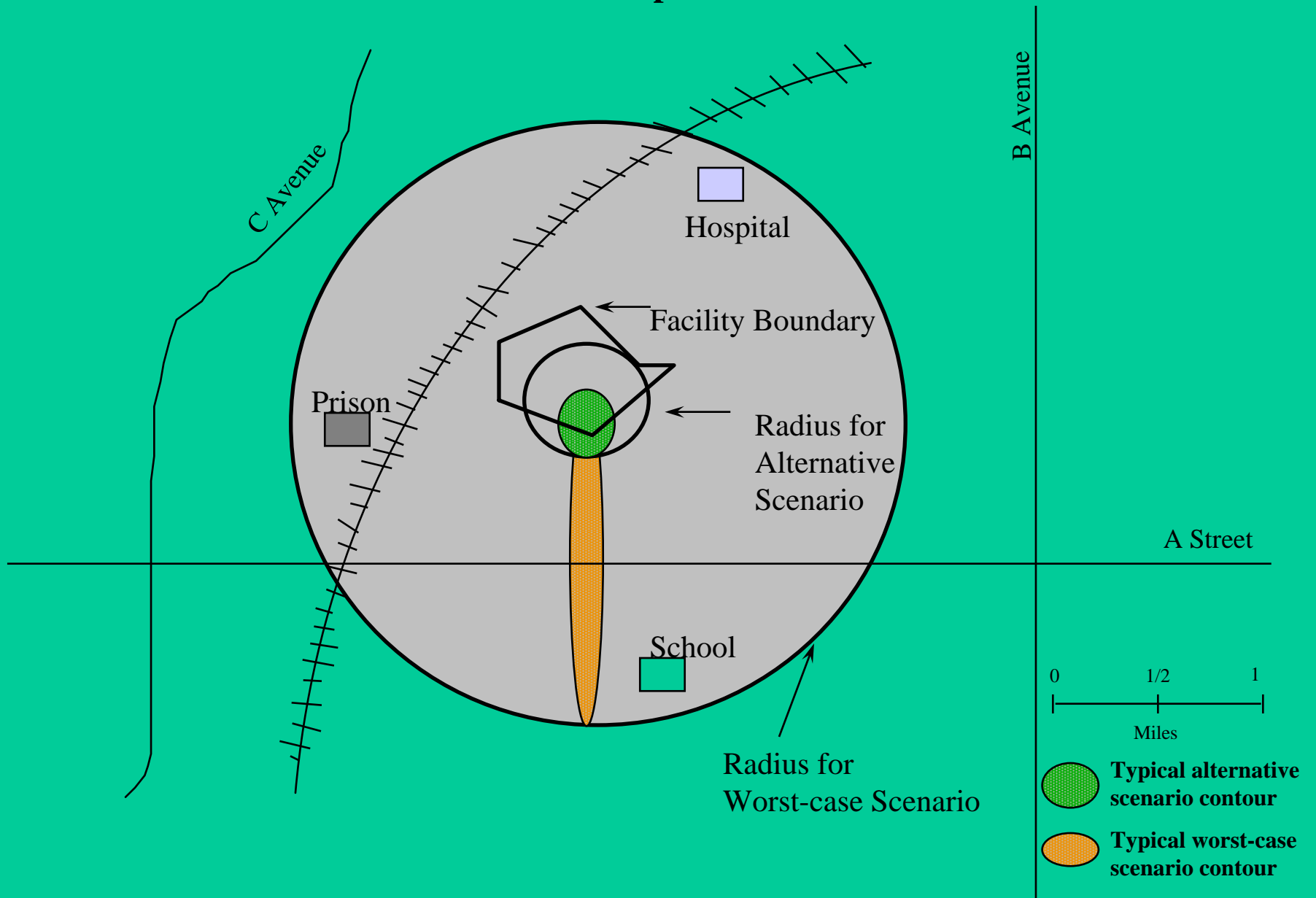
- Hazard assessment
 - analyze worst-case release scenarios
 - analyze alternative release scenarios
 - define offsite Impacts
 - complete five-year accident history
 - Management system
 - Emergency response program
 - Prevention program (PSM)
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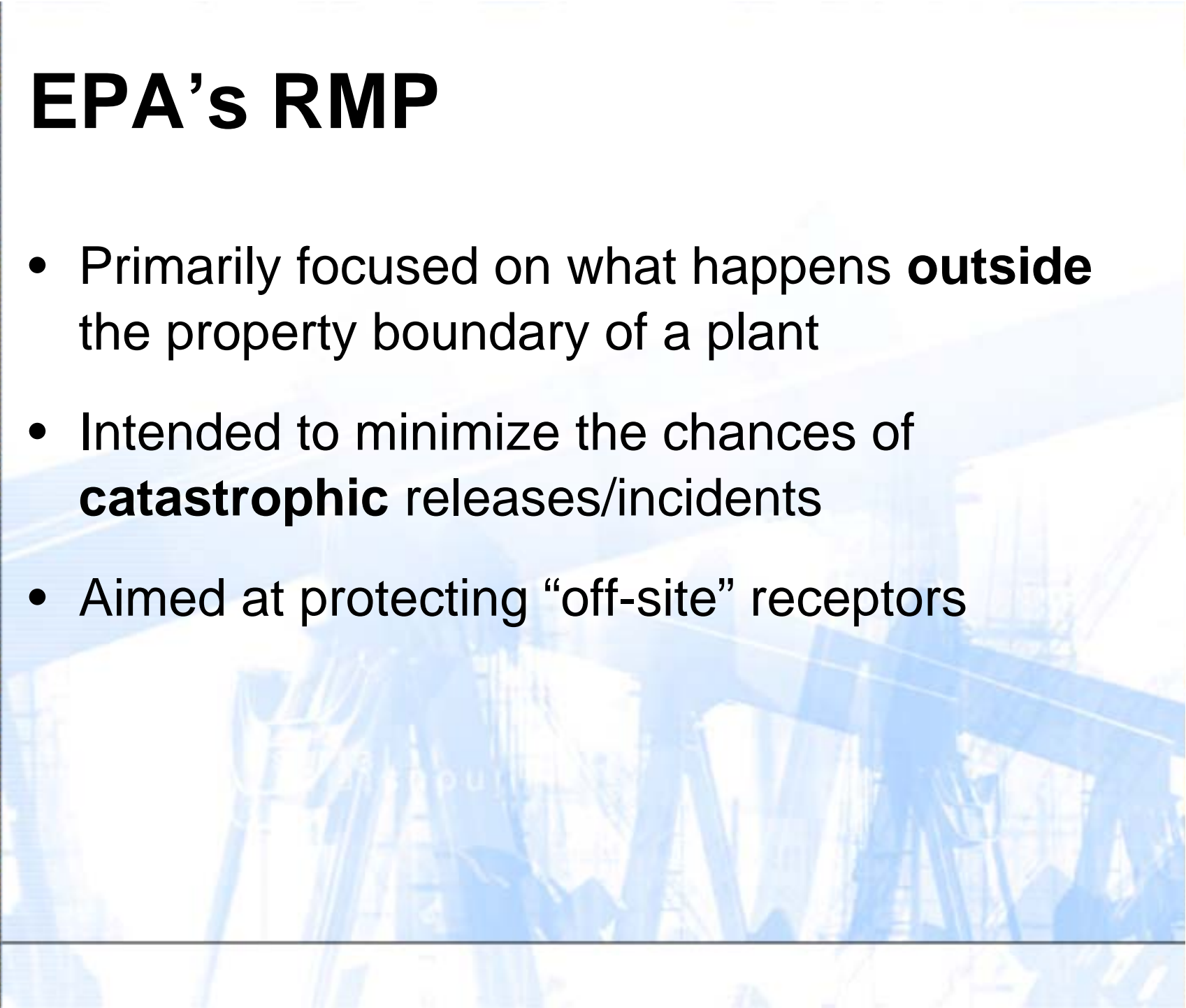
Figure 4-1 Simplified Presentation of Worst-Case and Alternative Scenario on a Local Map



Source: A. Santiago - EPA

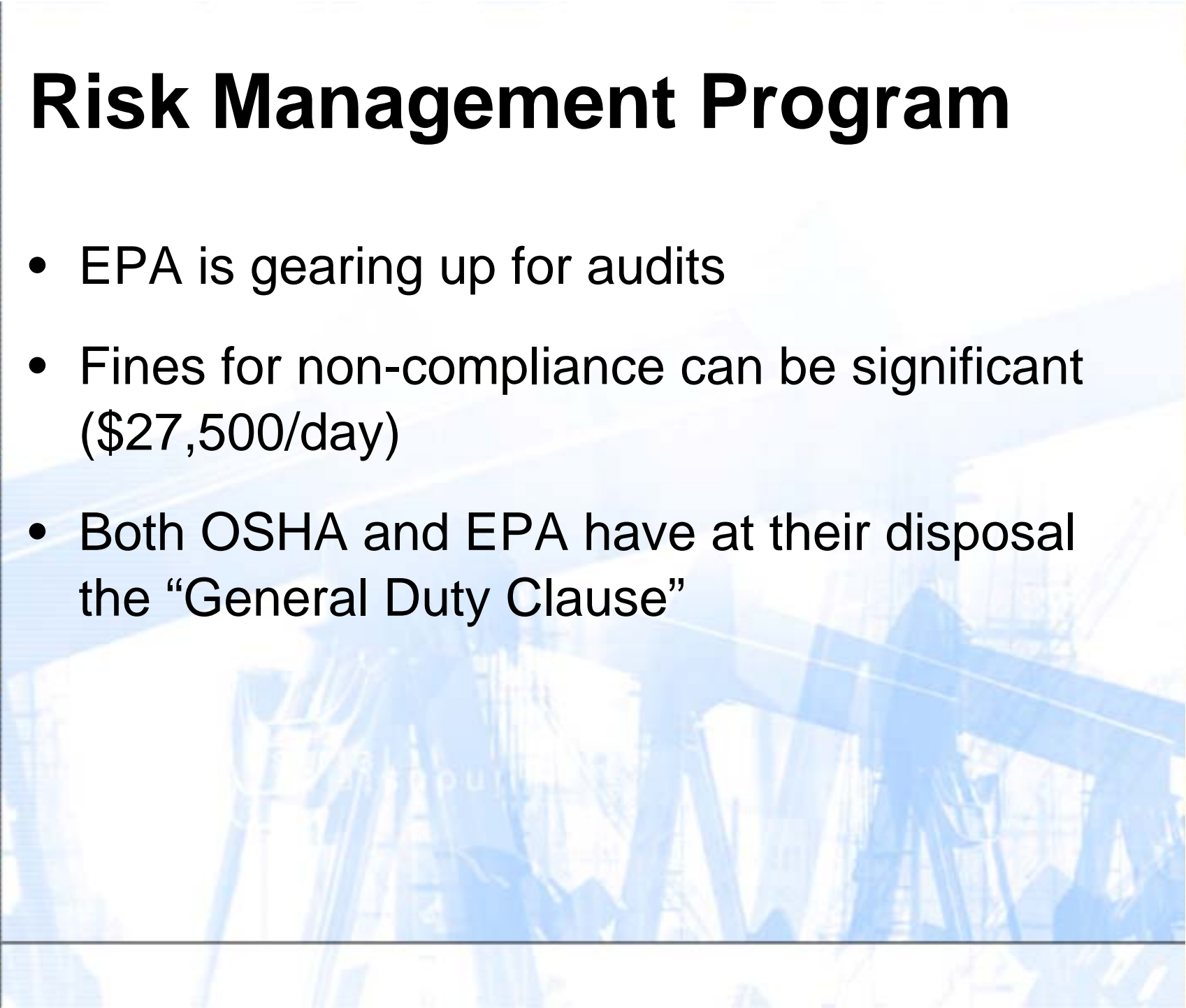


EPA's RMP

- Primarily focused on what happens **outside** the property boundary of a plant
 - Intended to minimize the chances of **catastrophic** releases/incidents
 - Aimed at protecting “off-site” receptors
- 



Risk Management Program

- EPA is gearing up for audits
 - Fines for non-compliance can be significant (\$27,500/day)
 - Both OSHA and EPA have at their disposal the “General Duty Clause”
- 



Other Issues

- **Counter terrorism**

- reduced information available to public
- heightened plant security
- addition risks under evaluation

- **Ammonia thefts**

- Methamphetamine market driving price of ammonia (\$300-\$500/lb)
- increased plant security
- some investigation into “designer ammonia”
- see new EPA bulletin: www.epa.gov/ceppo