Preventing Fires And Explosions In Pilot Plants And Laboratory Units

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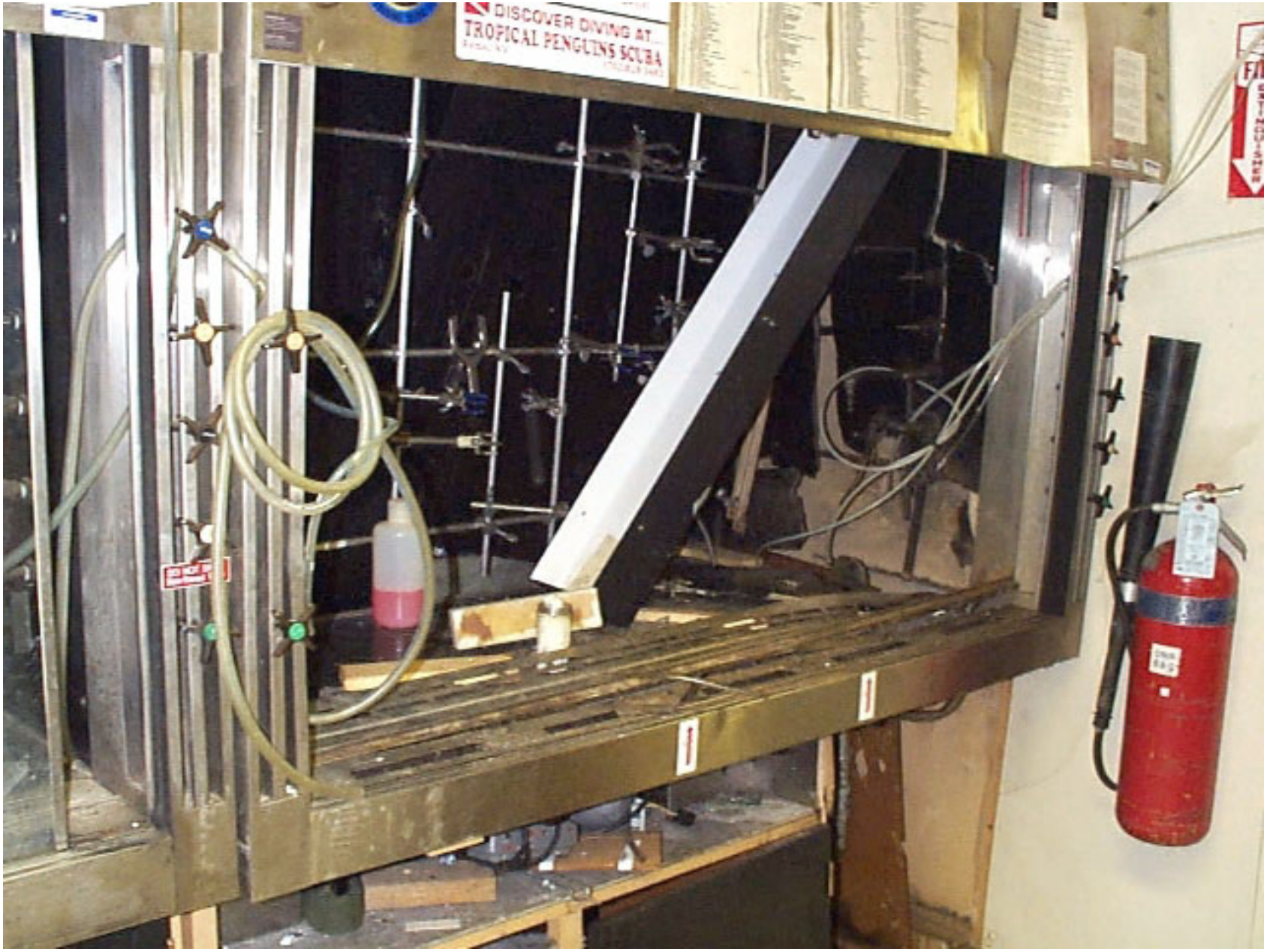
Introduction

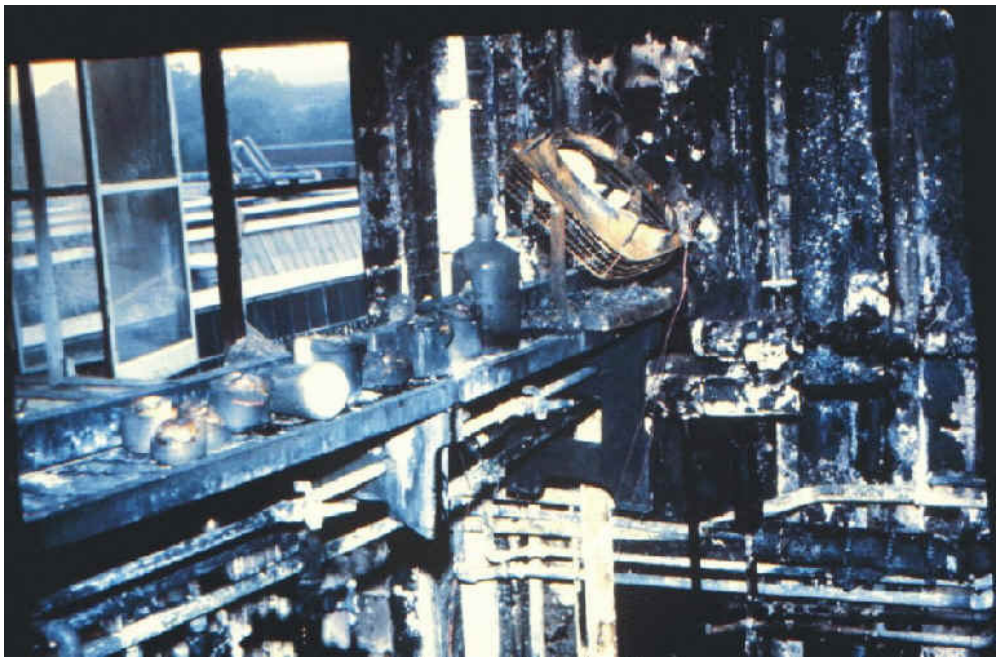
- Pilot plants and laboratory units in petrochemical service pose a special risk of fire and/or explosion
- Routine handling of significant volumes of flammable materials
- Frequent elevated temperatures and pressures
- Novel operations

Other Challenging Factors

- Exploratory nature of research
- Limited understanding of the chemistry
- Small size of the equipment
- Frequent need for unit modifications
- Need to ensure safety while still allowing research to continue


DISCOVER DIVING AT...
TROPICAL PENGUINS SCUBA

View of freezer in Room 803A source of explosion



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Comprehensive Approach Required

- No single activity can ensure safety
- Ensuring safety requires many complementary and overlapping programs
- This presentation will discuss some of ExxonMobil's key areas which have proved successful

Focus

- Design, construction and maintenance
- Numerous critical BBS and overall company safety programs and procedures also support and maintain a site wide safety culture

Major Areas

- Preconstruction safety reviews
- Research specific standards
- Leak tight design
- Proper construction
- Area electrical classification
- Ventilation
- Proper storage
- Proper maintenance
- Control of change procedure

Preconstruction Safety Reviews

- Key element in ensuring original design is safe
- Often preceded by other safety reviews for more hazardous operations
  - conceptual safety review(s)
  - preliminary safety review(s)

Comprehensive Review

- Reviews proposed design in complete detail
  - Piping
  - Wiring
  - Layout
  - Operation
- Identify potential hazards:

Equipment	Layout	Vessel design
Materials	Control systems	Leakage
Operations	Fire/explosion	Failure modes
	Etc.	

Assesses Proposed Design

- Assesses risks against a company wide matrix
- Recommends corrective actions where appropriate
- Recommends deviations and variances from approved standards/procedures where appropriate
- Approves proceeding to construction

Research Specific Standards

- Ongoing effort since 1960's
- Addresses research specific needs
- Over 60 standards currently exist
- New standards developed annually
- Existing standards continuously updated

Research Specific Standards (cont'd)

- Comprehensive review process across several different sites and organizations
- Standards include:
  - Prescriptive designs for common recurring needs
  - Performance requirements for varying needs
  - Risk assessment guidelines for special cases

Area Electrical Classification
Chemical Storage Cabinets
Compressed Gas Cylinder Location and Installation
Conduit Sealing Fittings
Decommissioning
Deviation Procedures
Electrical Furnace Installations
Electrical Heaters In Electrically Classified Areas
Electrically Heated Isothermal Sandbath Design
Emergency Showers and Eye Wash Fountains
Flow Limiting Devices
Gas Compressors
Gaskets
Hot Boxes for Compressed Gas Cylinders
Identification Of Pilot Plant and Laboratory Piping
Illumination Guidelines
Inert Atmosphere Dry Box (Glove Box) Installations
Insulation
Leak Testing
Location of Utility Branch Line Isolation Valves
Materials of Construction
Nonmetallic Tubing and Hoses
Over Temperature Protection
Piping (General, Gas, Liquid and Liquefied Gas)
Piping Inspection and Hydrostatic Testing
Potable/Process Water Segregation
Pressure Gauge Specification and Installation
Pressure Ratings of Common Fittings
Pressure Regulators
Pressure Relief Devices
Pressure Vessels
Protective Shielding Requirements
Pump Systems
Quick Disconnects
Reach Rod Design
Pressure Relief & Overpressure Protection
Rotameter Pressure Protection Systems
Safety Shut Down Systems
Sampling Systems
Sewer Systems
Steam Piping
Symbols For Use On P&ID’s
Vent Lines
Wet Meter Test Installation

Standard Compliance is Mandatory

- Rigorous deviation procedure
  - Engineering review
  - Safety standards committee recommendation
  - Site Standards Committee recommendation
  - Management approval
- Deviations are routinely approved but only after careful review ensures that adequate mitigating measures are in place

Leak Tight Design

- Specific designs with increasing levels of containment required for:
  - More hazardous materials
  - Multiple user systems
  - Higher risk designs
- Specific components and equipment or performance based specifications often mandated for most leak free operation

Continued Focus On Achieving Unit Integrity

- Pilot plant and laboratory start up and operations group to assist in initial start up as well as ongoing problems
  - Provides additional specialty skills, training and equipment to assist operators
- Specific leak test procedures covered in safety standards
  - Ensures safety and promotes efficiency

Proper Construction

- Significant effort in quality control including:
  - Uniform procedures
  - Site wide training
  - Proper design
  - Proper component selection
  - Proper installation
  - Ongoing construction supervision

Ongoing Effort

- Problems identified during start up are addressed through:
  - Revised standards;
  - Modified designs;
  - Improved training; and/or
  - Appropriate communications
- Considerable effort devoted to ensuring new tools, techniques and training are identified and deployed properly.

Area Electrical Classification

- Detailed site standards for area electrical classification of all research areas
  - Pilot plant areas
  - Engine test cells
  - Containment cells
  - Laboratories
  - Hoods
- Detailed drawings indicating the area electrical classification of all areas are maintained and followed

Area Electrical Classification (cont'd)

- In general, Class I Division 2 construction is mandated
- Safety standards provide alternate designs for some special research needs intended to ensure meeting intent while allowing more flexibility

Examples

- Positive pressure enclosures
- General purpose construction for units with minimal inventories
- Ventilation barriers
- Equipment separation
- Barricades
- Special conditions and equipment

Area Electrical Classification (cont'd)

- Most hood interiors are electrically classified
  - Even with high ventilation rates, releases have been found to cause fires and explosions before dilution
- This increases construction cost and difficulty but has proven to significantly reduce the potential for fires and explosions

Experience Has Shown Area Electrical Classification:

- Minimizes the risk of explosions
- Reduces the risk of fire usually to a minor hazard
- Can accommodate almost all research needs
- Can be done with minimal adverse operational impact with careful design

Ventilation

- All areas have strict ventilation standards
  - Pilot plant and engine test cells: CFM/square foot of floor area
  - Laboratories: Air changes/hour
  - Hoods: Face velocity
- Both high and low point ventilation is required for pilot plant areas
- Proper ventilation patterns are also mandated

Ventilation (cont'd)

- Smoke tests are often required
  - After new equipment is installed
  - In difficult to assess situations
  - As a final check
- Most areas are also continuously monitored for combustible and/or toxic materials
  - Typically inside the pilot plant area, engine test cell or laboratory
  - Typically outside the laboratory hood

Local Exhaust

- Local exhaust is provided extensively
- Common uses include:
  - Sampling
  - Filling
  - Draining and product collection
  - Areas of high leak potential
  - Components that need to be removed frequently
  - Components requiring frequent maintenance

Hoods

- Almost all laboratory units must be placed in a hood or ventilated enclosure
- These meet NFPA-45, ASHRAE 110 and AIHA Laboratory Ventilation requirements
- Site wide safety training addresses safe use and owner responsibilities
- Strong maintenance program ensures safe operation

Hoods (cont'd)

- Frequent surveys confirm proper use and operation
  - Allows identification and early correction of problems
- Latest focus is addressing over crowded hoods
  - Eliminating corresponding high turbulence and/or low draft areas

Appropriate Storage

- Hazardous materials must be stored properly
- Full compliance with NFPA-45 and local building/fire codes mandated
- Gas cylinders not allowed in laboratories and pilot plant areas
  - Stored outside or in separate cylinder storage areas
- Solvents stored in flammable storage cabinets whenever possible

Appropriate Storage (cont'd)

- Hoods not used for storage
- Quantities necessary for operations routinely challenged and reassessed

Proper Maintenance

- Routine maintenance of all common safety equipment and systems is an integral part of ExxonMobil procedures
- All safety systems must be checked on a basis determined during the design
- Strong work permit and lock/tag out programs

Site Wide Programs

- All relief devices are sized, issued from a central source and automatically checked
  - Interval varies with service from annually to every four years
- Regulators issued from a central source and also automatically inspected
  - Interval varies with service from annually to every four years
- All gas monitors calibrated quarterly
- No operator action required to initiate inspections

Control of change procedure

- Changes required for all modifications no matter how trivial
- Level of review varies with identified hazard and assessed risk
- Both procedural and operational controls in place to ensure all modifications are reviewed before work is started
- Safety system access for modification or disabling tightly controlled

Summary

- Preventing fire and explosions in a petrochemical research operation requires attention to numerous different areas
- Each area helps contribute to the overall safety of the research site
- The combination has helped ExxonMobil maintain a safe research environment