

**Codes and Standards and AHJs –  
Engineers, Installers and Inspectors –  
Oh, My!**



by:

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**Agenda**

- AHJs
- Codes and Standards
- Interdependencies
- Goals
- Engineers, Installers & Inspectors
- Anatomy of a Failure
- Solutions

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**Who, or what, are the AHJs?**

"An organization, office or individual responsible for enforcing the requirements of a **code** or **standard**, or for approving equipment, materials, an installation or a procedure."

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### The Birth & Life of an AHJ

- Laws, ordinances
- Regulations
- Codes
- Standards
- Guides



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### Understanding Codes and Standards

- Construction, occupancy and use codes
  - Building Codes
  - Fire Prevention Codes

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### Understanding Codes and Standards

- System or application standards
  - NFPA 13
  - NFPA 20
  - NFPA 90A & B
  - NFPA 150
  - NFPA 909
  - NFPA 72      Is it a *Code* or a *Standard*?

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### Understanding Codes and Standards

- Product standards
  - UL
  - FM
  - ISO



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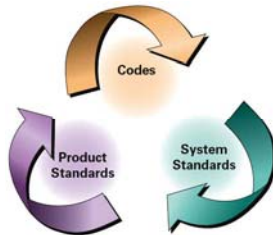
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### Understanding Codes and Standards Interdependencies



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### Understanding Codes and Standards Expectations

- Smoke detection
- Sprinkler systems
- Audibility
- Strobe lights



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### How is fire safety achieved?

- NFPA 550, *Guide to the Fire Safety Concepts Tree*

⊕ OR gate – probabilities are summed

⊗ AND gate – probabilities are multiplied

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### How is fire safety achieved?

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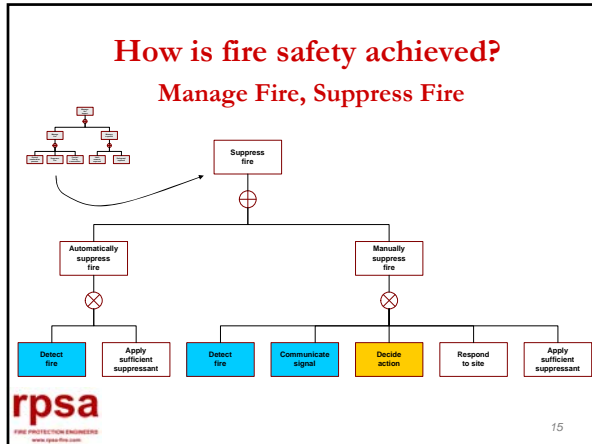
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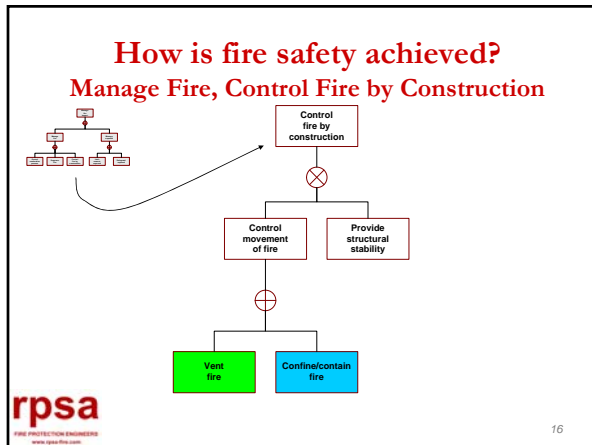
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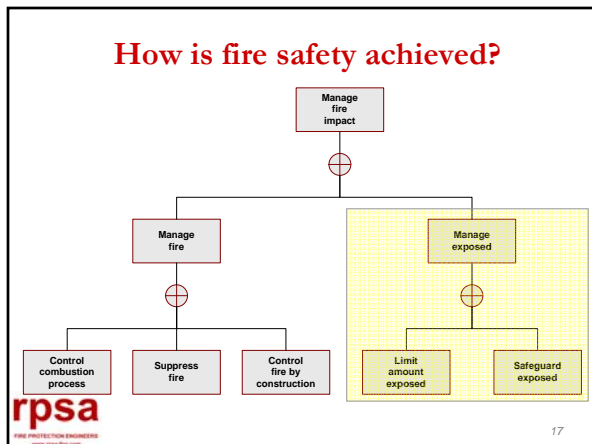
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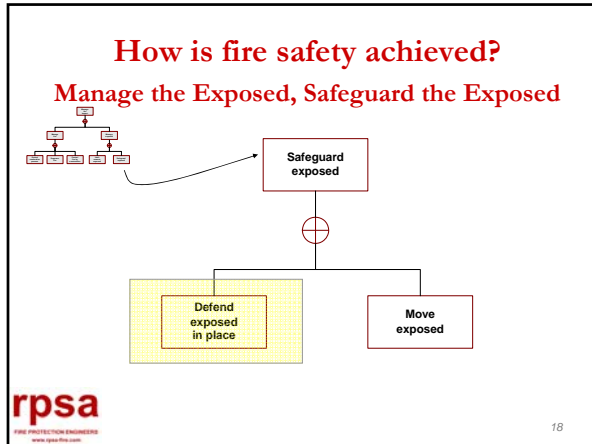
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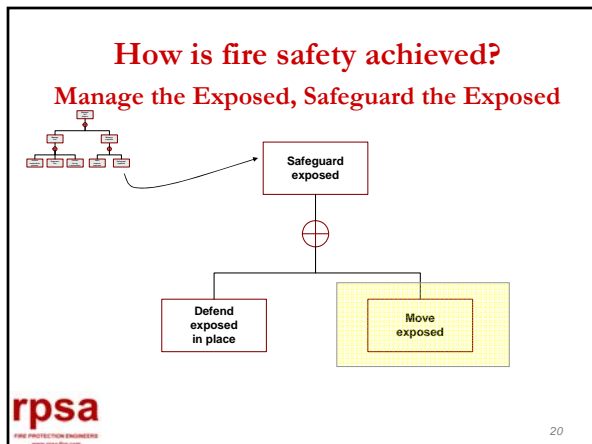
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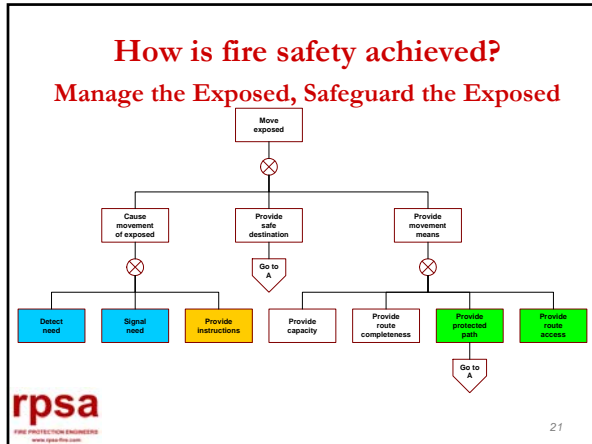
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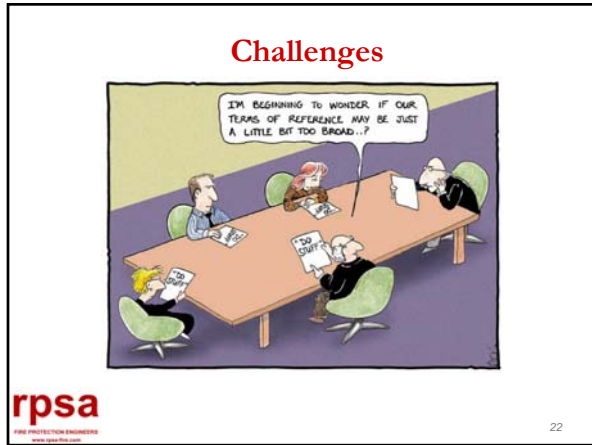
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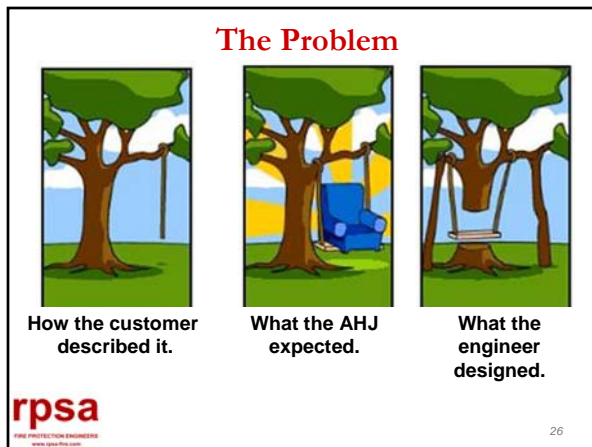
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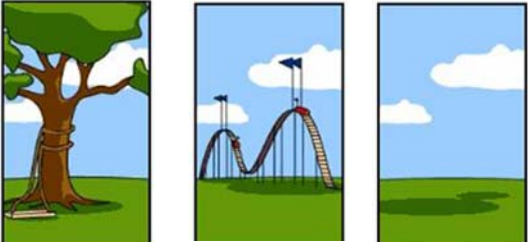
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### The Problem



The first panel shows a tree with a rope tied around its trunk. The second panel shows a roller coaster track with a car at the top of a loop. The third panel shows a flat landscape with a single tree in the distance.

What was installed.      How the customer was billed.      The as-built drawings.

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### Potential for Disaster



An aerial photograph showing a railway track cutting through a grassy field. A large pile of brown debris, possibly a derailed train or a collapsed structure, is visible on the left side of the track.

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### Anatomy of a Failure



A 3D CAD model of industrial machinery. It features a large green cylindrical tank on the left, a blue frame structure in the center, and various pipes and components on the right. A person is shown inside the blue structure, possibly for scale or to indicate a point of failure.

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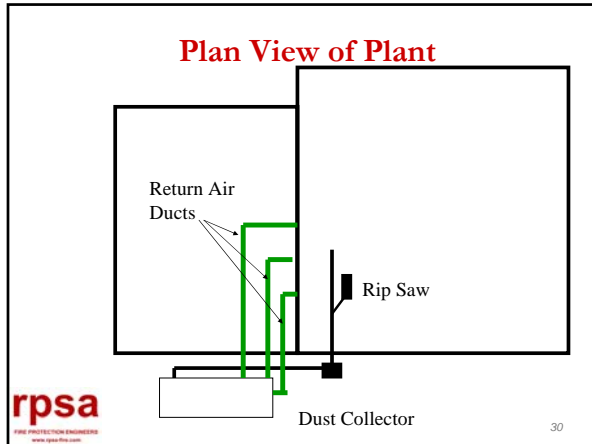
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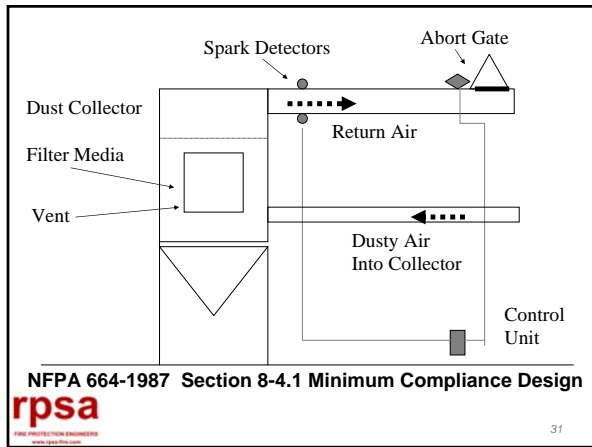
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- ### The Design
- Spark detection (inlet)
    - Water spray (inlet)
  - Differential temperature sensing (bag house inlet vs. outlet)
    - Shut down fans
  - Heat detection in bag house
    - High-rate discharge Halon 1301

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**The Design**

- Sprinklers (plenum of filter house)
- Explosion (pressure) relief doors
- Pressure sensors (outlet)
  - Fan shutdown
- Pressure sensors (outlet)
  - Halon deflagration suppression (In lieu of spark detection and abort dampers on outlet)

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**Process and Progress of the Fire**

- The fire and deflagration
- Individual system operation (or NOT)
- System interactions

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**Process and Progress of the Fire**

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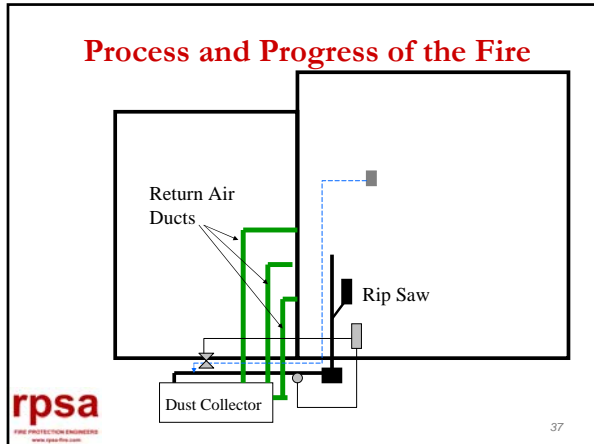
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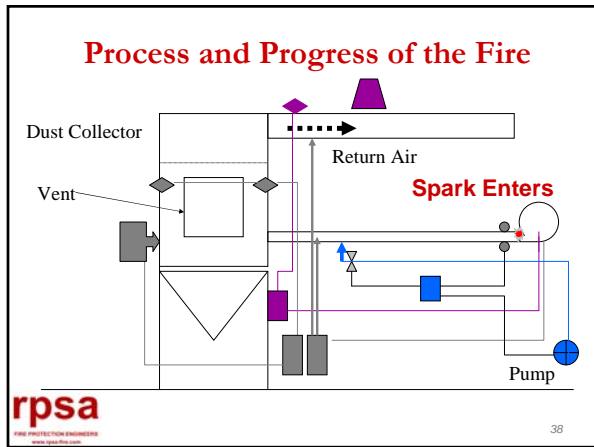
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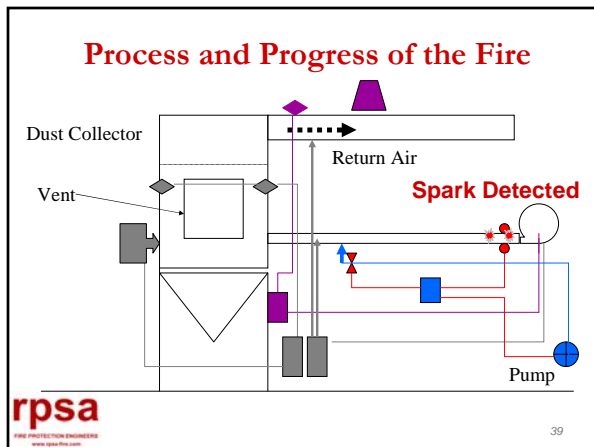
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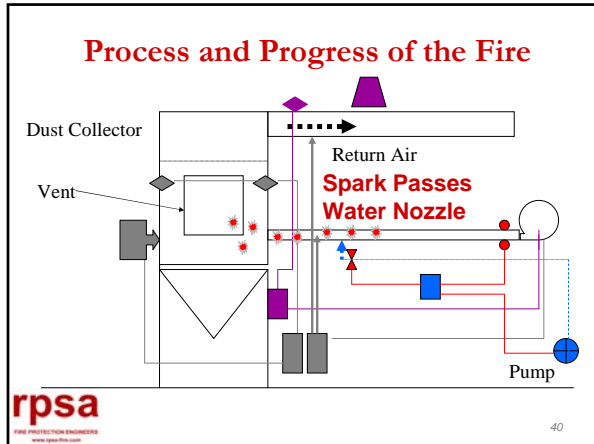
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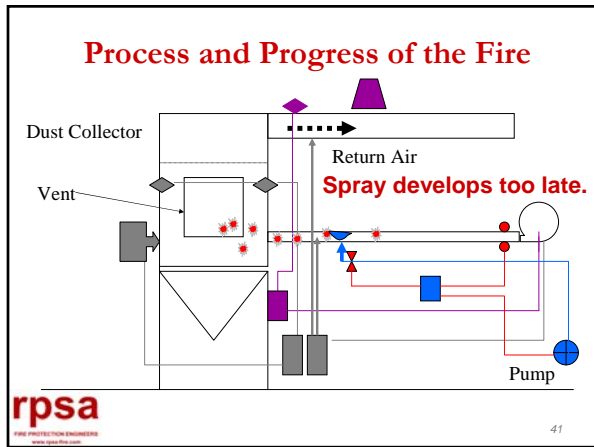
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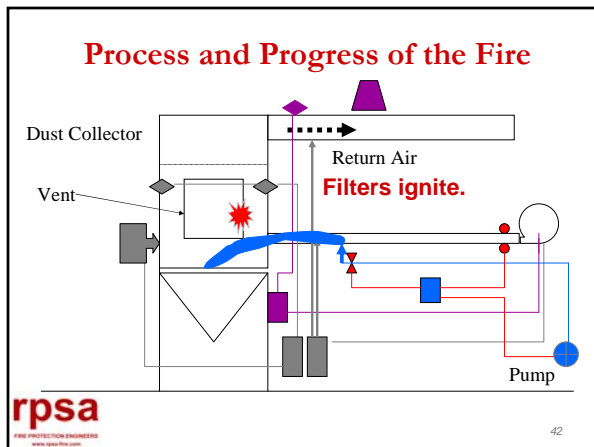
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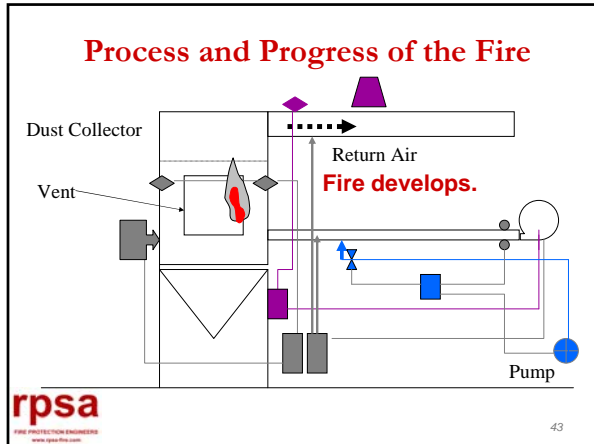
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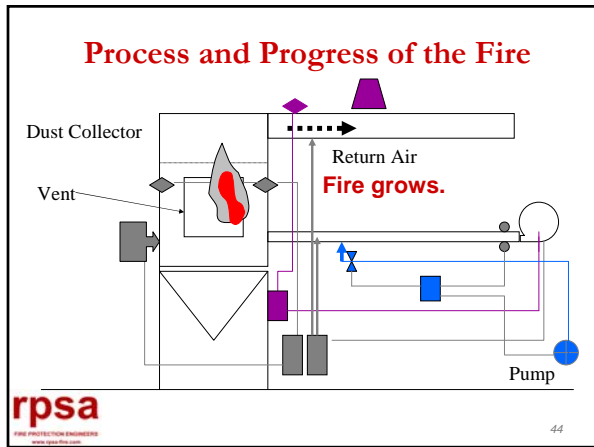
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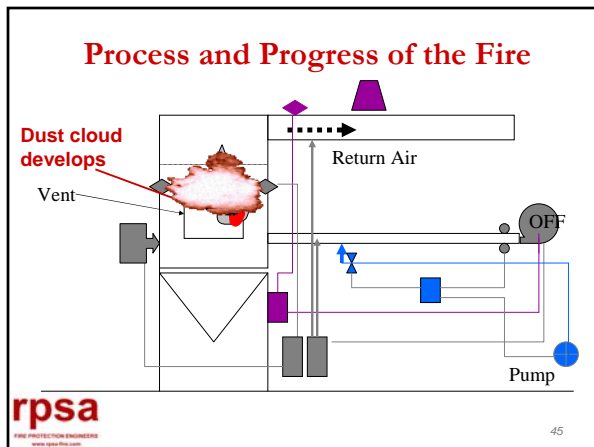
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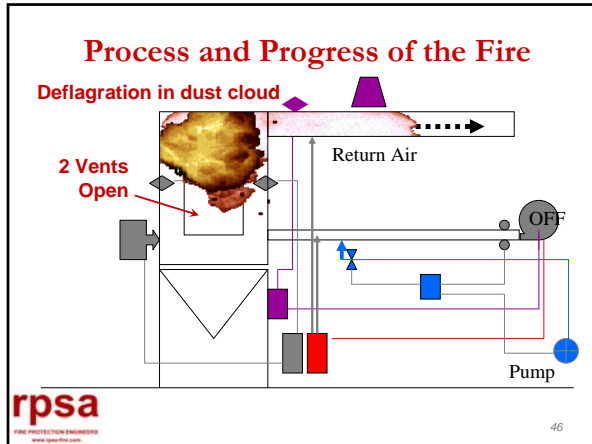
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- ### Process and Progress of the Fire
- Explosion relief reduces net pressure
  - Pressure sensor for fan shut-down does not operate
  - Pressure actuated Halon isolation units fail to operate
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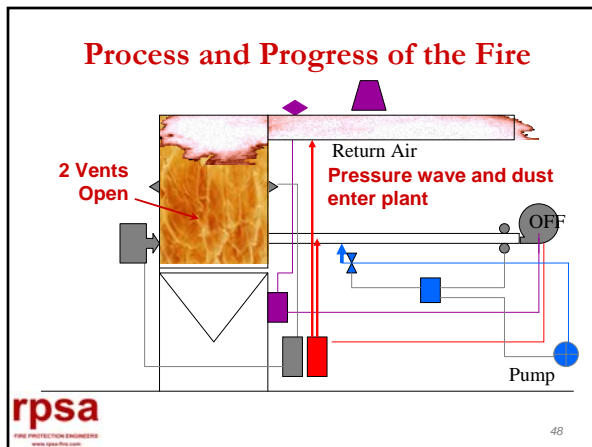
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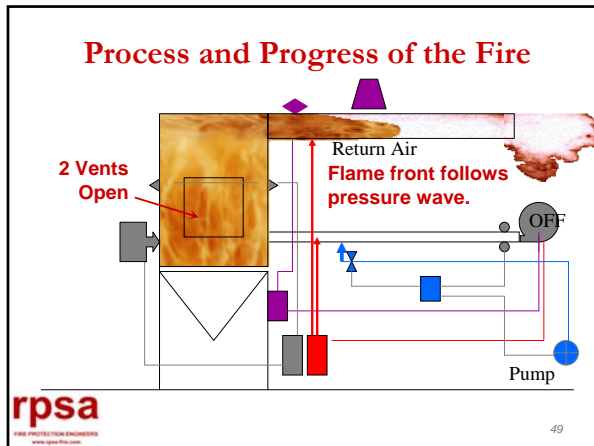
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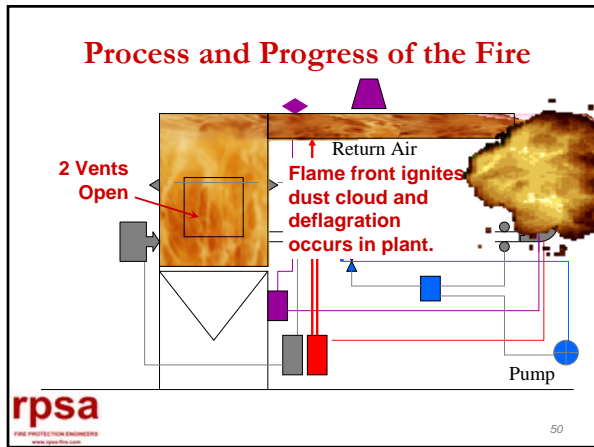
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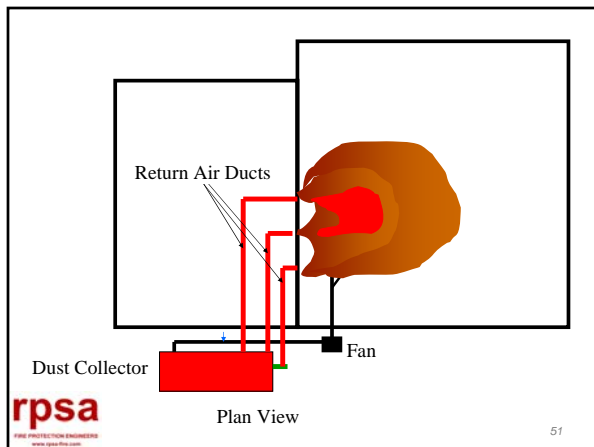
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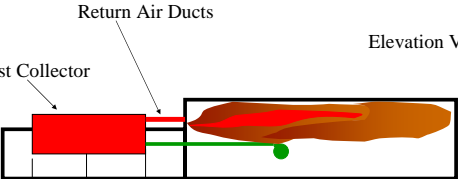
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### Process and Progress of the Fire

Return Air Ducts  
Dust Collector  
Elevation View



- Large mass of super-heated combustion products
- Radiant flux ignites secondary fires
- 268 Sprinklers open within seconds

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### The Design: Spark Detection & Water Spray

- Failure to engineer:
  - No expansion tank was provided
  - No alarm upon flow or water
  - The incorrect air velocity may have been used to calculate travel distance from the detectors to the nozzle

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### The Design: Spark Detection & Water Spray

- Installation failure:
  - The minimum distance between nozzle/valve and detector was not observed

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**The Design:  
Differential Temperature Sensor**

- Failure to engineer:
  - Air flow rate vs. heat release rate
  - Effect of loss of air flow

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**The Design: Heat Detection**

- Failure to engineer:
  - Temperature rating too high
  - Insufficient quantity of heat detectors
  - Effects of airflow not considered
- Installation failure
  - Location of heat detectors

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**The Design:  
Halon 1301 Suppression**

- Engineering failure:
  - Insufficient quantity of agent for volume
- Failure to engineer:
  - Failed to consider air flow dilution

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**The Design:  
Filter House Explosion Relief**

- Maintenance failure
  - Doors used for cleaning access
  - Shear bars must be pre-tensioned (torqued)

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**The Design:  
Pressure Detectors / Fan Shutdown**

- Failure to engineer
  - Failure to consider effect of fan shutdown
  - Failure to consider the lowest possible pressure during an event

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**The Design:  
Halon 1301 Flame Front Suppression**

- Engineering failure:
  - Insufficient quantity of agent
  - If it works, it only suppresses the flame front
  - Does not divert pressure wave from the plant

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**Anatomy of a Loss**

- Engineering failure:
  - Individual systems failed to perform as designed
- Compliance with minimum requirements of NFPA 664 would have prevented in-plant damages.



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**Anatomy of a Loss**

- Failure to engineer:
  - Individual protection methods were not coordinated
  - Systems interfered with each other
  - Some design elements may have directly contributed to the loss



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**Potential for Disaster Realized**

- Contractor acted as engineer
- AHJ did incomplete review
- Installers failed to follow instructions
- Owner failed with maintenance



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### Problems and Solutions

- We are all part of the problem
- We are all part of the solution

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### Problems and Solutions: Contractor / AHJ Eye Test

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|-----|-----|----|-----|-----|----|
| 15  | 110 | 30 | 60  | 135 | 90 |
| 110 | 30  | 60 | 15  | 110 | 90 |
| 15  | 75  | 90 | 135 | 110 | 60 |
| 60  | 110 | 75 | 90  | 15  | 40 |
| 60  | 110 | 30 | 60  | 15  | 75 |

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### The Life of a Fire Alarm System

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### Stakeholders



|                             |
|-----------------------------|
| Architects                  |
| Engineers – Other           |
| Engineers – Fire Protection |
| Technicians – Installing    |
| AHJ - Plans Reviewers       |
| Manufacturers               |
| Distributors                |
| Technicians – ITM           |
| Owner                       |
| AHJ – Inspector             |
| Listing Agencies            |
| Insurance Companies         |

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### Success Requires a Partnership

|                             | Planning | Design | Review & Approval | Product Configuration | Installation | Inspection | Testing | Maintenance | Use |
|-----------------------------|----------|--------|-------------------|-----------------------|--------------|------------|---------|-------------|-----|
| Architects                  |          |        |                   |                       |              |            |         |             |     |
| Engineers – Other           |          |        |                   |                       |              |            |         |             |     |
| Engineers – Fire Protection |          |        |                   |                       |              |            |         |             |     |
| Technicians – Installing    |          |        |                   |                       |              |            |         |             |     |
| AHJ - Plans Reviewers       |          |        |                   |                       |              |            |         |             |     |
| Manufacturers               |          |        |                   |                       |              |            |         |             |     |
| Distributors                |          |        |                   |                       |              |            |         |             |     |
| Technicians – ITM           |          |        |                   |                       |              |            |         |             |     |
| Owner                       |          |        |                   |                       |              |            |         |             |     |
| AHJ – Inspector             |          |        |                   |                       |              |            |         |             |     |
| Listing Agencies            |          |        |                   |                       |              |            |         |             |     |
| Insurance Companies         |          |        |                   |                       |              |            |         |             |     |

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### Success Requires a Partnership

|                             | Planning | Design | Review & Approval | Product Configuration | Installation | Inspection | Testing | Maintenance | Use |
|-----------------------------|----------|--------|-------------------|-----------------------|--------------|------------|---------|-------------|-----|
| Architects                  | ●        | ●      | ●                 |                       | ●            |            |         |             |     |
| Engineers – Other           | ●        | ●      | ●                 |                       | ●            | ●          |         |             |     |
| Engineers – Fire Protection | ●        | ●      | ●                 | ●                     | ●            | ●          | ●       |             | ●   |
| Technicians – Installing    |          |        |                   | ●                     | ●            | ●          | ●       |             |     |
| AHJ - Plans Reviewers       | ●        | ●      | ●                 | ●                     | ●            | ●          | ●       |             |     |
| Manufacturers               |          | ●      | ●                 | ●                     | ●            | ●          | ●       |             |     |
| Distributors                |          | ●      | ●                 | ●                     | ●            | ●          | ●       |             |     |
| Technicians – ITM           |          |        | ●                 | ●                     | ●            | ●          | ●       |             |     |
| Owner                       | ●        | ●      | ●                 | ●                     | ●            | ●          | ●       |             |     |
| AHJ – Inspector             |          | ●      | ●                 | ●                     | ●            | ●          | ●       |             |     |
| Listing Agencies            | ●        | ●      | ●                 | ●                     | ●            | ●          | ●       |             |     |
| Insurance Companies         | ●        | ●      | ●                 | ●                     | ●            | ●          | ●       |             |     |

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**The Solution**



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