
  
**Taking Action**  
**Committed to Excellence**

---

**Korean Society of Environmental Health**  
**May 30, 2003**

**Two Unplanned Incidents**

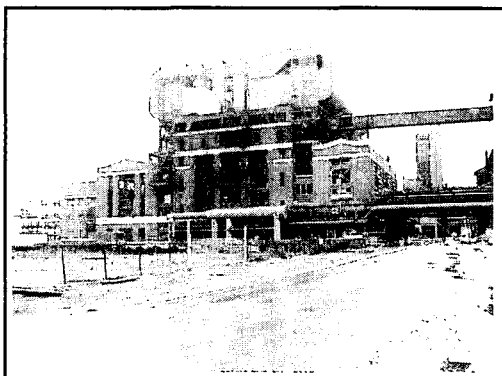
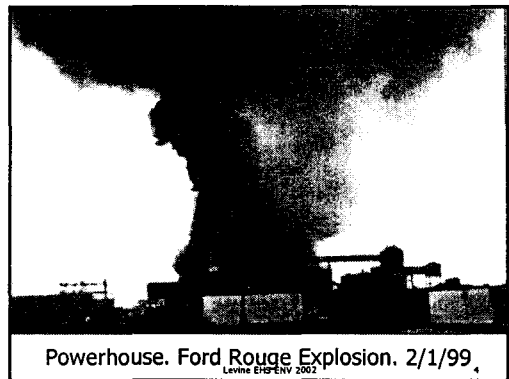
- Ford Rouge Steel – Dearborn, MI – February 1, 1999
- Pennzoil Products – Rouseville, PA – October 16, 1995
  
- Description of facilities, causes and effects

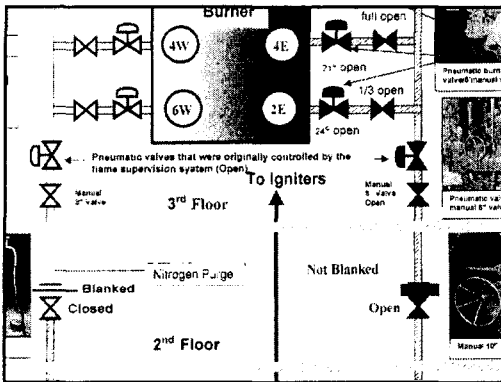
Steven P. Levine, Ph.D., CIH  
 Professor, Past-President, AIHA

**Ford-Rouge Module**

- Pictures of facility
- Process descriptions
- Sequence of events
- Audits: characteristics and results
- Pictures
- Financial impact

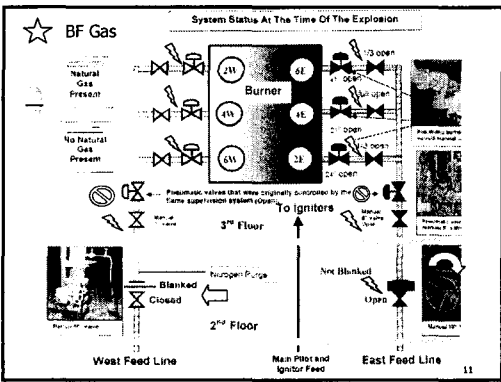
Levine EHS ENV 2002 3






### Sequence of Events 1999

- January 29: 1 of 2 blast furnace gas feed blanked
- (1000): Coal feeder shut off
- Feb 1 (1000): Second blast furnace feed line still not blanked
- (after 1000): Staff reports all natural gas lines closed; nitrogen purge started
- (just before 1300): "Someone left the valve open"
  - West gate valve closed with 50-60 ft-lbs of force
  - East gate valve required 230-240 ft-lbs – not possible to do
- (1300): Explosion



### ★ List of Findings

- **Flame detection controls defeated 1966**
- **Four consultant reports recommended FD controls be restored 1987-1998**
- **Nine insurance carrier reports made same recommendations 1990-1998**



## Findings

- **Pressure relief valves, electric spark igniters, low water alarms, blower interlocks, and all audible/visual alarms defeated or removed**
- **Coal dust buildup on shelves ignored**
- **No written SOP for shutting down**
- **No pre-job planning meeting**
- **No preventive maintenance program (no inspection and testing of valves, etc)**

Levine EHS ENV 2002 13

## Characteristics of an ideal audit

- **Establish and maintain documented procedures for planning and implementing internal audits.**
- **Schedule audits on the basis of risk severity and probability indices.**

Levine EHS ENV 2002 14


## Characteristics of an ideal audit

- **Plan and implement audits by personnel independent of those having direct responsibility for the audited activity.**
- **Implement audits by personnel specifically trained in auditing procedures, with witness signature by the responsible person.**

Levine EHS ENV 2002 15

## Characteristics of an ideal audit

- **Obtain worker input during audits, as appropriate.**
- **Record and communicate audit results to personnel having direct responsibility for the audited activity.**
- **Prioritize for corrective action deficiencies documented during the audit.**
- **Verify and record the implementation of the corrective action taken during follow-up audits.**



## #6 BOILER

**LOSS PREVENTION REPORT**  
BOILER/MAINTENANCE

Insured: Rough Neck Company Location: 801 Miller Road Duxbury, MA 01928 Contacted With: Sergei Rank Chief Engineer	Policy/Account Number: 98267001001 Company Code: 380 Date of Service: April 13, 1993 ESH Representative: David A. Sweeney Inspection ID: 01263
--------------------------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------

**EXECUTIVE SUMMARY**

The purpose of this visit was to conduct preventative inspection as required by law for owners of the State Certificate of Operation.

Serial No. M173736-4 was inspected visually and externally as required for renewal of the State Certificate of Operation.

The controls of the major critical load areas, and insulators were inspected. This inspection indicated several structural welds, girths, and surface were down piping, holes, tube ends, and support lugs. There was no scale, scale, excessive wear, blisters or visible distortion. The field-toe structural examination program appears effective.


The condition was inspected. This included examination of the generating tubes and water lines. The generating tubes showed no signs of erosion or cracking. The water lines showed no signs of flame penetration or visible deformation. All appeared to be in acceptable order.

The spall system and air-pressure were inspected. This includes examination of spall, insulation, gas baffles, and supports. There were no signs of excessive wear or distortion. The insulation and baffles appear to be in order.

The water storage discussed no evidence of low spots, overflows, or air leaks.

All personnel were very helpful and cooperative. The necessary signs has been returned to the International Bureau Directors to regular renewal of the Certificate of Operation.

EHS 10404/15/93 17



## Detroit Service Office The Hartford Steam Boiler Inspection and Insurance Co.

Levine EHS ENV 2002 18

All personnel were very helpful and cooperative. The necessary report has been submitted to the Jurisdictional Boiler Division to request renewal of the Certificate of Operation.

This inspection renewed the State Certification of Operation. There were no negative observations.

Levine EHS ENV 2002 19

**IRI** LOSS PREVENTION SURVEY  
CONFIDENTIAL

FORD MOTOR COMPANY ROUGE AREA (C)  
ROUGE STEEL COMPANY  
POWER & UTILITY OPERATIONS, POWERHOUSE NO. 1  
PULVERIZER BUILDING, 3001 MILLER ROAD  
DEARBORN, WAYNE CO., MI 48121

DATE: September 3, 1996  
BY: Tim Sullivan  
LOC ID: 809533/809533-C

Levine EHS ENV 2002 20

**IRI** LOSS PREVENTION SURVEY  
CONFIDENTIAL

FORD MOTOR COMPANY ROUGE AREA (C)  
POWER & UTILITY OPERATIONS, POWERHOUSE NO. 1 & PULVERIZER BUILDING  
3001 MILLER ROAD  
DEARBORN, WAYNE CO., MI 48121

DATE: March 4, 1997  
BY: R. A. Schulz  
LOC ID: 809533/809533-C

Levine EHS ENV 2002 21

**IRI** LOSS PREVENTION SURVEY  
CONFIDENTIAL

FORD MOTOR COMPANY ROUGE AREA (C)  
POWER & UTILITY OPERATIONS, POWERHOUSE NO. 1 & PULVERIZER BUILDING  
3001 MILLER ROAD  
DEARBORN, WAYNE CO., MI 48121

DATE: March 17-20, 1997  
BY: R. A. Schulz  
LOC ID: 809533/809533-C

Levine EHS ENV 2002 22

FORD MOTOR COMPANY BUSINESS CONFIDENTIAL

FORD MOTOR COMPANY Page 5 of 8  
809533/809533-C

96-1 COMBUSTION CONTROLS: Equip the seven blast furnace gas and natural gas-fired boilers, located in Power House No. 1, with the following devices: (Note: Boiler Nos. 2, 4 and 6 normally run on blast furnace gas; Nos. 1, 3, 5 and 7 are normally on coal or natural gas. Updated combustion controls are needed on all blast furnace and natural gas lines (including pilot lines) which are 400,000 btu/hr or greater. PLANS\*\*

- High and low gas pressure switches.
- Flame failure supervision.
- Interrupted proven gas pilot.
- Two safety shut-off valves on the main gas line.
- A normally open solenoid valve on a vent line piped to outside atmosphere and located between the two safety shut-off valves on the main gas supply line.

NOTE: Additional details and specific requirements can be determined by consultation with the IRI's Detroit District Office.

COMMENTS: Estimates for updating of combustion controls were obtained and found to be cost prohibitive due to the age of these boilers. There are no plans to comply.

COMBUSTION CONTROLS: Equip the seven blast furnace gas and natural gas boilers, located in Power House No. 1, with the following devices: (Note: Nos. 2, 4 and 6 normally run on blast furnace gas; Nos. 1, 3, 5 and 7 are normally on coal or natural gas. Updated combustion controls are needed on all blast furnace and natural gas pilot lines) which are 400,000 btu/hr or greater. PLANS\*\*

- High and low gas pressure switches.
- Flame failure supervision.
- Interrupted proven gas pilot.
- Two safety shut-off valves on the main gas line.
- A normally open solenoid valve on a vent line piped to outside atmosphere between the two safety shut-off valves on the main gas supply line.

NOTE: Additional details and specific requirements can be determined by consultation with the IRI's Detroit District Office.

- a. High and low gas pressure switches.
- b. Flame failure supervision.
- c. Interrupted proven gas pilot.
- d. Two safety shut-off valves on the main gas line.
- e. A normally open solenoid valve on a vent line piped to outside atmosphere and located between the two safety shut-off valves on the main gas supply line.

NOTE: Additional details and specific requirements can be determined by consultation with the IRI's Detroit District Office.


COMMENTS: Estimates for updating of combustion controls were obtained and found to be cost prohibitive due to the age of these boilers. There are no plans to comply.

---

Levine EHS ENV 2002 25

### Lesson learned

- The mechanical process problem that was the physical root cause of this disaster had been first reported in 1987, and was reported again each year from 1990 - 1998.




Levine EHS ENV 2002 26

**OVERALL RATING AS AN IRI RISK: Fair.**

---

Lesson Learned: The insurance company identified this facility as a "fair" risk. Presumably the insurance premium rates were increased in response to this finding. The cost of necessary repairs was apparently greater than the increased insurance cost.

Levine EHS ENV 2002 27



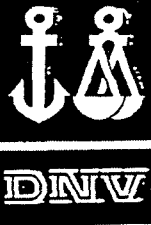
### LOSS CONTROL MANAGEMENT EVALUATION REPORT

PREPARED FOR: FORD MOTOR COMPANY  
Power & Utilities Operations

PREPARED BY: Andrew Wilson

DATE OF ASSESSMENT: December 8-12, 1997

28



The "Confidential" stamp is not meaningful. Anything you do should be assumed to be public knowledge.

Levine EHS ENV 2002 29

### Requirements to correct deficiencies

Each manager's individual responsibilities within the safety and loss control program should be defined in written list of accountabilities.

It is suggested that a safety and health committee be reestablished to provide interaction between management and employees on the identification, evaluation and control of loss exposures.

Levine EHS ENV 2002 30

**Requirements to correct deficiencies**

An inspection follow-up system should be developed to ensure that remedial actions are completed, provide adequate control of the risk and have no undesired side effects. The new follow-up procedure should answer the questions of *who*, *does what*, *when* or how often.

Levine EHS ENV 2002 31

**Requirements to correct deficiencies**

A written lock-out plan should be developed for Power & Utilities Operations.

In the DNV Audit System, there are Points required to reach Levels of achievement. But, there are no single items that indicate that catastrophe may occur and "points" no longer matter. The next few slide illustrate this.

Levine EHS ENV 2002 32

**DNV Level 5 Requirements**

1. Leadership and Administration
3. Inspections & Maintenance
5. Accident & Incident Investigation
8. Rules & Work Permits
11. PPE
12. Health & Hygiene Control

- Minimum score allowed on any element: 20%
- Minimum average score for Level 5: 40%

Levine EHS ENV 2002 33

**Actual scores on required elements**

1. Leadership and Administration	35%
3. Inspections & Maintenance	40%
5. Accident & Incident Investigation	28%
8. Rules & Work Permits	30%
11. PPE	71%
12. Health & Hygiene Control	44%
*15* Personal Communication	58%
*18* Hiring & Placement	67%
*21* Ergonomics	26%
*22* NJCHS Requirements	87%

**Actual scores on optional elements**

■ Leadership Training	56%
■ Job Safety Analysis Procedures	"0"
■ Job Observation	"0"
■ Emergency Preparedness	55%
■ Accident/Incident Analysis	18%
■ Knowledge & Skill Training	12%
■ System Evaluation	*"0"*
■ Engineering & Change Management	9%
■ Group Communication	10%
■ General Promotion	13%
■ Material & Services Management	36%
■ Off-the-Job Safety	7%

**Element 13: System Evaluation** FORD MOTOR COMPANY  
BUSINESS CONFIDENTIAL

<small>SUBELEMENTS</small>	<small>POSSIBLE POINTS/POINTS SCORED</small>	
13.1 Assessment of Safety/Loss Control Requirements	150.0	0.0
13.2 Regular System Monitoring	270.0	0.0
13.3 Evaluation of Compliance with Safety/Loss Control System Standards	155.0	0.0
13.4 Perception Surveys	100.0	0.0
13.5 Recordkeeping	23.0	0.0
<b>Total Possible Score</b>	<b>700.0</b>	<b>0.0</b>
<b>Element Percentage</b>	<b>0.0%</b>	<b>0</b>

DNV audit has ten levels. System Evaluation not required until Level 10. This facility was evaluated at Level 5. Nonetheless, there was "no measurable activity" in these subjects.

Levine EHS ENV 2002 36

Element 13: System Evaluation		FORD MOTOR CO BUSINESS CONFIDENTIAL	
ITEMS	POSSIBLE POINTS	POINTS	SCORE
Assessment of Safety/Loss Control Requirements	150.0		0.0
Regular System Monitoring	270.0		0.0
Evaluation of Compliance with Safety/Loss Control System Standards	155.0		0.0
Perception Surveys	100.0		0.0
Recordkeeping	25.0		0.0
<b>Total Possible Score</b>	<b>700.0</b>		<b>0.0</b>
<b>Element Percentage</b>	<b>0.0%</b>		<b>0</b>

Lesson Learned: Level 5 numbers were achieved, but conditions for catastrophe existed and were identified.

Levine EHS ENV 2002 37

PART 2 SAFETY AND HEALTH ASSESSMENT REVIEW PROCESS CONDITIONS EVALUATION			
CATEGORY		NUMBER CHECKED (C)	NUMBER SUBSTANDARD (S)
<b>A. GENERAL WORKPLACE CONDITIONS</b>			
1. Floors (Slipping & Working Surfaces)		IIII IIII IIII IIII	IIII
2. Aisles and Passageways		IIII IIII	IIII
3. Permanent Platforms or Temporary Scaffolding		IIII	II
4. Ladders		IIII	II
5. Stairs		IIII	II
6. Exit/egress		IIII IIII IIII	IIII
7. Roadways		IIII IIII	IIII
TOTALS 'A'	C =	66	S = 16
<b>B. FACILITIES</b>			
8. Ventilation		IIII IIII	II
9. Lighting		IIII IIII IIII	IIII
10. Noise Exposure		IIII IIII	IIII
11. Human Engineering/Ergonomics		IIII IIII IIII II	II
TOTALS 'B'	C =	49	S = 11
<b>C. MATERIALS</b>			
12. Stacking and Storage		IIII IIII IIII	II
13. Flammable Handling		IIII IIII IIII	IIII
14. Compressed and Filled (Small Volume Containers)		IIII IIII IIII	IIII
15. Compressed Gas		IIII IIII	IIII
16. Waste Treatment		IIII IIII IIII	IIII
17. Waste Treatment		II	II
18. High-Pressure Storage Tanks		II	II
TOTALS 'C'	C =	63	S = 14

TOTALS 'A'	C =	66	S = 16
		IIII IIII	II
		IIII IIII IIII	IIII
		IIII IIII	IIII
		IIII IIII IIII II	II
TOTALS 'B'	C =	49	S = 11
		IIII IIII IIII	II
		IIII IIII IIII	IIII
		IIII IIII IIII	IIII
		IIII IIII IIII	IIII
		II	II
TOTALS 'C'	C =	63	S = 14

PART 2 SAFETY AND HEALTH ASSESSMENT REVIEW PROCESS CONDITIONS EVALUATION			
CATEGORY		NUMBER CHECKED (C)	NUMBER SUBSTANDARD (S)
<b>A. GENERAL WORKPLACE CONDITIONS</b>			
1. Floors (Slipping & Working Surfaces)		IIII IIII IIII IIII	IIII
2. Aisles and Passageways		IIII IIII	IIII
3. Permanent Platforms or Temporary Scaffolding		IIII	II
4. Ladders		IIII	II
5. Stairs		IIII	II
6. Exit/egress		IIII IIII IIII	IIII
7. Roadways		IIII IIII	IIII
TOTALS 'A'	C =	66	S = 16
<b>B. FACILITIES</b>			
8. Ventilation		IIII IIII	II
9. Lighting		IIII IIII IIII	IIII
10. Noise Exposure		IIII IIII	IIII
11. Human Engineering/Ergonomics		IIII IIII IIII II	II
TOTALS 'B'	C =	49	S = 11
<b>C. MATERIALS</b>			
12. Stacking and Storage		IIII IIII IIII	II
13. Flammable Handling		IIII IIII IIII	IIII
14. Compressed and Filled (Small Volume Containers)		IIII IIII IIII	IIII
15. Compressed Gas		IIII IIII	IIII
16. Waste Treatment		IIII IIII IIII	IIII
17. Waste Treatment		II	II
18. High-Pressure Storage Tanks		II	II
TOTALS 'C'	C =	63	S = 14

### So why didn't they just fix the place up?

- Roll the dice: Any number but 2 or 3 and you get a bonus for reducing costs and thereby increasing profits
- Roll a 2 or 3 (about 1 in 10 odds) and the place blows up. You get fired.
- Ford-Rouge went 11 years with those audit reports before the place blew up.

Levine EHS ENV 2002 41

### Lesson Learned

You will carry these decisions with you through your professional and personal life, and people will know.

(A reasonable alternate explanation is that these people did their best but were powerless to change decisions by the 6-man executive team.)

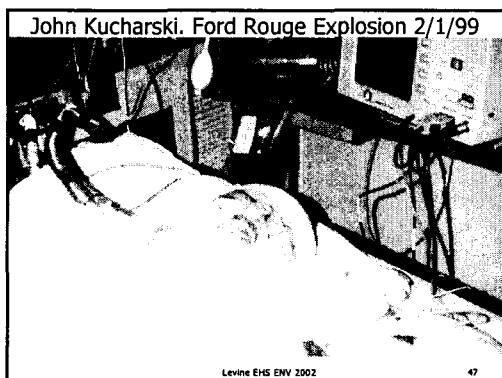
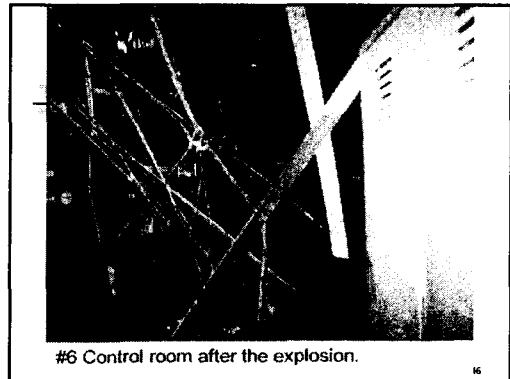
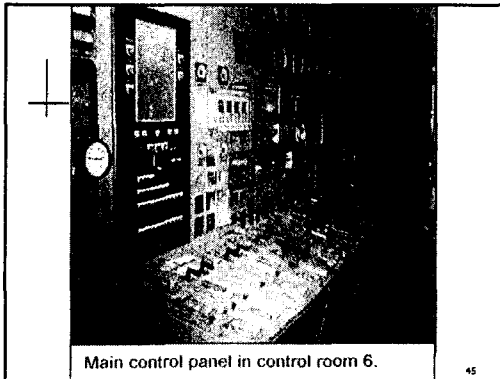
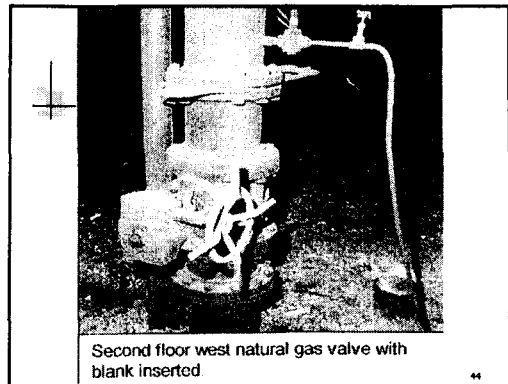
There is no gentle way to state this!

Levine EHS ENV 2002 42

**SATISFY** the headline test

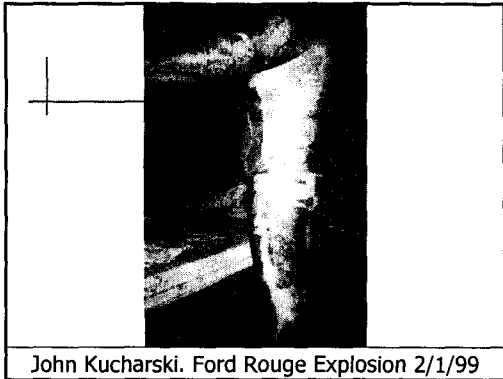
- Ask yourself if you'd feel comfortable seeing your action reported in the news
- Think about how your family and colleagues would feel about your decision
- Consider the consequences of your decision - on the company, on customers, on your family, on yourself

Levine EHS ENV 2002 43





Two Unplanned incidents in the United States



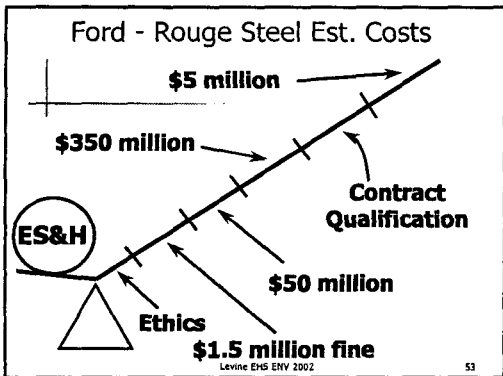
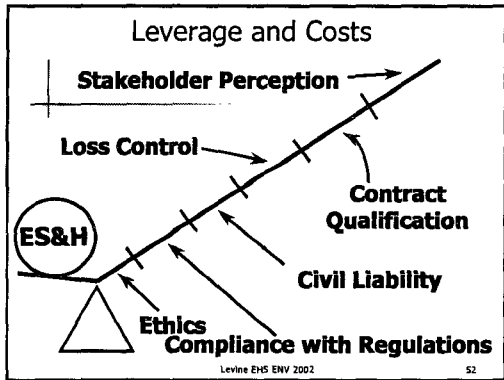
John Kucharski. Ford Rouge Explosion 2/1/99



John Kucharski. Ford Rouge Explosion 2/1/99



John Kucharski. Ford Rouge Explosion 2/1/99




**Rouge Steel's Insurers Sue Claim Ford negligent in deadly explosion**  
 Detroit Free Press 3/22/00 p. 2F

- Factory Mutual:
  - \$134 million suit (3/14/00)
- Five more insurers:
  - \$25 million suit (3/21/00)


Levine EHS ENV 2002 54

### Ford - Rouge Steel Plant

- Donald Harper, 58- pipefitter (0)
- Cody Boatwright, 51- welder (4)
- Warren Blow, 51- power service (11)
- Ken Anderson, 44- pipefitter (13)
- John Arseneau, 45- pipefitter (19)\*
- Ron Moritz, 46- supervisor (19)




Levine EHS ENV 2002 55



John Arseneau - April 15, 1953 - February 20, 1999

### Pennzoil Products Co. Rouseville, PA



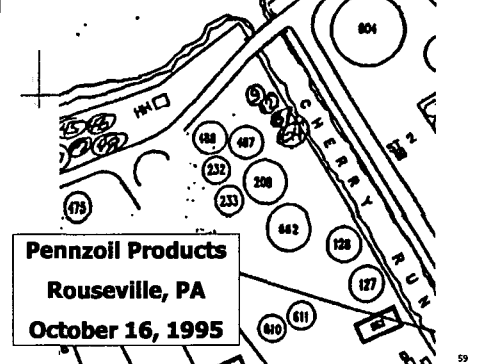
Front gate: process unit left; admin. bldg. right

Levine EHS ENV 2002 57

### Pennzoil Rouseville Module

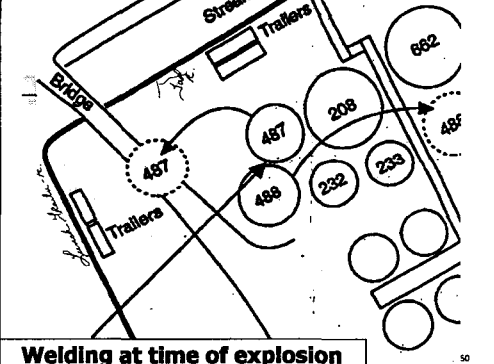
- Description of facility
- Pictures
- Root cause analysis
- Missing SOP's
- Role playing for students
- Discussion

Levine EHS ENV 2002 58



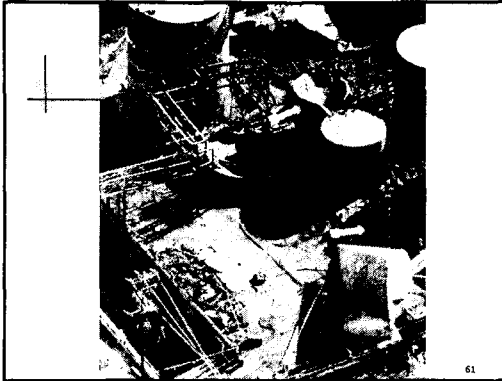
Pennzoil Products  
Rouseville, PA  
October 16, 1995

59



Welding at time of explosion

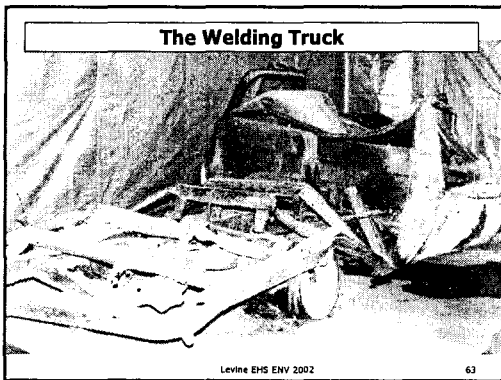
60



61



The process unit – explosion was behind this unit



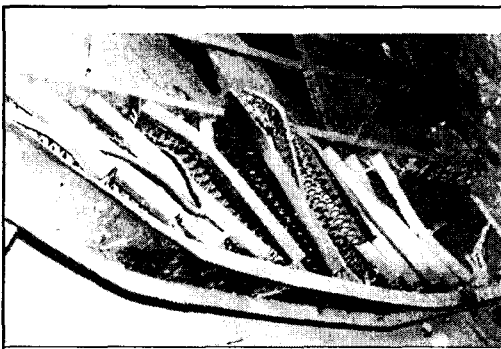
The Welding Truck

Levine EHS ENV 2002

63

### One of the deaths

- Mickey (Michelle - the welder) at the point of the explosion (deflagration):  
"She rode the flaming tank and stairs into the air and across the yard. It landed on top of the trailer and crushed two workers. She was on fire, and was flipped across the road where she was found later. She was still alive when she was taken to the hospital. She couldn't speak, but was awake. She died soon after reaching the hospital."



Stairs that the welder rode through the air to her death

### Investigation Reports

- OSHA Citation and Notification of Penalty. Inspection 122163967. October 17, 1995 – March 21, 1996. Citation Issued April 15, 1996, and related documents.
  - \$1.5 million penalty
- EPA Chemical Accident Investigation Report. EPA 550-R-98-001. Office of Solid Waste and Emergency Response (5104)

Levine EHS ENV 2002

66

### Root cause analysis 1

- A spill or leak of a flammable liquid or vapor from one of the tanks, cause unknown, was the initial event.
- It is clear that there is a striking, and at very least unfortunate deficiency in Pennzoil's procedures, documentation and system.

Levine EHS ENV 2002

67

### Root cause analysis 2

- The question of "was the hot work permit hazard analysis survey follow the protocol" is difficult to answer since there was no written protocol.
- It is clear that the very heavy workload of the safety staff may have been one of the root causes of this catastrophe (the role playing in a few minutes will illustrate this)

Levine EHS ENV 2002

68

**There were few, if any, standard operating procedures (SOP's) in place that covered the following subjects, and those that were there were neither followed nor documented:**

1. calibration of instruments
2. a sampling strategy
3. continuous or follow-up monitoring
4. training in instrument use

### Missing SOP's

5. development and documentation of SOP's
6. documentation of results
7. auditing of hot work permit procedures and results
8. communication between departments related to the content of tanks
9. tracking of denied permits

Levine EHS ENV 2002

70

- Tanks were old, rusted, had holes and weak welds, no venting, and failed at the bottom rather than venting properly or failing at the top.
- There is no evidence that Pennzoil management followed their own directive: "Management [will] ensure that safety procedures will be followed by all employees working on refinery property... [and] ensure that those who perform hot work and supervise are suitably trained in safe operations of their equipment and the process."

- There is no evidence that any of these components of certain appropriate API or CMA codes were known or instituted or, if instituted, were documented.
- There are two widely accepted truths in management: "what is not documented, has not been done" and "what is measured and rewarded gets done." There was little, if any, documentation.

Levine EHS ENV 2002

72

- **There was no safety audit system, no system to track denied hot work permits, no system to track and correct deficiencies.**
- **The egregious and almost complete lack of an operational Pennzoil safety management system is the true root cause of the disaster of October 16, 1995.**

Levine EHS ENV 2002

73

### Regulations and guidelines to prevent such disasters

- 29 CFR 1910.119: Process Safety Management (PSM) of Highly Hazardous Chemicals
- 57 FR 6356: PSM of Highly Hazardous Chemicals: Explosives and Blasting Agents, Final Rule
- 57 FR 38600 PSM of Highly Hazardous Chemicals: Compliance Guidelines and enforcement procedures
- 29 CFR 1910.252: General Requirements re: Subpart Q – Welding, Cutting and Brazing

- 55 FR 13694 re: Welding, Cutting and Brazing Final Rule – re-designation and other non-substantive revisions
- OSHA Directive CPL 2.35 CH-17 – Changes to Regulatory General Industry Standard Alleged Violation
- ANSI/NFPA 51B: Standard for Fire Prevention in Use of Cutting and Welding Processes (1994)
- ANSI/NFPA 306: Standard for the Control of Gas Hazards on Vessels (1997)
- API 2009: Safe Welding, Cutting, and Other Hot Work Practices in Refineries, Gas Plants, and Petrochemical Plants (Sixth Edition, September 1995)

Levine EHS ENV 2002

76

- 29 CFR 1910.146 App B: Procedures for Atmospheric Testing
- OSHA Technical Manual, Section II, Chapter 3: Technical Equipment
- CMA Responsible Care: Process Safety Code of Management Practices (October 1990)
- API 750: Management of Process Hazards (January 1990)
- ANSI/ASQ E4: Specifications and Guidelines for Quality Systems for Environmental Data Collection... (1994)

### Lessons learned

- Physical and managerial methods of prevention of such disasters is a well-known and commonly practiced science
- Regulations and voluntary standards are numerous
- There was no mystery or accident here

Levine EHS ENV 2002

77

### In class we do role playing

- **Safety Technician #1**
- **Safety Technician #2**
- **Safety Supervisor**
- **ESH Manager**
- **Seven Contractors' Work Crew Supervisors**
- **The time: 0630 AM**

Levine EHS ENV 2002

78

### In most accidents we find:

- Deviations from Approved Procedures
- Abuse of equipment
- Defeat of engineered safety features
- Insufficient maintenance frequency
- Failure to follow approved working conditions

Levine EHS ENV 2002

79

### We find:

- Education & Training Weak
  - Procedure unknown or forgotten
  - Rarely performed
  - Too Complex
  - Inadequate assessment of training needs

Levine EHS ENV 2002

80

### Solutions

- Near Misses as useful lessons
- Systematic Data Collection
- Avoid "shame & blame"
- Root cause not just physical cause
- Make changes
- Involve supervisors, manager, union representative

Levine EHS ENV 2002

81

### Solutions

- Better site management
  - Management responsibility, authority, and resources
- Better training
- Improved work practice
- Personal protective equipment

Levine EHS ENV 2002

82

### Quote from a Trauma Burn nurse

"If production is paramount and injury prevention is secondary you have a problem"

Levine EHS ENV 2002

83



Do you believe this?

### Pennzoil Rouseville Module

- Description of facility
- Pictures
- Root cause analysis
- Missing SOP's
- Role playing for students
- Discussion

Levine EHS ENV 2002

85

### Ford-Rouge Module

- Pictures of facility
- Process descriptions
- Sequence of events
- Audits: characteristics and results
- Pictures
- Financial impact

Levine EHS ENV 2002

86

### Summary

- **These are not accidents**
- **They are "unplanned incidents" that had multiple, obvious causes (both minor and egregious)**
- **Prevention would have involved no more than good safety and good management practices**
- **The outcome was predicable, and included loss of life, loss of production capacity, civil lawsuits, and OSHA citations.**