25 Real Life Hazards....... & WHAT TO DO ABOUT THEM! (Boilers, fuels, steam systems)

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Who is John Puskar, P.E.?

Licensed Professional Engineer
Practicing over 30 years
Founder – CEC Combustion Services
BSME, Mechanical Engineering, Youngstown State Univ., 1981
MBA, Weatherhead School of Mgt. Case Western Reserve Univ., 1985
Former/Member of NFPA 54, 56, 85, 86, 820, ASME CSD-1
Author and presenter of more than 50 papers.

Also, had some significant real life experiences on some very public projects and cases in more than a dozen countries.

www.PrescientTS.com
This presentation takes you through FINDING and then FIXING these HAZARDS.

Apollo Arez Furnace Explosion 10/18/2010

ConAgra Garner 2009 Nat.Gas Explosion, 4 dead

Kleen Energy 2010 Nat.Gas Explosion, 6 dead

17 dead in 3 Incidents I have had personal experience with.
We want to remove **HAZARD’s**:

1. **FIND**
2. Get people to care
3. **FIX**
   - Technical thing, pretty straight forward
   - People thing, brutal, culture change, someone will pay an emotional price

**Easy, lots of People can do this**
We will find and discuss 25 hazards!

People have told us about it our entire lives and many have experienced it!

Be aware if Involved!

Call this out If I see it!
25 hazards from 5 key groupings

- Being Aware
- Starting-up
- Gas Hazards
- Piping & Valves
- Hot Work
1. Not more than 2 (two) start-up attempts!
What happens when we hit the start button?
Gas gets released into firebox every time you hit the button.
Trials For Ignition – 10 seconds

Gas released for the pilot and for the main flame

Ignition should not take more than 2-3 seconds
If you did this a bunch of times and you did not get a good purge, it would accumulate!
Even with electric motors, starting them generates heat in the windings.
If you don’t let them cool after multiple trips the windings get damaged.

Motor Winding Damaged by Excessive Heat
2. Start-up Precautions

Start-up/shut down procedure CAUTIONS

Equipment Pre-Start Walk-Around

It is good practice to perform a walk-around of your equipment prior to start-up. This should especially be done after a unit has been down due to maintenance, repairs, or on extended down time. This walk-around should attempt to identify any deviations from normal operation/condition of the equipment. The following checklist should be used to identify these issues. Note: This checklist is not specific to any particular piece of fuel-fired equipment but should be used as a guideline only. Equipment specific walk-arounds should be generated for each piece of equipment.

A. Review control panel lights, markings, and internal wiring. Look for jumpers across terminals and relays that may be open/closed.
B. Review all safety interlock switch settings to make sure they appear reasonable; (as per marked settings).
C. Review all valves (manual gas cocks and safety shut-off valves) to make sure they are in the proper position prior to start-up (i.e. safety shut-off valve visual indication shows closed).
D. Review that all sensing lines to interlock switches, ratio regulators, and other devices are connected.
E. Review all firebox and/or entrance doors to combustion chamber or furnace/oven chamber to make sure all are latched properly.
F. Review fan dampers so that they are free to move and are not jammed. Check that all filters are unclogged and in place. Check fan blades and general fan condition. See if purge fans are moving air.
G. Review exhaust system fans, dampers, and related components.
H. Locate the termination of each vent/bleed line. Review for gas flow and inset/bird nests (or other type of blockage).
I. Check the time settings on all purge timers.
J. Do a no fuel ignition sequence if possible to see that BMS sequences properly.

"15 Minutes to walk things down” can SAVE YOUR LIFE!!!
Any evidence of sooting?

Loose / Disconnected Instrument Tubing?

Anything bent or damaged?

Any gas, air or water or leaks?

Create your own specific start-up and take over shift checklists
Verify actuator & linkage conditions

Are all linkage Rods engaged

Starting-up

look at cotter pins
Is every linkage connection in the plant match marked? Go check them!

- Shaft Match Mark
- Rod Match Mark
- Linkage moved from markings
Never stand in front, bolted things fly off if an explosion

Example of an item on start-up checklist: Where to stand!
3. Starting up steam lines

The steam immediately turns to water until the pipes heat up.

Your systems Require manual Start-up draining.

https://www.youtube.com/watch?v=aGyeLxpX5vs
Hammering noise, pipes moving, sometimes things break and fly off

Steam traps are not usually designed for start-up flow.

Have to go slow and keep lines drained!
If tube ruptures or if you had a big Steam leak, you need to get out fast!

Over 120°F and 12% moisture = Severe lung burns and death!
(Operators crawling out- hands & knees)

4. High pressure steam/water leaks can be deadly!

Piping & Valves
Report steam or PV leaks right away!
Little leaks can turn deadly
Gasket material gets crushed and flows into the flange grooves. This creates the joint seal. Even clamping force makes the joint successful.

Report damaged flanges
Pitting, scratches, or improper cleaning

Improper surface and damaged fasteners or improper torque pattern
Catastrophic Recent Incident

Loy-Lange Box Company
4 dead, one injured
April 19, 2017
Figure 7. Drawing of various parts of the SCR
Remaining “ring” of bottom head showing significant corrosion damage. Original thickness was 1/4 inch. Current thickness 1/8 inch.

Shell steel - clean and undamaged

Behind this bar is the shell-to-bottom head weld

Skirt metal
Came out here

Landed here, 520' away, killing 3

Could have
Killed this
person
5. Don’t force valves open or closed!

Report valves that are seized or difficult to operate

Bent valve handle
6. Operate valves carefully!

Always open all valves slowly
Use proper PPE
Never Trust Valve Handle Positions
25 hazards from 5 key groupings

- Starting-up
  - Being Aware
    - Hot work
    - Gas Hazards
  - Piping & Valves
7. HP compressed gas tubing can ruin your day!

Just touched it and it came apart!
7. HP compressed gas tubing can ruin your day!

Swagelok has an installation manual and gauge blocks to do it right!

Consider witnessing and check offs for each fitting installed.
8. Never use damaged fasteners, inspect carefully

Bolts want to be in tension
(thousandths of an inch can change everything)
Careful
Reusing fasteners

Verify that threads are not damaged
9. Always use the right strength fasteners.

Bolts & Nut Strength: It’s about the markings

Unmarked
The lack of slash marks on a bolt’s head indicates that this fastener meets SAE 2 standards, which confirms the fastener is made of low- to medium-carbon steel. Such fasteners deliver a minimum tensile strength of 74,000 psi in sizes ¼ to ¾ inch in diameter and 60,000 psi in sizes ³⁄₈ through 1½ inch in diameter. This makes them best suited for general hardware use where high strength is not required.

Six Slash Line
Indicate that a bolt meets SAE 8 standards, confirming the fastener is made of high-carbon steel (both quenched and tempered), zinc plated, and able to deliver a minimum tensile strength of 150,000 psi in sizes ¾ to 1½ inches in diameter. They are ideal for applications where high strength and hardness are required. A stainless steel version of this fastener is identified as 18-8.

Three Slash Line
Indicates that this fastener meets SAE 5 standards, confirming the bolt is made of medium-carbon steel (both quenched and tempered). Such fasteners deliver a minimum tensile strength of 120,000 psi in sizes ¼ to 1 inch diameter and 105,000 psi in sizes 1 to 1½ inches, making them ideal for automotive uses and other areas where higher strength is needed.
Anatomy of a Catastrophic Boiler Piping Accident #1

SS Iwo Jima LPH2
10 dead
October 30, 1990
Valve bonnet and bolts
Thoughts about why:
1. Wrong nuts, “Human Factors”
2. Poor QA process, (no pressure test)

Are enough threads engaged?
If not enough or too many threads are engaged we have a problem!
11. Has the steam piping moved? Still supported?

Spring not Compressed NO LOAD on this Hanger
Unloaded hangers means other hangers are taking load not designed for and piping is deflected.

This means LEAKS.

Report hangers missing, broken, loose.
12. Corrosion can be a big killer!

Only .147 left

Original .280
Paint thickness specs, paint gauge
Because, you lose coating annually

Report pipe exterior corrosion
13. Do you have the right parts?

All flanges, fittings, & valves need to be the right material and right temperature pressure rating for the project!
25 hazards from 5 key groupings

- Starting-up
- Being Aware
- Gas Hazards
- Piping & Valves
- Hot Work
14. Don’t work on energized pressurized piping systems!

Don’t tighten bolts on any pressurized systems


Metallurgy changes over time, high temperature creep failure, erosion or corrosion inside.
Catastrophe working on a live pressurized line!

http://www.csb.gov/videos/

1:30 to 4
Fire in Baton Rouge
What’s a Flash Fire?
What makes something officially FRC clothing?
What are some important FRC performance factors?
16. **Lockout/isolation – more than a closed valve!**

**Might not seal tightly**

Because:

- Wire drawing - erosion of valve disc and seat due to high velocity flow.
- Debris in seat, stem proper location?
- Bushing wear/failure, (sloppy movement)
Positive Isolation Technique (#1)

Get correct type & thickness!

Blinds
Disconnection and Misalignment from Source (Needs Capping/Sealing)

Install blind flange

Piping needs better support
Positive Isolation Technique (#3)

Double Block and Vent

Valves Leak Free?

Vents to a safe place

Vent line to some distance away

Line pressure

Work Area No pressure
17. Line breaking can be trouble – be prepared!

Line breaking precautions!

Loosen Bolts First
Away From Your Face

Spray shields

Bonding jumpers
25 hazards from 5 key groupings

- Starting-up
- Being Aware
- Piping & Valves
- Hot Work
- Gas Hazards
18. Purging gasses requires special procedures!

Never release gas into a building!

6 Dead, and all of this from a mistake purging a new 4” gas line
Understanding Safe Gas Piping Practices

6 steps for safe gas piping work:

1. Shut-offs and isolation
2. Pre-repair purge or venting
3. Make the repair
4. Pressure test/Leak check
5. Post-repair purge
6. Gas re-introduction

Any awareness of NFPA 54 purging rules or NFPA 56 Standard at all?
19. Even a small natural gas leak can be a BIG PROBLEM!

Report all gas leaks immediately!

Odor Fade & Odor Fatigue

You can’t trust your nose
Ignition sources are everywhere!

1) Dragging your feet with gravel imbedded in your shoes can create a spark.
2) Wearing plastic clothing, especially socks, can also build up and discharge a static electricity spark, especially on cold dry days.
3) Lighting, Electric motors or controls
4) Weld slag coming out of a pipe under pressure
5) Cell phones or radios or instruments, even flashlight
6) Two metal parts at unequal potential moving apart from each other, (separating flanges), tools.
7) Stray currents from electrical equipment.
8) Liquids flowing through non-conductors
9) Opening a metal door and it separating from the frame, different potentials
10) Explosion rated electrical equipment not installed properly or not put back into service properly after maintenance.
20. Two (2) gasses that can kill immediately!

**Hydrogen Sulfide & Nitrogen**

**Toxicity**

**H₂S** POISONOUS GAS

Rotten egg smell
Very levels are toxic
Can occur in sewers, tanks, and process areas
With little ventilation

**Nitrogen Asphyxiation**

No odor, used for purging
Nitrogen, 78% of each breath but
One breath at 100% and you’re dead
25 hazards from 5 key groupings

- Starting-up
- Awareness “Senses”
- Hot work
- Gas Hazards
- Piping & Valves
21. Gauges should not be bouncing!

No gauges should be bouncing around, shows process instability somewhere.

Processes and pressures should be stable
22. Bad vibrations from boilers and rotating equipment!

Combustion rumble, burner problem

Boiler shaking or vibrations?
Misalignment or failed bearings can make a motor shake.
23. Boiler flames are trying to tell you something!

Being Aware

Things to Look For – COLOR, SHAPE, MOVEMENT, SYMMETRY, STABILITY

Burner Damage (impingement/lick)

Never watch a light off!
Knowing about flame color

Things to Look For – COLOR, SHAPE, MOVEMENT, SYMMETRY, STABILITY

Burner Damage (impingement/lick)

Too Lean, pale, high energy!

Too rich, lazy, smoky!
23. Report flame impingement

Impingement

Steel changes properties @ about 850F

Damaged from impingement
If there’s too much or too little fuel for the air/oxygen

Combustion Products become =

\[ \text{CO}_2 + \text{CO} + (\text{Other Compounds}) + \text{H}_2\text{O} + \text{Fuel} + \text{Nitrogen} \]

\( \text{CO} \) – about the same weight as air
Hangs around the breathing zone

Could be many things

Carbon Monoxide
24. Strange smells/sooting=PROBLEMS!

Report strange smells & sooting IMMEDIATELY!
Don’t leave anyone with symptoms alone

CH₂OH       Alcohol
NH₃         Ammonia
H₂CO        Formaldehyde
C           Carbon (i.e. Black smoke
CO           Carbon Monoxide

CO – cumulative effect, appearance of drunkenness
Eyes burn?
Funny smells?
25. Report Refractory Problems!

Deformation & Discoloration

Things to Look For

Report these immediately!
Steel Beam
Furnace support

Steel changes properties @ about 850F

Refractory

Need to manage start-ups & shut-downs very carefully

Steel expands at different rates than the refractory

Refractory very brittle (except fiber), Can be permanently damaged from improper start-ups/shut-downs.

25. Report Refractory Problems!
You now have at least 25 HAZARD’s to be aware of:

1. **Find**
2. **Get people to care**
3. **Fix**

Technical thing, pretty straight forward

Time consuming, unpredictable, frustrating

If things never get fixed, we never really HELP anyone!
This is where I change from ENGINEER

Psychologist

Coach & Motivator
Safety is our number one thing! It’s the only thing, safety, safety, safety!

What others say to you the safety professional!

I gotta keep this place running and I have no money to fix anything & Oh Yeah, safety safety safety!
Middle Management

Board Room
C-Suite

Operations & maintenance

1% OF REAL LIFE Incidents at this level

If a Really Big Problem & Fatalities

EASIEST to Get Things Done, Unlimited authority, BUT PEOPLE USUALLY HAVE TO DIE TO GET PROBLEMS TO THIS LEVEL.
Corporate memory about terrible tragedies is only about 10 years.

Immediately a lot of attention & funding

BUT - How Long will they care?

Then BAD BEHAVIORS OFTEN COME BACK
Example #1: Ford Motor Company
1999 Rouge Explosion Kills 6, Bill Ford Jr.

Example #2: US Steel, 2010 Clairton Plant Coke Plant Gas Explosion, John Surma CEO

Some Companies Really Get It!
EASIEST to Get Things Done, Unlimited authority, BUT PEOPLE USUALLY HAVE TO DIE TO GET PROBLEMS TO THIS LEVEL.

99% OF REAL LIFE HAZARD ABATEMENT
Show up with your new 25 HAZARDS & human nature kicks in

Middle Management

• But who says we have to “do that” or “need that”
• It’s been fine for 50 years
• That’s never been a problem before
• We are grandfathered by the code
• That’s wasn’t a near miss!, that was just abnormal operations
• Who’s this “Ass%^&* Puskar”?
The problem is an emotional chasm or gap, can’t be filled With facts and figures.

Make it an emotional battle
In January 2016, a Hamilton County grand jury returned an indictment, charging Environmental Enterprises with nine counts, including involuntary manslaughter, reckless homicide, tampering with records, tampering with evidence, and violating the terms of a solid waste license. The case is pending.

Henzerling’s supervisor, Kyle M. Duffens, faces one count of involuntary manslaughter, one count of reckless homicide, and three counts of violating the terms of a solid waste license, according to the indictment.

This strategy assumes that your management team is intelligent and has a shred of morality!
You need to understand:

NEGLIGENCE/GROSS NEGLIGENCE
https://www.youtube.com/watch?v=NFuyKbFiMv8 (1:06)

2nd Degree Murder vs.
INVOLUNTARY MANSLAUGHTER
https://www.youtube.com/watch?v=NuyhxIKdp54 (1:26 – 3:58)
BUILD AN EFFECTIVE PAPER TRAIL

• Document everything and include times, days, temperatures, chemical concentrations, witness statements, prepare like you are going to trial, because at some point YOU MIGHT BE!

• Make sure that you get minutes from meetings that identify that things were discussed, ask for acknowledgement of your emails.

• Communicate the possible danger of the hazard: can it result in death or a major injury?

• Provide management with copies of sections of codes or standards that are applicable.

If all else fails, keep yourself out of JAIL!
It will help to know What codes & standards are being VIOLATED?

For Most Boiler & Power Facilities
Gas Line & Boiler might involve 5 different codes

Utility guarantees quality and supply (i.e. pressure)

Various listings

ASME CSD-1
ASME Boiler Code
NFPA 85
ASME B31.1
Current or former member of 7 different code committees including NFPA 54, 56, 85, 86, and ASME CSD-1 and API-54.
Any Questions?

www.PrescientTS.com

216.213.6201