Thermal Oil Hazards: Risk Identification and Prevention

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WECHSLER
ENGINEERING | CONSULTING

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About
Wechsler Engineering & Consulting, LLC.

- In business since August 2003 ~ 13 years
- Located in Decatur, Georgia (Atlanta Area)
- Providing specialized engineering and field service to the panelboard and wood industries worldwide

Expertise

Specializing in:

- ❑ Biomass combustion processes
- ❑ Energy recovery:
  - ***Thermal oil systems***
  - Hot gas & wood drying
  - Steam boilers
  - Power generation
- ❑ "Back-end" Air Pollution Controls (APC)

Elements of a Safety Program

- ❑ The audit
- ❑ Action Plan
- ❑ Implementation

Safety Standards

- Who's ?
- Where do they come from?

Safety “Standards”

What do we have and where do they come from?

Institutional Standards

- Insurer's – based on “financial” loss prevention
- NFPA 87 addresses thermal oil heater safety functions but only for gas fired systems (does not address wood-fired specifically).
- ASME - general pressure vessel (ASME section VIII), not specific to thermal oil
- NFPA - covers various aspects, generally fire protection methods etc.
- OSHA – covers personnel safety, but not specific to thermal oil

Industry Standards

- Best Practices
- Manufacturer's/engineer’s recommendations

Safety Standards

Who's?

Unlike Boilers, no specific safety standards have existed for thermal oil systems until very recently. Even recent NFPA 87 "Recommended Practices"

- are too recent (2011 first issue) to have been applied to the bulk of systems built in the OSB industry, which occurred in the boom of the mid 90's to early-mid 2000's, and
- do not address specifically the wood/biomass thermal oil systems most common in the wood products industries.
- As a result, many wood-fired thermal oil systems exist with minimal to no standards applied, depending on time and manufacturer.

Safety Standards

What do we have and where do they come from?

Insurer's "Published" Standards:

- Most of today's published safety standards in the wood products industry rely on work done by industrial insurers
- Most insurance standards are focused on protecting the highest loss areas of the plant (for example press and production areas), in a "macro" sense, and thus may not have focused on specifics in "non-production" areas; such as specific design practices of heat generation equipment
- While they do protect personal as well as equipment, additional standard practices are still necessary to add sufficient focus to other areas of the plant and personnel safety

Safety Standards

What do we have and where do they come from?

"Best Practice":

- To cover areas not specifically addressed by insurance standards, and due to lack of other (NFPA or similar) standards specific to industry has followed "best practices"
- "Best practices" are evolved out of necessity by the thermal oil industry for liability and to protect life and equipment, outside of what may be covered by insurers
- Being non-published, these may vary to some extent from plant to plant and may or may not be adopted at any given location, depending on users/operator's awareness

The Audit

Why Audit ?

The Audit

Loss History

For a 10 year period, FM Global loss experience shows 54 fire and explosion losses involving organic or synthetic heat transfer fluids. The gross loss amount as US$150,800,000 The average loss amount was US$3 million.

The dollar value distribution can be broken down as follows:

- Less than US$100,000: 18 losses
- US$100,000 to US$300,000: 15 losses
- US$300,000 to US$1,000,000: 9 losses
- US$1,000,000 to US$2,500,000: 1 loss
- US$2,500,000 to US$5,000,000: 1 loss
- More than US$5,000,000: 5 losses

The Audit

Basis

Audits are based on a combination standards as any one does not cover all aspects of thermal oil safety:

- FM99 Guidance
- "Best" industry practices
- NFPA 87 "equivalence" for interlocking
- ASME Section VIII pressure vessel code
- WEC design and operational "best" practices
- Known plant "best" practices

Requires auditor to have knowledge and experience!!!

The Audit

Main Elements

Consists of the following elements:

- ❑ Design Review
- ❑ System Inspection
- ❑ Operational Review
- ❑ Fire Protection System Review
- ❑ System Interlocks
- ❑ Audit Report

The Audit

Design Review

Consists of the following elements considering quality and availability:

- ❑ Adequate design features for safety and operability
- ❑ “Failsafe” features
- ❑ P&IDs
- ❑ Wiring diagrams
- ❑ O&M Manuals
- ❑ Other Design Documentation
- ❑ Previous Inspection Reports

The Audit

System Inspection

- ❑ Furnace/Burner
- ❑ Thermal oil heater(s)
- ❑ Primary and Secondary Pumps
- ❑ Emergency Pump
- ❑ Expansion tank, thermal buffer, drain tank
- ❑ Piping system including valves, isolation valves, control valves
- ❑ Instrumentation
- ❑ Secondary loops including press pump room (excluding press area itself), and other secondary loops
- ❑ Steam generator loops
- ❑ Control room
- ❑ HMI screens accuracy
- ❑ Safety valves
- ❑ Housekeeping
- ❑ Any other observed potential hazards

The Audit

Operational Review

- ❑ Interview Operators
- ❑ Operator Logs
- ❑ SOP’s
- ❑ Emergency Procedures
- ❑ Emergency Pump test log
- ❑ Tube Thickness test log review
- ❑ Thermal Oil test results

The Audit

Fire Protection System Review

- ❑ Design review and visual inspection
- ❑ Review of written fire response procedures
- ❑ Review of PM procedures
- ❑ Review of PM logs
- ❑ Inspection of Isolation/By-pass valves

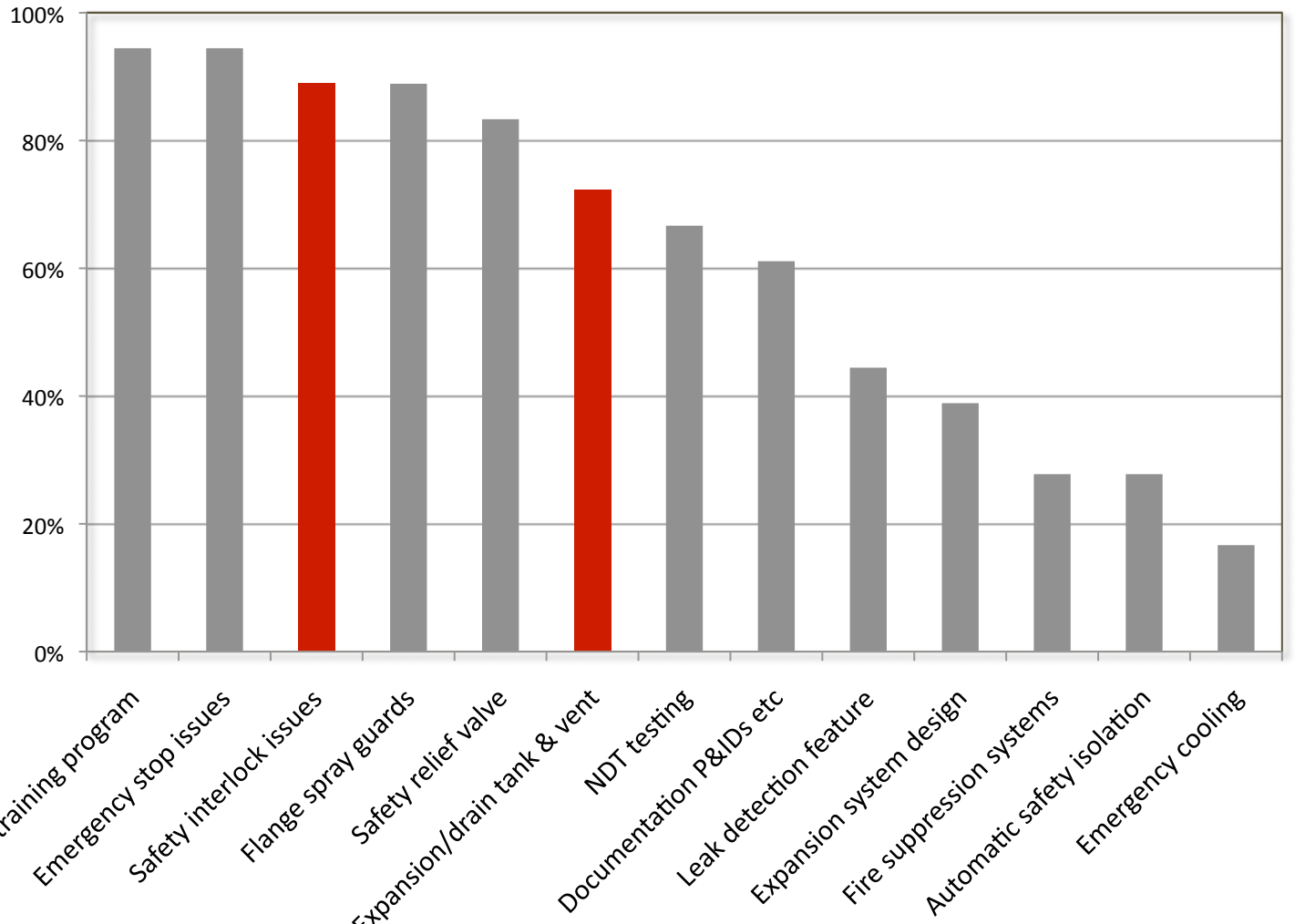
The Audit
Interlocks Testing

Actual on site testing of critical Interlocks:

- ❑ Low flow
- ❑ High oil temperature
- ❑ High exhaust gas temperature
- ❑ Low expansion tank level
- ❑ Low draft (where applicable)

Typical Findings

(sampling based on frequency of occurrence or severity of outcome)



Training

The cornerstone of safety:

- Build basic understanding of fundamentals and awareness
- Know what can happen
- Why it happens
- Know how to react

An effective training Program (for wood-fired systems) should address:

- Wood Combustion
- The Energy Plant
- Thermal Oil System
- Upset Conditions

Simple Things!

Piping

Spray guards on flanges

(prevent fine mist sprays from flange leaks)

Simple Things!

Piping

Missing pipe caps

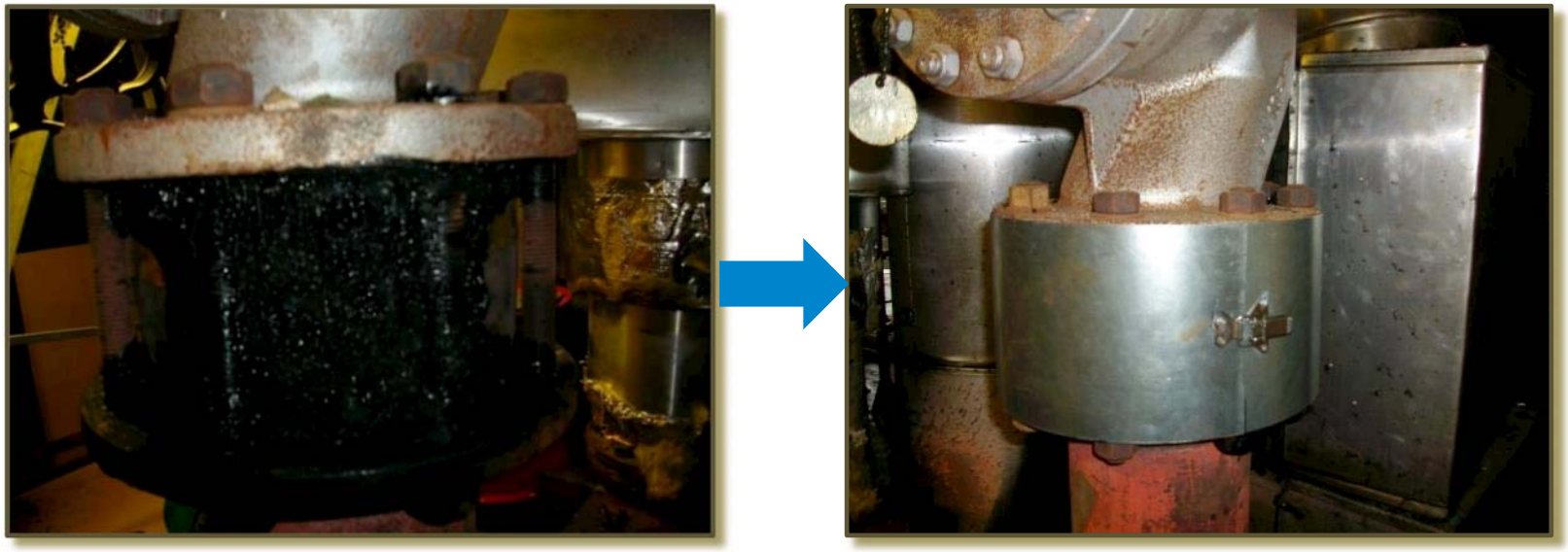
(unintended opening/major spill/personnel protection)

Simple Things!

Piping

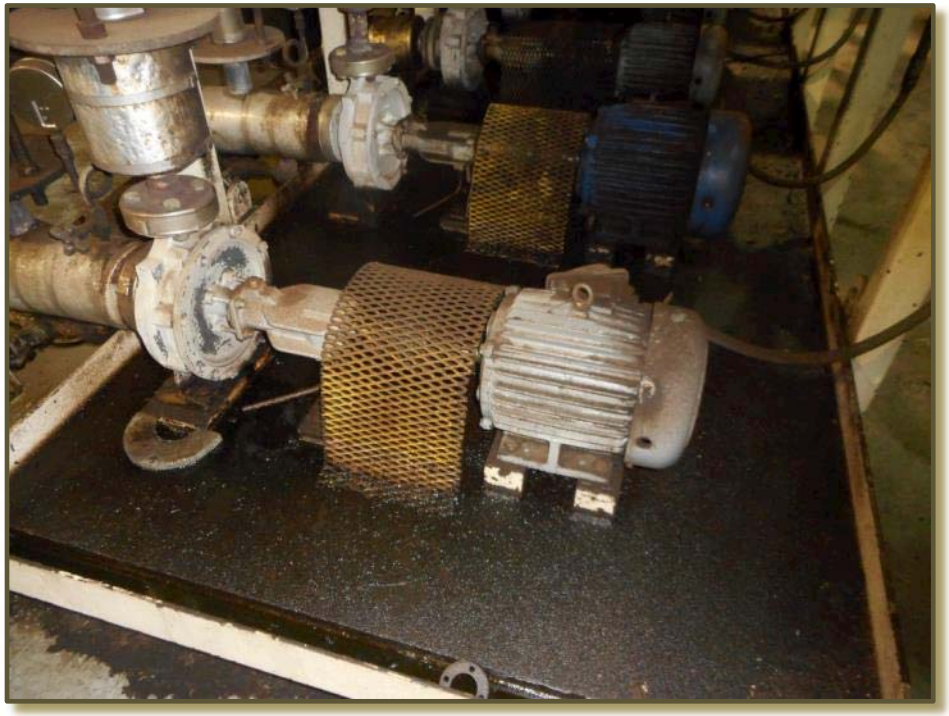
Maintenance: Proper gasketing and torqueing of bolts

(Slow leaks, slip & fire hazard)



Simple Things!
Housekeeping

Prevention: Housekeeping
(slip & fire hazards)



Design Issues

Potential Failures

A leak waiting to happen!

Prevention

Containment: Preventing spread of leaks reduce fire hazard

Emergency Conditions

E-stops

No E-stop outside pump room!

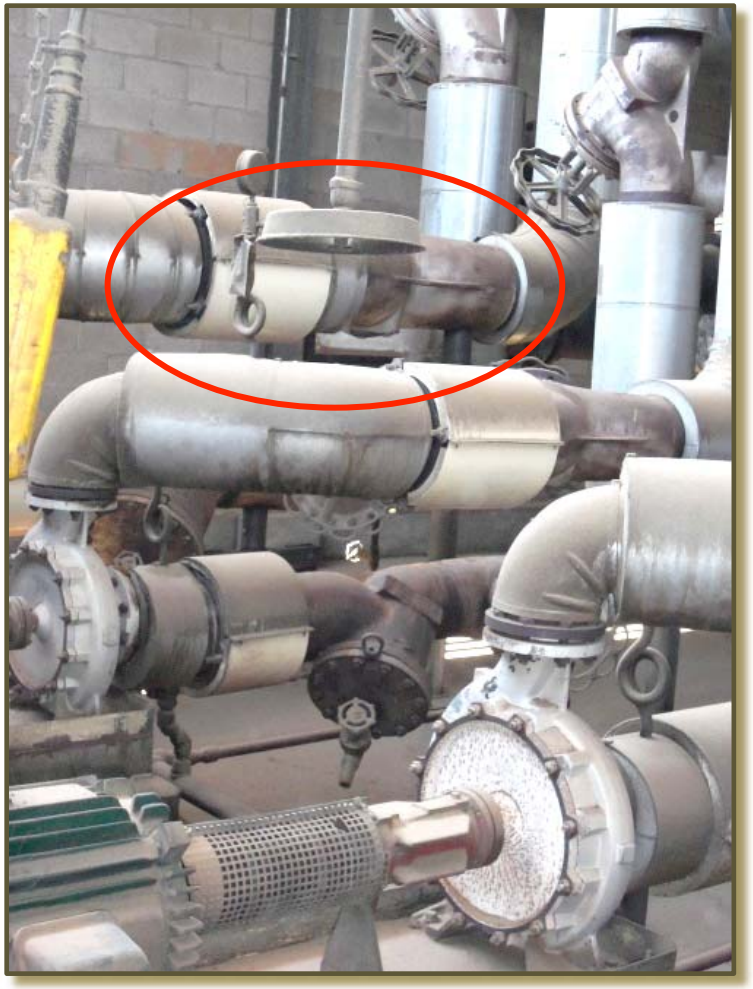
Good practice: E-stop outside pump room

Prevention!

Leak mitigation & prevention

Preventative measures:
Pump leak detection can provide early warning of seal failure

Prevention!
Fire protection



Fire protection:
Misting nozzles at T.O. pumps control fires early – first step in firefighting.

Prevention – Simple things to Evolving Science!

Safety and Pump Room fire – with misting system

Prevention – Simple things to Evolving Science!

Pump Room Seal Fire: Foam Suppression

Interlocks

Small Internal Leaks

Very small leaks – can be detected by:

- ❑ Low level in expansion tank
- ❑ No automatic refill!! Expansion tank must be adequately sized

"Larger" small leaks can be detected by:

- ❑ Exhaust gas temperatures high ("larger" small leaks)

Interlocks

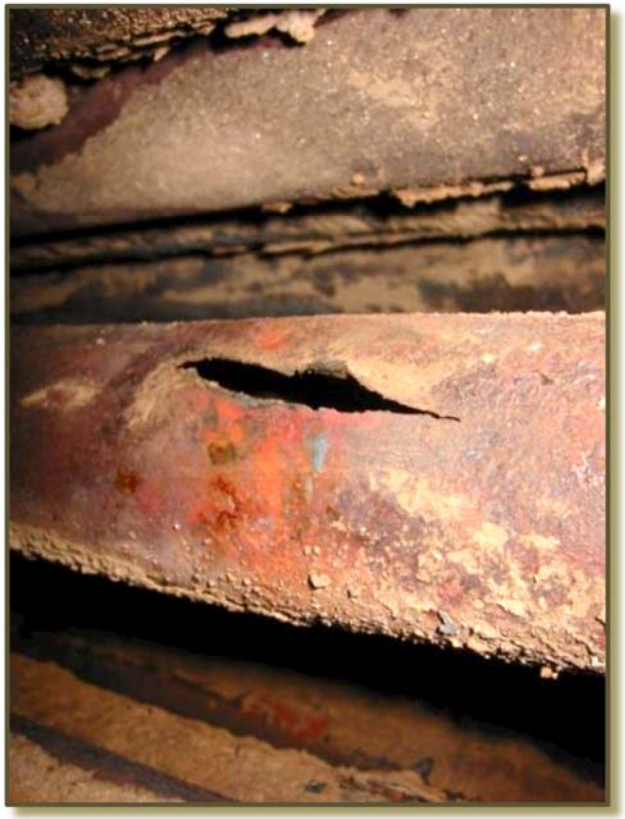
Low Heater Flow

Undetected or ignored can lead to coking of oil…

Interlocks

Low Heater Flow

…and dramatic failure



Rupture…

… to point of melting

Summary

The Audit

- Based on multiple standards and practices
- Comprehensive - from design to operations to systems testing!
- Auditor – experience with thermal oil operations and safety
- Auditor independence – adds validity and credibility – no stake

Action Plan

- Based on audit findings
- Prioritize by severity and likelihood of outcome!

Implementation

- Do the “easy” things first!
- Schedule implementation based on likelihood and severity of outcome, then cost
- Re-audit every 2-3 years

Questions?

Thank You!

The End