

**Tuesday 11 April 2023, 12 noon to 4 pm,
MetaForum 0.547 / MF 4**

Short Course

Understanding Condensation-Induced Water Hammer in Steam Systems

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Fee: € 100.

Understanding Condensation-Induced Water Hammer in Steam Systems -- *the first 4 hours*

The Seminar includes videos of water hammer in a glass model, a live demonstration of a rapid steam bubble collapse, and over 100 animated slides that depict step-by-step what's going on inside steam lines. The first 4 hours give people working with steam a gut understanding of what really causes destructive water hammer in steam pipes (Hint: it's not slugs of condensate accelerated by fast moving steam crashing into pipe elbows). While the intensive 2-day, 8-hour seminar was designed specifically for steam workers and operators *to keep them from repeating the mistakes made in previous accidents*, Engineers have gotten the most out of the seminars. The seminar has been refined over 150 presentations primarily in North America to over 4000 attendees. It is theoretical, but it does not contain formulae beyond the Joukowski Equation. It corrects many misconceptions propagated over videos and descriptions on the Internet.

Outline

1. **The Quiz—A Review what you already "know" about water hammer in steam systems.**
2. **Condensation-Induced Water Hammer -- *This is the kind of water hammer that kills operators!***
 - The worker who opened this steam valve was killed. What would you have done to open this valve?
 - What Everyone *"thinks they know"* about Water hammer.
 - What Manufacturer's literature and most Authorities say causes Water hammer.
 - **Acquiring the Correct Mental Model -- *Let's look inside a steam pipe to see what's going on.***
 - How Condensation-Induced Water Hammer *Actually* Occurs in Steam Systems. Live demonstration of rapid steam bubble collapse.
 - Video of "water cannon" experiment showing water moving *fast into* a steam bubble collapsing.
 - **Water Hammer, the Phenomenon --** What makes it so forceful? Live Demonstration. There's an engineers' and non-engineers' version of this discussion.
 - **Video of Steam Waterhammer in a Glass Model** as it occurs in a horizontal steam line. This video is run in slow motion so as to show all the detail of what's happening.
3. **Return to the Initial Accident. *This is what happened when the worker opened the steam valve.***
 1. Would a bypass on the valve have mattered? How about a drain upstream of the valve? What about re-activating the trap?
 2. *Is there any way to have activated the system while avoiding a water hammer?*
4. **What Won't Hammer and What Will. *A discussion of the circumstances that must align for a Condensation-Induced Water Hammer to occur.***
5. **Now, Do You Know Enough to avoid a steam Water Hammer accident? *Re-visit the Fatal Accident with which we began and list what should be done before opening any valve in a high-pressure steam system.***
6. **The Hanford Nuclear Reservation Site East Power Plant Accident.**