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Process Safety Beacon

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Messages for Manufacturing Personnel

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Water, water everywhere…

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Water is often found in many places in a plant. It is used for cleaning process equipment and pipe, for general building and plant washing, and as a lubricant or seal flush. Water is also a common heat transfer fluid – as cooling water, mixed with salts or glycol for refrigerated cooling, and as steam for heating. Water is a common solvent used in many processes. But water can also be dangerous if it gets into the wrong place. Here are some examples.

- **Water as a reactive chemical:** Water reacts with many materials, and the reaction can cause heat, pressure, or toxic reaction products. The initiating event for the December 1984 Bhopal, India tragedy (Fig. 1), the worst industrial disaster in history, was contamination of a tank of methyl isocyanate with water. The reaction generated heat and pressure, releasing toxic material into the community causing thousands of fatalities and injuries.
- **Water as a reaction catalyst:** Water can catalyze other chemical reactions such as decomposition. For example, contamination of a distillation residue with 1% water reduced its decomposition temperature by 100 ºC. The temperature of steam heating on a pipe containing the contaminated residue was above the reduced decomposition temperature. The residue decomposed and ruptured the pipe (Fig. 2). Fortunately nobody was in the area.
- **Water as a physical explosion hazard:** Water boils at 100 ºC, below the operating temperature of many processes. If water contacts hot material or equipment, it will rapidly boil and generate pressure in a closed or inadequately vented vessel. Water can explosively increase in volume by 1600-1700 times when it vaporizes to steam at atmospheric conditions. In 1947, a blast furnace in a steel mill Pennsylvania (Fig. 3) was being prepared for replacement of the brick lining. Workers were improperly told to add water to the furnace while it still contained molten iron and other hot materials, in violation of standard operating procedures. The water boiled, and pressure from the steam blew a hole in the bottom of the furnace. Molten metal was released and engulfed nearby workers. There were 11 fatalities.

Fig. 1

Fig. 2

Fig. 3

What can you do?

- Be aware of chemical reaction hazards of water in your plant – as a reactive chemical, and as a catalyst for other reactions. Understand the design features of your plant which protect against hazardous interactions with water.
- Remember the hazard of boiling water from contact with hot (above 100 ºC) equipment or material.
- Always follow standard operating procedures designed to keep water from getting into places in your plant where there may be a dangerous chemical or physical interaction.
- If there are parts of your plant where water is not supposed to be used, never set up a temporary water supply to get water into that area. If there is a real need to use water in an area where it is not normally allowed, there should be a standard operating procedure (SOP) for this special activity. Special precautions may be included in the SOP, and a permit may be required. If this is not the case, make sure that the activity is given a thorough job safety analysis or management of change review, and follow all procedures identified by that review.

Water – common but it can be dangerous!

The Beacon is usually available in Arabic, Afrikaans, Chinese, Czech, Danish, Dutch, English, Filipiono, French, German, Greek, Gujarati, Hebrew, Hindi, Italian, Japanese, Korean, Malay, Marathi, Norwegian, Persian, Polish, Portuguese, Romanian, Russian, Spanish, Swedish, Telugu, Thai, Turkish, and Vietnamese.

Questions:

1. **(5 min)** List the three hazards of working with water in a chemical plant outlined by the article.

2. ***(20-30 min)** List three hazards of working with water in a plant environment not mentioned in the article. (E.g. water may freeze, expand, and burst pipes.) You may find this resource helpful.

3. **(5 min)** *What did you learn?*
   Because water is a ubiquitous component in most chemical plants, considering the lessons learned from this article, what are the best ways to stay vigilant about its hazards when working in a plant environment, performing a hazard and operability study (HAZOP), or redesigning a unit?