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DRAIN HOLES FOR CRITICALITY SAFETY CONTROL-
GUIDANCE FOR THE ANALYST

abstract

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1.0 INTRODUCTION

The Enriched Uranium Operations (EUO) processes at the Oak Ridge Y-12 Plant have been undergoing significant upgrades in safety analysis, particularly in the discipline of nuclear criticality safety.

Drain and overflow holes are integral to the nuclear criticality safety basis of many processes and provide different functions in achieving their safety goal. In most cases, unverified engineering judgement was used to conclude that the holes were adequate to accomplish their mission. Such judgement may adequately serve some configurations but is inadequate in other applications. It was determined that the exact function of every hole for both normal and upset process conditions must be understood and clearly documented. Y-12 has embarked on an effort to document engineering analyses of drain and overflow holes. This effort is essential to demonstrating that the holes are capable performing their intended safety function.

One example of inadequacy involves use of drain holes to limit levels of constantly flowing coolant for lathe-type machines. The central coolant system supplies many machines, and an operator at each machine adjusts coolant flow to get enough coolant to the machine without overflowing the coolant trough. An unexpected overflow that overwhelmed the drains in one machine occurred at the end of an operating shift, when coolant flow to other machines was shut off as part of the shut-down of the machines. The effect was to significantly increase coolant system pressure and flow to the remaining machine that still had coolant flow, resulting in coolant levels above the required depth maximum. The problem investigation and performance testing of each machine resulted in physical modifications to add more drainage capacity for several of the machines in the area.

2.0 TYPES OF DRAINS FOR CRITICALITY SAFETY

For the analyst to avoid similar problems of drain function, he or she must be aware of the various types of drains, and their limitations. For simplicity, drainage devices can be split into three main categories: 1) Draining for normally dry unsafe geometry equipment, 2) drains for maintaining levels of fluids, 3) additional uses.

2.1 Drains for normally dry unsafe geometry equipment

The purpose of these is to remove incidental liquids leaking into areas where liquids are not expected. Examples are large geometry instrument cabinets, tool boxes, or filter housings located in areas that handle fissile solutions. Other examples are dry process gloveboxes and ventilation ductwork. Since inflow into these systems is unlikely and expected to be very slow, engineering judgement can be used to place the drain holes and assume that any liquids would easily be kept at a level near the bottom of the drain holes. Problems arise when this type of engineering judgement is inappropriately used for other types of drains.

2.2 Drains for maintaining levels of fluids

The purpose of this type of drain is to keep normally flowing liquid to a certain depth. Examples are machine coolant flowing through a reservoir or machine turnings or filtering operations. For this type of function, an overfilling condition could result in overwhelming of the drain holes. The analyst must show the system is subcritical with all credible overflow conditions, for example with throttle valves completely open. Demonstration of subcriticality may require detailed flow rate calculations and/or analysis with realistic rather than optimum criticality parameters. In cases of significant inflow, an inflow/outflow balance will usually require depth above the midpoint of the drain holes.

2.3 Additional uses

When drains are already in place as passive features for overflow, the analyst may also credit them for helping the operator maintain a level below the holes. The holes may serve as a visual aid to help measure depth, and operators are more likely to maintain levels below the bottom of drains, if liquid splashing out will cause contamination problems.

3.0 OTHER CAUTIONS ON THE USE OF DRAINS

3.1 Pressure Seals

Ductwork and gloveboxes are often under a negative air pressure. When drains are placed in these systems, engineering analysis must be performed to ensure liquids can overcome this negative pressure to drain out. This is sometimes accomplished by use of a drain tube submerged in a liquid seal. These liquid seals have the additional benefit of providing contamination control for dusty operations.

3.2 Drainage Collection

When drains are provided for overflow of fissile liquids, the analyst must ensure that the collection point for the liquids is subcritical. At The Y-12 Plant, the most common ways to show this is to overflow directly onto a very large flat process are floor, or to drain into safe geometry containers.

3.3 Maintenance and Surveillance

Because most drain holes are not used frequently, operators may not notice if they become blocked with solid material or are otherwise degraded. For these, a routine surveillance should be performed, on a frequency determined by engineering or experience.

4.0 SUMMARY OF Y-12 EUO APPROACH TO CRITICALITY SAFETY DRAINS

The Y-12 EUO approach is based on criticality safety function and engineering analysis. The main components of the policies regarding drain holes are:

- The criticality safety requirements are written in terms of function (e.g., depth in pan filter must always be less than 5 cm).
- Engineering justifications are being written to show existing drains meet required function. Sometimes, detailed analysis of inflows and outflows is required. In some other cases, physical functional tests are performed.
- Drains are documented on controlled drawings to ensure configuration control.

A program of periodic inspections (usually annual) is in place for each required drain.