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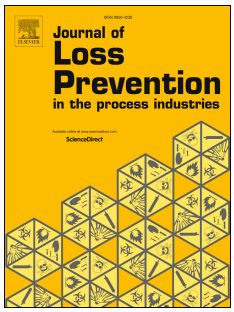


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# Concepts for Dynamic Barrier Management

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## Abstract

Safety barrier management is an important activity to maintain or reduce process safety risk of an operating facility. Barriers can be hardware, human or organizational, or some combination of these. Barriers are normally fully functional after installation or commissioning when all equipment has been tested and all staff trained, and the facility risk will be at or better than target level, as the design risk assessment this will have assumed some barrier failure probability. However, barriers degrade at different rates, and these degradations start to increase facility risk. Some barrier failures can increase risk dramatically, especially where barrier dependencies exists. Conventional barrier management applies fixed inspection and maintenance intervals to these with the intent to return these to full functionality and the risk to target, but take no account of dependencies.

Dynamic barrier management uses the full suite of information available, including direct and indirect indicators of barrier performance to infer barrier status in near real-time. This can be through a smart combination of inspection, preventive maintenance, audit, sensors, process control, and near-miss or incident records, and big data concepts. Barrier maintenance can then be planned optimally based on quantitative barrier importance to risk control, in a manner similar to risk based inspection (RBI). Higher Importance barriers (i.e. risk affecting) would be assigned higher priority than other barriers. This can achieve better safety at lower cost than current barrier management processes.

This paper presents the concepts for dynamic barrier management. All the details have been developed and this completes the design phase activity. A practical application will be next to prove these ideas.

Keywords: Barriers, Risk, Safety Management, Asset Management

## 1. Introduction

The barrier risk management approach has been in use in aviation, rail, and oil & gas industries for more than 15 years, and for even longer in the nuclear industry where it is termed Defence in Depth. The bow tie model extends this idea by creating a bow-tie shaped figure defining a central “Top Event” which in Oil & Gas terms would correspond to a loss of containment, a loss of structural integrity or a loss of control . Barriers located to the left of this (the Threat side) are termed Prevention Barriers, and those on the right (the Consequence side) are termed mitigation barriers. There is no current standard for the Bow Tie risk method, and many companies have their own internal bow tie procedures. Public method documents exist from CGE Risk (2013), DNV GL (2014) amongst others, and CCPS is currently working on a Guidelines text so that there will be a public standard in 2016.

The bow tie method links well to regulatory requirements in Europe for O&G and chemical facilities covered by the onshore Seveso Directive or the new EU Offshore Safety Directive (Zuijderduijn, 2000). Offshore regulations call for a risk assessment that defines safety critical elements (SCE), and for each of these to define required performance standards (PS) as well as a written scheme to specify the required maintenance, inspection and competence regimes to keep each SCE at its defined PS. Norway has issued a guideline on the management of barriers PSA (2013) highlighting these are not static and hence the need to manage barrier systems to keep them functioning at their desired performance level.

Zuijderduijn suggested that 10-12 well designed bow ties can capture most key barriers for a refinery, and that logic would also apply to offshore installations. Some other companies start with a basic set of bow ties but customize these for specific units, so staff can recognize their facility barriers and owners can be specific individuals rather than generic job titles.

Barriers degrade in service and unless suitable remedial actions are taken then risk levels will be higher than assumed from design, perhaps much higher if there are barrier dependencies,.

Definitions

The Norwegian PSA (2013) defines a barrier as: Technical, operational and organizational elements which are intended individually or collectively to reduce the possibility for a specific error, hazard or accident to occur, or which limit its harm or disadvantages. This definition is broader than an independent protection layer in LOPA or in UK safety case regulations for a safety critical element.

A barrier system is a safety function that can be hardware, human or organizational or some combination of these and addresses a holistic safety area such as firefighting system or ESD shutdown system.