



Mary Kay O'Connor Process Safety Center
2005 International Symposium
Beyond Regulatory Compliance, Making Safety Second Nature
October 25-26, 2005

Updated Hazard Rate Equation for Dual Safeguard Systems

Marc Rothschild, P.E.
Rohm and Haas Company
Engineering Division
3100 State Road
Croydon, PA 19021
(215) 785-7327
mrothschild@rohmmaas.com

Abstract

A previous paper by this author showed that commonly used analytical methods for quantifying failure rates tend to overestimate the risk in some circumstances. This can lead the analyst to believe that a given operation presents an unacceptable risk, requiring additional safety measures when, in fact, it may meet criteria.

For a single safeguard system, a formula was presented that accurately evaluates the risk over a wide range of conditions.

For a single safeguard system, a demand on the system challenges the safeguard. If the safeguard is in a failed state at that time, then the consequence will result. The likelihood of a safeguard failure is primarily a function of this demand rate, along with the safeguard failure rate and its frequency of testing. The analysis becomes more complex with more than one safeguard system. These safeguards can activate in series or in parallel.

When in series, the demand rates for the two safeguards are not the same and need to be determined for each safeguard in series. When the safeguards are in parallel, the demand rates are the same. However, in this arrangement, a hazard only occurs when all parallel safeguards exist in a failed state at the time of the demand.

This paper presents the analysis for dual safeguard systems. For safeguards in series the analysis is straightforward, as the hazard rate for the first safeguard becomes the demand rate for the second safeguard. The Monte Carlo simulation approach was used to evaluate dual parallel safeguard systems. From this, the following empirical formula was developed:

$$\text{Hazard Rate} = \left\{ 1 - (2.33 - 0.163 \times \lambda_A T)^{-\lambda_B T} \right\}$$

where:

- l - Failure rate (failures per time period) for safeguards A and B
- T - Testing interval (time period per test)