# Powered Flood Gate Drive Systems – Safe & Reliable?


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# Why does the question arise? What is Reliability

Reliability is associated with unexpected failures.

Understanding why these failures occur is key to improving reliability.

Reliability is a journey and not a destination

# Standards of Protection

- UK Flood defence is typically the 1 in 250 year (0.4% probability)
- For the flood resilience of the electrical and mechanical assets a 1:1000 year (0.1% probability) is often specified.

Flood gates and their operating systems are subject to a number of international design codes:

- DIN19704:2014
- Eurocode 3 – BS EN 1990:2005
- BS EN 1090-2:2008

Generally, standards may specify requirements for materials, structural load cases, etc. but do not generally specify reliability levels.

Compliance with a code does not guarantee reliability.

# Reliability for UK Flood Defence

To overcome this, the traditional approach to specifying flood gate systems has followed a number of paths:

- Redundancy equals resilience
- Prescriptive design solutions
- “Shopping List” of machinery features
- “The gates must be reliable”….but what does this mean?

But, things go wrong!

Unexpected and/or unwanted consequences often follow.

# Reliability for UK Flood Defence

Resilience tends to be equated with redundancy and thus typically a specification requires:

- Dual electrical supplies from different parts of the grid (if available)
- Duplicated electrical drive motors
- Diesel engine back-up/generator
- Plug in point for a mobile generator
- Gravity or Manual means of deployment

The assumption is that if such features are present, then the system must have resilience.

The emphasis has previously been placed on “good engineering design” and demonstration of performance through factory and site testing.

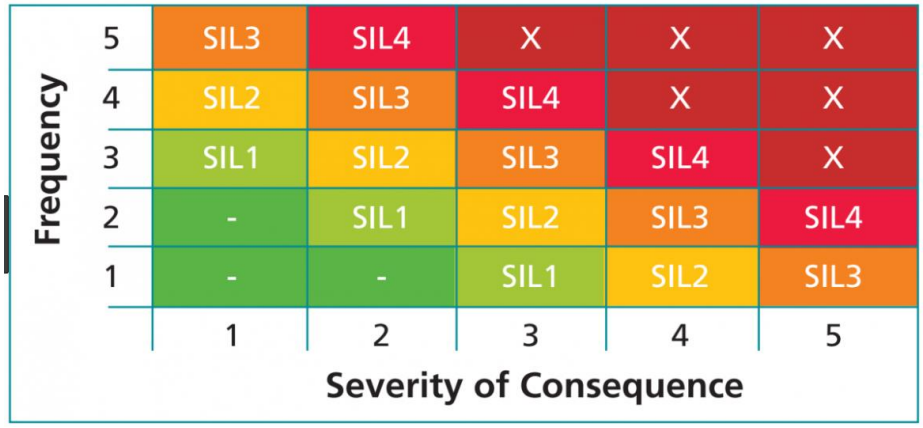
It is often found that machinery incorporates common cause failures, so..

The appearance of redundancy becomes an illusion

# Safety Integrity Level (SIL)

In terms of general machinery there have been a number of standards introduced that take a risk based look at machinery and/or their control systems. These include Harmonised European Standards and also ISO standards.

Safety Integrity Level (SIL) has been introduced as a means to specify and assess reliability. It considers the probability of dangerous failure on demand




There are four SIL levels:

| | |
|---|---|
| SIL 1 | $10^{-1}$ to < $10^{-2}$ |
| SIL 2 | $10^{-2}$ to < $10^{-3}$ |
| SIL 3 | $10^{-3}$ to < $10^{-4}$ |
| SIL 4 | $10^{-4}$ to < $10^{-5}$ |

# Hazard Identification and Risk Analysis

These studies typically address three main risk questions:

| | |
|---|---|
| Hazard | What can go wrong? |
| Consequences | How bad could it be? |
| Likelihood | How often might it happen? |

Risk is the arithmetic product of the probability of an event and its consequences.

No action can be taken to avoid, or reduce the effects of hazards that have not been identified.

# What risks do we all take!

Do you know the risks you are taking everyday?

We do not live in a risk-free world and we are intuitively aware of this and comfortable with it.

There have been a number of published studies about risks taken in everyday life. In the UK, for an individual, the risk of death from:

- A natural disaster (per individual) is $2 \times 10^{-6}$ per annum (2 in 1,000,000)
- A road traffic accident is $6 \times 10^{-5}$ per annum (6 in 100,000)
- An accident in the home is $4 \times 10^{-4}$ per annum (4 in 10,000)

# What risk is acceptable!

The idea is that an individual should not be exposed to a greater risk than they would have naturally been exposed to. In the UK this means:

- $10^{-4}$ per annum (1 in 10,000) minimum tolerable risk - employees
- $10^{-5}$ per annum (1 in 10,000) members of the public
- $10^{-6}$ per annum (1 in 1,000,000) an aspiration -ALARP

## Hazards are everywhere and are often site specific:

- Failure to close flood gates
- Unexpected opening
- Jamming due to excessive debris or silt.
- Failure of a structural component
- Exceptional loading on a gate
- Vandalism
- Terrorism
- Loss of electrical power

# The Process

The process for acceptable risk assessment is as follows:

1. Perform a Hazard analysis and identify what could arise from one or more failures.
2. Determine the consequences from those hazards arising, how many people are at risk, etc.
3. From the hazard-consequence analysis determine the Safety Integrity Level (SIL) required of the gates and systems bearing in mind that different risks might require different SIL levels.
4. Design the equipment incorporating the required Safety rated components/systems.

The key is to apply good risk mitigation practice from the very beginning of the project and to continually pass the results of this work to those that come later in the process.

# Conclusions

1. Consultants and purchasers should undertake the hazard and consequence assessments. They pass these to the scheme designers.

2. Scheme designers/contractors need to demonstrate that they have achieved the reliability levels specified, by the application of a probabilistic analysis.

3. The information needs to be recorded and made available for future periodic review by the asset owner – things change with time.

The big message:

Reliability is a journey and not a destination