Asset owners and operators are continuously being driven by the regulators to demonstrate that the risks posed by their processes and equipment are reduced to ‘As Low As Reasonably Practicable’ (ALARP). Where instrumented systems are used to provide a significant amount of the risk reduction (more than a factor of 10), then international functional safety standard, IEC 61511, is considered to be the current best practice and guidance. At the same time, operators are seeking ways to increase productivity by extending test intervals, minimising shutdown durations and reducing the overall maintenance load. A significant contributor to the maintenance and shutdown work-scope is the SIF proof testing.

The SIL calculation
The amount of risk reduction provided by the instrumented system is denoted by the Safety Integrity Level (SIL). This is calculated by working out the average Probability of Failure on Demand (PFDavg). In its simplest form, the PFDavg is a function of instrument failure rates and test intervals. Variants of the PFDavg calculations vary in complexity; however there are only ever three parameters that can be manipulated:

- The target PFDavg
- The instrument failure rates
- The testing interval

For all existing SIFs, to determine if the test interval can be potentially extended, or whether there is an opportunity to reduce interruption to on-line production, then each of these parameters should be considered in turn.

What we offer
ABB have a group of experienced functional safety specialists with both the practical and theoretical knowledge to investigate if working with these three parameters can provide benefits by extending proof test intervals or reducing the shutdown proof testing load by doing more on-line testing.

Target PFDavg
Potentially the most cost effective option is to review the target PFDavg. For existing operations the increased understanding and experience of operating the plant allows us to revisit the target SIL determination; the LOPA methodology is generally used. Previous reassessments by experienced ABB LOPA leaders working alongside the operating company have found that values used in the initial study can be expressed more realistically. Using the latest data, it is possible that the target PFDavg may be increased. A less onerous target PFDavg will directly result in extended test intervals.
Alternately, the target PFDavg may be increased if additional, independent protective layers can be identified or installed. Again, the use of an experienced LOPA leader is required to ensure that the protective layer is truly independent of the initiating cause and that the risk reduction claimed, especially by humans, is not over-optimistic.

**Instrument failure rates**

There are a number of different strategies that may be considered to reduce the instrument failure rate.

- Reviewing the original PFDavg calculation. Were the failure rates used appropriate for the process conditions and environment?
- Replacing old instrumentation with equipment that contains in-built diagnostics to reduce the dangerous, undetected failure rate
- Replace digital sensors (switches) with analogue instruments and use other, existing measurements to track the readings and provide deviation alarms
- Consider developing specific ‘prior use’ argument for the failure rates. If you have used generic failure data (such as OREDA) for your PFDavg calculation, then the functional safety standards quote statistical reliability models and confidence levels that may be used to derive your own instrument failure rates

Other options for improving SIF integrity include:

- Put in more instruments in a voting configuration (1oo2, 1oo3, 2oo3) to enable safe testing while the asset remains on-line
- For valves, consider if you can directly act upon an existing control valve as well as the ESD valve to give redundancy in the final action

**The testing**

There are a number of strategies that can be employed in the testing itself. These include:

- **Partial testing** - most commonly partial stroking of valves. These may be manually or automatically performed and act as a form of diagnostic. Analysis using data from OREDA has shown that for the final element diagnostic coverage of between 50% and 70% may be achieved with partial testing. This allows the full test interval to be extended
- **Different test intervals** - testing the sensors more frequently than the final elements. The most effective proof test is to test end-to-end, however the testing theory and calculations enable you to consider testing the sensors more frequently than the final elements, extending the time between process interruptions
- **Test coverage** - there may be occasions where the sensing element cannot be easily accessed, and a signal is injected into the device to simulate the trip condition. The untested part of the SIF may only be examined during the shutdown or when it is replaced at end of life. The SIL calculations can be reviewed to take account of these limitations and may enable extended test intervals to be attained

**Benefits**

Extended test intervals or minimising process interruptions while testing are possible by applying a number of strategies to the basic PFDavg formula. However, it is relatively easy to make the ‘numbers’ fit the desired result. Experienced ABB functional safety specialists assist in ensuring that any gains are justifiable, reflect the local process and environmental conditions and that the required risk reduction is realistically attained.

**Why ABB?**

We have a dedicated functional safety team with TÜV certified engineers working in the chemical, petrochemical and oil & gas sectors with access to further technical support from a wide-range of asset and equipment consultants. We provide support and solutions across the full range of safety lifecycle activities.

Our engineers and consultants have an operational background and use their experience to make pragmatic technical judgements. This approach ensures cost effective solutions specific to each problem. Our team are fully versed in the legal requirements for both onshore and offshore assets.