Technical Whitepaper

Integrated SIS
Perfect Companion for Batch Processes

Integrated SIS: Perfect Companion for Batch Processes – A Whitepaper by David Huffman

It is often perceived that the continuous and batch process industries are different manufacturing worlds. Certainly there are notable differences, but on many levels they are the same. But one element that is often perceived as being the same is functional safety requirements. Frequently however, in this instance, there are key differences.

In continuous processes, typically the general operating parameters are fixed for long periods of time. The functional safety parameters (setpoints and the active or disabled state of safety functions or initiators) also stay the same for long periods. But in batch processing operations, functional safety conditions can vary significantly from one product type, or family, to another when the plant is capable of making a range of products. And the larger the diversity of products, the more likely the functional safety parameters will need to be changed with the production recipe to safely manufacture the products.

Understanding Functional Safety Requirements is key

Too frequently, when a Functional Requirements Specification (FRS) for a Safety Instrumented System (SIS) is created, there is a simplifying assumption made that trip conditions for Safety Instrumented Functions (SIFs) will be set once and rarely changed. This may be a valid assumption in many single product continuous processes, but often one that is improper in batch processing when different product recipes are executed.

It is not uncommon for batch processes to have requirements that dictate changing SIF parameters when a production cell is tasked to manufacture a product different from the last. Too often an engineer must intervene to make the changes to SIF parameters. This can lead to process delays if the engineer is not immediately available when the production change occurs.

An alternative to engineers making changes is to task operators to execute the changes. This may not be practical to maintain proper control over security and change management of the SIS working within the guidelines of ISA84 (IEC 61511) when the skills and training of the individuals involved could be lacking.

Regardless of the individuals involved, in either case, these types of changes may be required frequently. Done manually, the opportunity for a mistake by a human must be considered in the risk analysis. If the risk is determined to be high enough, it could impact the overall Risk Reduction Factor (RRF) of the system with a corresponding impact to the safety integrity level (SIL) rating of the SIFs involved.

There is a better way. Integrating the basic process control system (BPCS), where the batch processing is occurring, with the SIS, and programmatically incorporating any changes to SIF parameters or operational state into fully vetted production recipes, is both safer and faster than when integration is not available.

Let us not forget that proper procedures, checks, and verifications still need to occur as part of the integrated processes, but the integrated automation interactions can be done to avoid the need for humans to type in data and enter an incorrect value that could lead to an unwelcome process trip in the best case, or a catastrophic process failure in the worst case.

The integrated design

Separation of BPCS and SIS hardware and software, sometimes even brands, is still frequently the battle cry of many specializing in process safety. In decades past, it was best practice, and frequently the only real choice to remove common cause failures. But the diverse technologies applied in some recent SIS products has evolved significantly and a high degree of integration between BPCS and SIS that maintains functional independence can be safe, practical, and cost beneficial at the same time.

The demands on manufacturing sites to produce more with less has exponentially increased the need for flexibility and creativity in the use of production equipment. Where plants were originally designed to make one product suite, that same plant today may manufacture a large variety of disparate products with chemicals and manufacturing conditions, normally well within equipment design limits, but that require process safety intervention at significantly different conditions across the breadth of the products. Integrating SIS into the BPCS, especially for batch facilities, allows for a well-choreographed and regulated workflow when a change in product recipe on a piece of equipment or an entire process cell means changing SIS functionality.

A product recipe when initiated, can trigger communications with the integrated SIS to make programmatic changes to SIF enable/disable conditions or trip settings. The updates can be approved by an operator with specific functional safety credentials using embedded safe online write (SOW) capabilities. The updated values and conditions can be read back and validation dialogues reviewed and electronically approved by the operator to ensure the requested changes, appropriate to the recipe, have been completed before any actual manufacturing starts.

The human interactions to the process are limited to authorizations and approvals, removing the possibility that a mistyped or a forgotten change that could lead to an undesirable response to conditions by the SIS.

In the above integrated workflow, all of the actions are occurring within either the batch manager (writing values to the SIS logic solver, reading values back from the SIS logic solver for verification, and issuing messages to the operator for approval or authorization), or within the embedded SOW functions. Traditionally where manufactures have attempted to "automate" this functionality in separate systems, the solution involves controller level logic in the BPCS along with hardwired I/O connectivity between the BPCS controllers and the SIS logic solvers as the means of sending data between the two systems. This can increase the degree of complexity in the logic for both the BPCS and SIS leading to opportunities for errors as modifications occur over time. Additionally, the maintenance of these interfaces may add significant lifecycle cost to the operation.

Examples

Some sites are already using at least some form of integration to manage situations where SIS updates are required according to the product targeted for manufacturing. In the following examples, the communication and verification checks are being performed at the control application level.

In one case, the same process cell is used to manufacture two distinctly different product classes. The first is made from a combination of two key reactant chemicals while the second only uses one of them. The reaction conditions of the two primary reactant product demands a small set of SIF conditions to be set at significantly different values than the one primary reactant product. Batch size and ratio of reactants has also been identified as allowing for unreacted species of intermediates to accumulate that can create undesirable results and require different SIF trip points than other recipes. Additionally, when only using the single primary reactant, the SIFs associated with the unused reactant must be disabled so that there is no chance of a "false positive" occurring within those SIFs and causing an unwanted process shutdown.

The integration has been done so that when a product recipe begins, the recipe ID is communicated to the SIS via hardwired I/O signals, where information stored there related to that specific production recipe is identified and updated to the proper setpoints and status inputs to the appropriate SIF applications. The updated values are communicated back to the BPCS controller for comparison. A mismatch between the recipe values and the SIS values results in an alarm and a recipe hold condition until the differences are eliminated.

In a second example, the conditions that identify the safe operating window for the process change when a critical reactant is charged in a single dosing or in multiple dosings. As a result, the SIS trip conditions need to be modified accordingly to maintain safe operating conditions. Again the recipe starts by communicating, via the controllers, the new setpoints to the SIS and the requested values are compared to the SIS parameters for a match before the actual production can begin.

In a more interactive example, a number of material charges are required and each one has special safety considerations as they relate to active and inactive SIFs and conditional trip setpoints for the batch unit. In this case, each step of the recipe sequence during the charging operations sends new values and status setpoints to the SIS. As with the other examples, the updated setpoints are verified prior to the operations continuing with the charging steps.

Summary

Imagine, as in the last example, that without an integrated SIS, there would be a need to have someone making manual updates to the SIS at each of several operations within a single batch. The chances of making a mistake grow exponentially increasing the risk of a dangerous mistake.

Using an integrated BPCS and SIS for hazardous batch operations almost seems more of a requirement than an option, making integrated safety the perfect companion to batch production operations.

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