The Process Safety Management Suite (PSMS) is a range of software packages designed to assist in the lifecycle management of Safety Instrumented Systems. Allowing for a defined and controlled approach to simplifying the design and validation of system development and modification.

The PSMS tools assist engineers, operation managers, control room operators, maintenance teams and many more personnel who have an active role within the systems lifecycle.

These tools have been designed and developed by certified functional safety engineers, providing a package which endeavours to reduce the time and costs involved with the management of a system yet providing an increased understanding and confidence with the operation of the system and the application logic.

The development activities for the PSMS have been externally audited by two independent auditing bodies against the requirements of IEC 61508.
If only our Cause & Effect was up to date in real time

Back Drafting of Cause & Effect documentation can often lag long behind actual system modification processes. CERES can ensure up to date Cause & Effect management, track history and improve safety integrity.

Key features
- Lifecycle Management of Safety System Cause & Effects
- Graphical Interface for developing & maintaining Cause & Effects
- Search tool for querying cause & effect database
- Production of Cause & Effect Drawings
- Full lifecycle history and comparisons
- Red Line mark-up tool for modifications
- Import facility to convert existing Cause & Effects
- Export tool to VESTA for system testing
- Export tool to PALLAS for system monitoring

CERES is a package of innovative software tools that allow for the development, maintenance and life cycle management of Cause & Effect documentation for safety-instrumented systems. CERES acts as an interface to the vast amount of data needed to produce a full system’s C&E drawings and allows for modifications to be directly introduced to the lifecycle of the C&E. CERES introduces a consistency to C&E drawings by maintaining a record of past database versions, ensuring development is carried out on the most current C&E drawings and providing a trail of past modifications. Existing C&Es can also be treated with the same level of lifetime support as CERES provides a tool for converting existing C&E drawings into the CERES C&E style. The versatility of the functions CERES provides a useful and practical software tool for the management and development of SIS C&E Charts. CERES offers high levels of efficiency and control through out the life-cycle of a system’s C&E Charts with powerful and unique functionality.
CERES Design allows the design and modifications of the Cause and Effect database.

Using CERES Design, users can Construct, Destruct and Modify system Inputs, Outputs, Cause and Effect relationships, system notes, system information and Fire/Process Zone mapping.

Each modification is logged with a date / time stamp, the user who implemented the change and the version of the CERES Database.

Before implementing modifications, the version of the CERES Project can be updated. This archives the current version. This allows all previous versions of the CERES DB to be interrogated and compared.

CERES View produces Cause and Effect drawings based on information contained within the CERES database.

The Cause and Effects drawings are created based on user specified templates which allow the Cause & Effect drawings to meet end user document specifications

The CERES Cause and Effect drawings allow for:

- Input/Output Grouping & Segregation
- Display of Voting Inputs, including ANDing, MooN etc.
- Revision History Details
- External Document Referencing.
- Cause & Effects are exported in excel and PDF format
CERES insight provides users with a quick and easy access method to obtain relevant Cause and Effect information. Using the query fields users can enter search criteria to display system and Cause & Effect information relevant to the queried inputs and outputs. This information can be used to swiftly determine the relationships between input and output without the need to search manually through the Cause and Effects drawings.

The search parameters can be saved as CERES queries which can be loaded back to allow for quick access to common searches.

The query results can be exported thereby allowing for reporting and user specific applications.

CERES Versions allows for comparison between two versions of the CERES Project. This allows for pre and post modification verification, highlighting any changes made between the two versions.

The differences are listed and can be displayed on the cause and effect matrix.
CERES Extract can be employed to extract existing Cause & Effect databases, Cause & Effect drawing information and populate a new CERES Database.

Utilising a library of easy to use extractors CERES extract can be used on a large number of formats including Excel, Access DB, Paradox DB, and SQL DB.

If a standard extractor cannot be deployed Process Safety Solutions can produce bespoke extractor tools to remove the need for manual transfer.

CERES Test is an export tool passing the CERES Cause & Effect information to VESTA and PALLAS for off and on site validation of the system Cause & Effect, against the running SIS application logic.
Why does it invariably take over 400 man hours to test my systems application software after only a minor change?

Do you compromise safety integrity and test only those areas affected by the change or accept that in any aspect of manual intervention there could be implication to any part of the system, and carry out 100% Cause & Effect test?

Using the PSMS a 100% system test can be set to run automatically. Typically a system test on 1000 I/O system test would complete in approximately 6 hours.

Key features

- Testing of Cause & Effects to verify functionality of Safety PLC application logic
- Import existing C&E charts in a variety of formats (Autocad, Excel etc. via CERES)
- Create Test Sequences to mimic C&E functionality
- Automatically condition System to a ‘healthy’ state
- Full Cause and Effect testing of System logic
- Verification of expected Effects against initiating Causes
- Detection of unexpected Effects
- Production of C&E Charts and reports from tests
- Fully automated, fast, accurate and repeatable testing
- Carry out ‘before’ and ‘after’ verification of system application logic
- Pre and post modification. Compare results.
- Fully satisfies the requirements of IEC 61511 Part 1 Clause 17.2.7 Paragraph 9: “Tests used to verify that the change has not adversely impacted parts of the SIS which were not modified.”

VESTA is an innovative off-site conditioning and test tool for safety instrumented systems (SIS) that allows completely automated testing of safety application programs, running on a variety of target hardware. It simulates inputs/outputs (Causes) into the safety application running on a Safety PLC or emulator, then compares the expected outputs’ states (Effects) against actual Effects observed, and produces reports, based on the results of testing. The need for clumsy arrays of switches and lamps typically required to carry out SIS application verification testing is not only eliminated with VESTA but the speed, repeatability and accuracy of such testing procedures is vastly improved.

Application logic modifications may also be tested in the same manner, allowing an audit trail to be produced; pre and post modification.
VESTA maintains a database of Tags, System Addressing and Tag Trip Points. These Trip points include Low Low, Low, Mid, High and High High. These Trip points can be called using Trip commands within VESTA sequences and CERES Cause & Effects.

VESTA allows for the allocation of set points to each analogue input and sets the normal state of each digital input and output.

Sequences

The VESTA Sequence editor can be utilised to define VESTA test sequences which can be used to validate a large variety of SIS functionality, including:

- Analogue Span Checks
- Differential Trips
- Time Delay Trips
- Voting
- Override Testing
- Logic Function Testing
- Function Block Testing
Cause & Effect Testing

After the Cause & Effect test is completed, VESTA produces a test report detailing any discrepancies between the defined Cause & Effects and the tested application logic.

This report can be utilised as evidence of the full Cause & Effect testing and can be used in conjunction with factory acceptance documentation.

Test Reporting

<table>
<thead>
<tr>
<th>Name</th>
<th>Expected Trip</th>
<th>Un-Expected Trip</th>
<th>Expected Trip. Not Recorded</th>
<th>No Trip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol</td>
<td>X</td>
<td>X</td>
<td>O</td>
<td>No Trip</td>
</tr>
</tbody>
</table>
Key features

- Live Cause & Effect Matrix Viewer
- Cause & Effect information can be converted from various standard formats
- Alarm and Event Logging
- Replay of logged data from PALLAS or ESOE
- Connects to Safety PLCs via OPC
- OPC Alarms and Events (1.x)
- OPC Data Access (1.x, 2.x and 3.x)

PALLAS is a live Cause & Effect Matrix viewer for onsite Cause & Effect verification and alarm logging.

The main feature of PALLAS is the live viewing of a C&E Matrix as alarms and events occur in the system being monitored. Causes will be highlighted as they happen and any corresponding Effects which are initiated in the SIS by the input change are monitored and compared to the C&E Chart for the system.

The comparison between live data with the system C&E Charts allows for a clear understanding of how the system operates with regards to Cause and Effect, it also offers an immediate insight into problems or faults within the system or C&E Charts.

Logs are kept by PALLAS of every event which happens in the system therefore offering a view of historical data and logging of data up to the exact moment of any potential problems or shutdowns.

Why does it take hours of trawling though Sequence of Events Logs to identify what caused the Shut Down?

PALLAS’s historic playback feature allows for the First Up trip to be quickly identified using the Cause & Effect playback mode, assisting with Root Cause analysis, resulting in more efficient shut down analysis and plant recovery.
PALLAS has a Live Cause & Effect Viewer. Utilizing known 'normal' system states, the current system state (Using the A&E data) and a Cause & Effect matrix defined from CERES (or manually).

When a system input transitions to a tripped state, the input is flagged as tripped on the input section of the Cause & Effect matrix.

PALLAS also monitors the system outputs highlighting when the outputs transition to trip.

If input and output correspond based on the defined Cause & Effect information, the appropriate intersect will be highlighted as tripped.

If there is any discrepancy between input and output, either an unsuccessful trip or an unexpected trip, the intersect field will be highlighted as failed.

The colours displayed on the matrix are user configurable allowing PALLAS to conform to end user requirements.

Once connected to an OPC Alarm and Events Server PALLAS starts logging all events. These events are stored locally on the PALLAS PC allowing for access to historical event data.
Each element defined within PALLAS can be associated with feedback inputs. These inputs can include valve limit switches and switchgear tell backs.

Numerous feedback signals can be declared for each output and the ‘healthy’ and ‘tripped’ feedback states must be declared.

Using this information, an output discrepancy is flagged and logged when the feedback signals disagree with the output state.

This feature acts as a record for end-to-end testing of system and elements.

Using the feedback signals, output timing can be measured allowing for the open/close times of valves etc to be recorded.

PALLAS calculates the time between the system output state change and the feedback signal confirmation.

These time values are logged and allow for access to a large number of timing data. This data can be used to monitor valve health and to assist in valve maintenance.

Using the archived A&E data, PALLAS can replay the historic system events allowing for plant shutdown occurrences to be replayed and to assist in Root Cause Analysis.

Using the time stamped data, PALLAS can replay in ‘real time’ or step by step the shutdown occurrence highlighting first up inputs and allowing operation personnel to identify the cause and the shutdown quickly and efficiently, allowing for quicker plant recovery.

The log files can be extracted from the on-site PALLAS PC and transferred to any other PALLAS PC allowing for data to be analysed by off site personnel, including maintenance, management and governing bodies.
Cyclic Cause & Effect Verification

Utilising CERES, VESTA and PALLAS, a complete confidence with a systems Cause and Effects can be achieved.

On many existing installations, the Cause and Effect drawings are static "dumb" drawings which cannot be interrogated by software.

The traditional means of testing the Cause & Effects against the system was a long paper exercise where an engineer would sit with the application logic running off a computer, force each input and then check each output against Cause & Effect print outs.

This method was time consuming and costly and unattainable to repeat after every system modification.

Utilising CERES and VESTA, once a systems Cause and Effects has been defined within CERES, the same information can be used to generate the Cause & Effect drawings is placed to VESTA for testing.

Once the application software has been implemented on site PALLAS can be utilized. Placing the same Cause & Effect information from CERES to PALLAS, PALLAS can monitor the live system and flag up any discrepancies found during operation.

Once the application logic has been tested by VESTA, the test report will highlight any discrepancies between the CERES Cause & Effects and the application Cause & Effects.

Once these discrepancies have been resolved, the VESTA test should yield no discrepancies. When this has been achieved the knowledge that the Cause and Effect database, the Cause and Effect drawings and the Cause and Effect application software match has been accomplished.

Cyclic Cause & Effect Verification

Employing CERES, VESTA and PALLAS in a PLC based system a cyclic verification of the system and system modifications can be accomplished.

Once a basic line CERES DB has been developed and verified against the application logic using VESTA, the following can be followed for any system modifications:

1. Modify the application software as per project documentation.
2. Test the modified application software using VESTA against the base line Cause & Effects.
3. Any discrepancies flagged will highlight any modifications made to the logic.
4. Modify the CERES database with the appropriate changes.
5. Using CERES Versions, confirm the modifications are correct against the baseline database.

Once the modified application has been installed on site, PALLAS will be loaded with the latest Cause & Effect Database and begin to monitor the modification.

Once the modification has been confirmed on site a full confidence with the systems Cause and Effects has been achieved.