HEXAGON

White Paper

Leveraging the Engineering Design Basics Across the Plant Lifecycle

SmartPlant® Enterprise for Owner Operators

Contents

1 Executive Summary

Hexagon PPM's SmartPlant® Enterprise for Owner Operators (SPO) solution uniquely enables owner operators (O/Os) to manage the technical complexity of the virtual plant asset and associated work processes in one place, during all phases of the lifecycle.

With SPO, O/Os can significantly lower capital expenditures (CAPEX), achieve production startup earlier, lower operating expenditures (OPEX), reduce revenue loss due to unplanned outages, minimize health and safety risks, and ensure demonstrable compliance with laws and regulations.

Owner operators can greatly benefit from interoperability between the dynamic engineering design basis and other information systems in the context of critical work processes across a plant's lifecycle. SPO provides preconfigured work processes and out-of-the-box integrations with operations systems to provide major efficiency and information consistency improvements across the owner operator system landscape. SPO manages Process Safety Information, providing a platform to support Process Safety and Asset Integrity Management initiatives. Comprehensive solutions for data validation and handover reduce the time and costs of data take-on and ensure the quality and completeness of data handover. The solutions support both the incremental and final handover of information and documentation between contractors, and from contractors to the O/O.

SPO's modularized template solutions allow for highly flexible implementation strategies. The user can begin with a fast-initial implementation and incrementally extend the implementation with new work processes and capabilities as required.

1.1 Overview

The purpose of this white paper is to review owner operator challenges throughout the lifecycle of a plant asset and the role Hexagon PPM's SPO can play in meeting these challenges. This paper:

- Discusses some of the key work processes related to
  - Greenfield/brownfield project execution
  - Handover to operations
  - Plant operations
  - Plant maintenance
- Highlights
  - Hexagon PPM's solutions and their associated benefits
  - Quantifiable return on investment
- Presents the Hexagon PPM approach to SPO implementation
- Explains the technologies explored.

1.2 Introduction

Throughout the years, many O/Os have chosen Hexagon PPM's industry-leading SmartPlant Enterprise integrated suite of tools to manage their dynamic engineering design basis. Building on this success, Hexagon

PPM developed SPO. SPO offers preconfigured work processes covering the complete plant lifecycle and interoperability with third-party operations systems such as maintenance, reliability, and inspections systems.

SPO supports integration with Hexagon PPM's world-leading SmartPlant Enterprise design tools to enable the maintenance of the engineering design basis throughout the plant lifecycle, but recognizes that information deliverables typically are also received from many other third party sources and can seamlessly accommodate and manage these.

1.3 Business Drivers

Owner operators in the capital-intensive process, power, and marine industries are facing greater challenges to their profitability and long-term viability than ever before.

- Owners are expanding existing facilities and building new capacity to meet growing demands in the global market. They must do this safely, with finite resources, within demanding schedules to minimize time-to-market and maximize time-in-market, and within stringent capital expenditure (CAPEX) budgets. CAPEX projects are growing larger and more complex, both in terms of expenditure, regulations that must be followed, and number of stakeholders involved.

- Operations are also under unprecedented pressure to maximize asset performance to achieve safe, sustainable production at lowest possible costs (operating expenditures, or OPEX), while global competitive pressures have never been higher.

At the same time, regulatory authorities' demands for compliance are on the rise, and owners are responding by implementing process safety management and asset integrity programs. The owner operator's "digital twin," in-plant documentation, and IT systems must be consistent with the current physical state of the plant in operation. Also, a demonstrable management of change process is needed with full traceability and a complete audit trail of plant changes.

Retention of plant knowledge in the face of an aging workforce is an additional unavoidable factor owner operators increasingly confront given current demographic trends. Systems are required to capture knowledge and provide a standard solution platform to enable workers to be flexibly deployed across multiple plant assets.

Certain industry segments face additional drivers, such as:

- Life sciences industry – Short patent windows drive a need to go into production sooner.

- Chemical industry – Certain products may be in high demand, but with considerably less margin if there is an overproduction.

- Power industry – Reliability of power supply must be ensured and load shedding avoided.

Hexagon PPM understands the urgency of these business drivers, and responds with solutions that are quick to implement, easy to learn, and provide a rapid return on investment. Our SPO solutions are designed to offer fast, low-cost, and low-risk implementations. We have modularized our SPO solutions to allow for a fast-initial implementation and subsequent incremental implementation of additional work processes as and when required.

Hexagon PPM not only understands these business developments, but also pioneers the course of engineering technology solutions. We have provided powerful, comprehensive, and proven solutions to build and operate plants for decades. Our aspiration is to partner with owners so they become the best in their businesses.

2 Overview

Sid Snitkin, Vice President and General Manager of ARC Advisory Group, discusses in his white paper, “Improve the Functional and Financial Performance of Your Plant through Better Plant Asset Information Management,” the importance of information management and interoperability[1] between work process participants in achieving maximum profitability for the owner operator.

Snitkin identifies that, “Achieving high (plant) performance requires a different model of Asset Lifecycle Management, and an information management infrastructure that enables effective Interoperability among all stakeholders.” He proposes a DOMinO model (Design, Operate, and Maintain for Owner Operators), which highlights the interoperability needs between groups (both the internal and external Design, Operate, and Maintain (DOM) teams) and the importance of a common web portal, as shown in Figure 1.

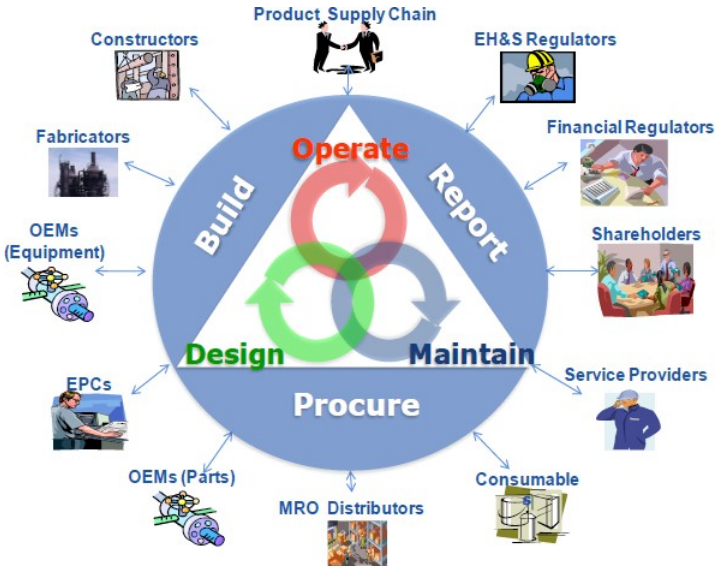

Figure 1: ARC’s DOMinO model enables interoperability with the external DOM team.

Snitkin cites Hexagon PPM’s SPO as an illustrative example of an initiative in line with the DOMinO model through the provision of interoperability between the highly dynamic engineering design basis and other operations systems. SPO provides a common, role-based web portal and interfaces for the integration of business processes across the project value chain.

To meet these challenges, facility owners have a mandate to improve work processes and affiliated costs to retain a competitive edge and increase market share and their margin. These challenges find resolution not through the traditional CAD path, but via an exponentially more efficient process – a data-centric approach that transforms engineering data into a strategic asset that is as valuable as the physical plant itself.

[1] Interoperability can be defined as the ability to manage and communicate electronic product and project data between collaborating firms and within an individual company’s design, construction, maintenance, and business process systems.

Hexagon PPM's SPO solutions form the engineering design basis for the plant and the gateway to communicate with other operation-critical systems, such as Computerized Maintenance Management Systems (CMMS), Distributed Control Systems (DCS), Enterprise Resource Planning (ERP), reliability, and safety systems.

Data and data interrelationships are the key to the plant's asset configuration and management. This new technological approach offers a much more effective way to create, modify, and access plant information to support operational tasks than document centric approaches of Enterprise Content Management/Document Management systems. The owner can begin to significantly lower costs at commissioning and handover with the delivery of datasets in an accurate, well-organized, and non-redundant format.

Plant operation revolves around continuous safety and reliability. SmartPlant Enterprise lifecycle products assist directly support these priorities by assisting with planning maintenance, risk-based inspections (RBIs), and scheduled plant shutdowns – minimizing shutdown time, maximizing productivity, optimizing product quality, facilitating training of new operations personnel, and ensuring the safety of personnel and the entire facility.

The importance of the plant data lies in the asset it represents, rather than in the data itself. It is an integral part of every phase of the plant lifecycle, from the bid proposal and conceptual design to operations, maintenance, and finally decommissioning. At some point in time, every person involved in the operation of a plant must access plant data to perform his or her tasks. Therefore, it is critical that data is continually kept up-to-date, accurately reflecting the physical as-built plant at all times.

Given that no single company can answer all the needs of the plant owner, Hexagon PPM provides an open software platform and has adopted a partnership approach that combines Hexagon PPM's engineering and operating software with complementary software from other leading industry vendors, resulting in a holistic, truly effective solution for the life of the plant. The alliance serves as an integrated operational solution, based on Hexagon PPM SmartPlant Enterprise, which integrates both within the SmartPlant product suite and with partner applications.

SPO is based on Hexagon PPM's SmartPlant Enterprise suite of industry-leading information management and design tool applications (see Figure 2). SPO provides key out-of-the-box, preconfigured owner operator work processes; integrations with other leading third-party owner operator systems for maintenance, reliability, DCS, etc.; and a common web client. In addition, SPO provides data exchange with contractors and suppliers, as well as validation, transformation, and loading of data exchanged to facilitate project execution throughout the project value chain.

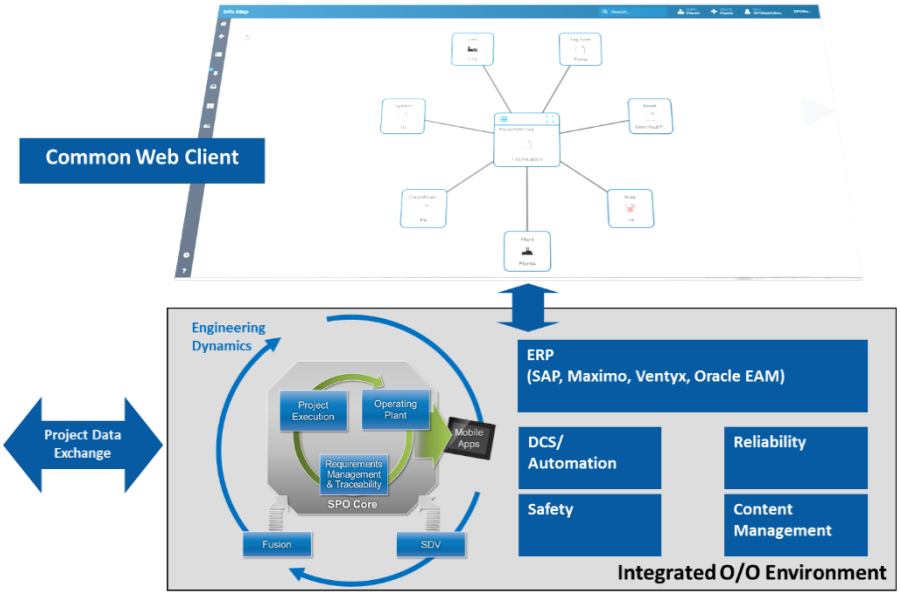

Figure 2: SmartPlant Enterprise for Owner Operators is a modular solution, providing interoperability with other operations systems

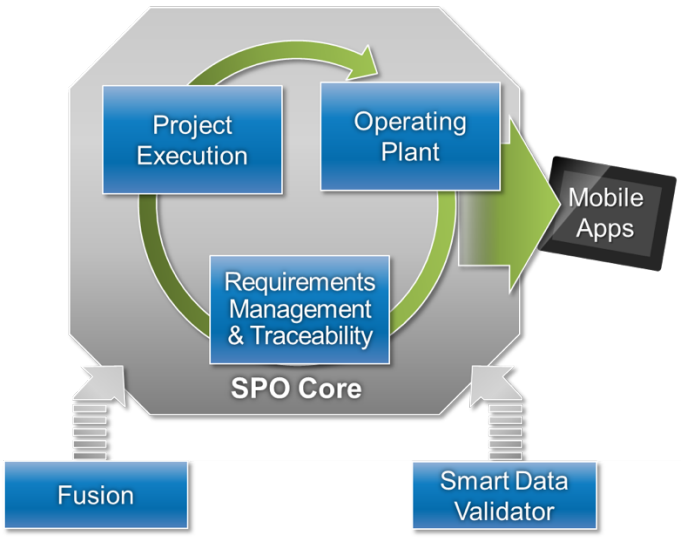

Figure 3: SmartPlant Enterprise for Owner Operators offers nine solutions.

SPO is comprised of seven solutions as shown in Figure 3. Each SPO solution provides out-of-the-box preconfigured work processes:

- SPO Core Solution – Manages work processes relevant to the entire plant lifecycle, such as plant breakdown structure, work breakdown structure and tag management, document management, Microsoft® Office integration, transmittals, electronic dossiers, risk-reducing measures, Action and Issue Tracking, and data loading.
- SPO Operating Plant Solution – Manages work processes relevant to the operations and maintenance part of the plant lifecycle, including management of change, equipment inspection, and synchronization of the dynamic design basis with the computerized maintenance management system and other third-party systems.
- SPO Project Execution Solution – Manages work processes for successful greenfield/brownfield project execution delivery, including management of change in projects, interface management, non-conformance (deviation/waiver) management, and management of technical and site queries.
- Intergraph Smart® Data Validator (SDV) – Manages data collection from multiple sources (contractors, suppliers, and legacy systems) and provides a secure staging area for data validation prior to loading into operations systems, including SPO or third-party systems such as CMMS, reliability, inspection, and content management systems. SDV also manages the handover of data and documents between SPF based systems, for example between EPCs using SmartPlant Enterprise and an O/O using SPO.
- SmartPlant Fusion – Makes unstructured information deliverables such as 2D CAD drawings, scanned images, and office documents available in a structured environment. Techniques including OCR and hot-spotting extract intelligence from existing files and create relationships within SmartPlant Fusion. End users can access documents quickly and easily through a web portal. Documents and tags from Fusion can be promoted from Fusion to SPO Core where they can be managed in a structured environment. For more information, refer to the SmartPlant Fusion Solution Sheet and white paper.
- Hexagon PPM mobile solutions - A new generation of SPO mobile app is planned to be available on Android and iOS. This solution allows for briefcasing of tags and documents, online/offline access annotation of documents and capture of photos, video and audio clips.
- SPO Requirements Management and Traceability Solution – Enables O/Os to identify and track specific requirements in laws, regulations, international standards, corporate best practices, etc. and show how these are satisfied in the plant configuration and design specifications. The solution provides auditable traceability and demonstrable compliance for regulated industries such as nuclear power and pharmaceuticals as well as other industries where requirements need to be positively tracked against information deliverables and the plant design or physical plant assets. This traceability provides an instant “impact analysis” to plant components and documentation affected by changing requirements, as well as rapid confirmation of governing requirements and design basis documents when identifying proposed physical or information changes to a plant.

The preconfigured SPO template work processes may be rapidly adjusted to meet any customer’s specific needs. This is further discussed in “Section 6: Implementation” of this white paper.

Many of the solutions prepared for SPO are equally relevant for Project Management Contractors and EPC contractors. SPO solutions are available to contractors under SmartPlant Enterprise branding with identical capabilities. The only difference is found in the commercial licensing arrangements.

3 Work Processes

The heart of SPO is the delivery of template work processes. We developed a highly structured methodology to define these work processes, and categorize them at three levels of detail (see Figure 4).

- Level 1 – An owner operator work process is described, independent of the tools used to execute the process. The focus is to define the roles involved and the high-level steps involved.
- Level 2 – The Level 1 work process is mapped to the applications involved in the work process at a high level.
- Level 3 – The Level 2 work process is mapped to the detailed actions performed, including details of transactions undertaken in applications. Where appropriate, links are provided to annotated screenshots or AVIs that explain each step in the process in detail.

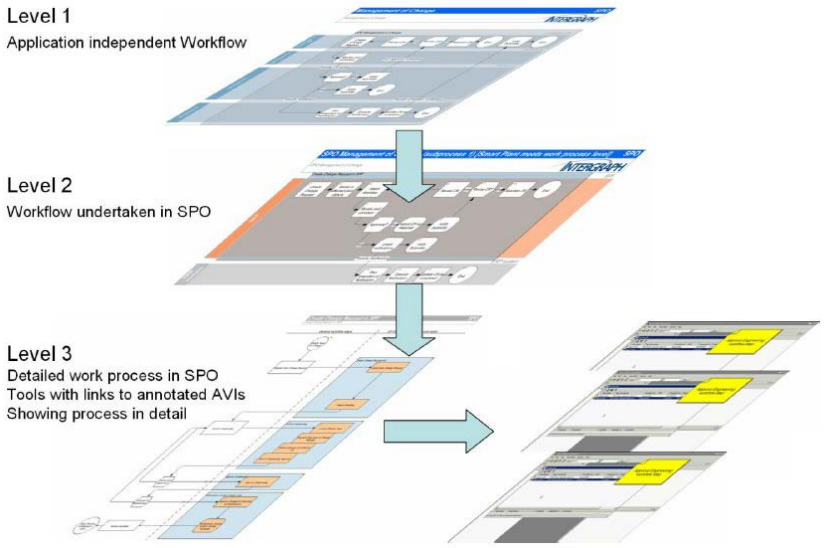

Figure 4: SPO offers three levels of work processes.

These workflow diagrams provide both a model and basis for the consistent development of the work processes delivered in SPO, but they are available to customers as a published web-based help system. The published diagrams provide an intuitive guide to the user, showing the work process provided in SPO. Simple hyperlink drill-downs to increasing level of detail and annotated videos represent how work process steps will be executed. This provides a simpler, more interactive form of user assistance than lengthy function/feature-based help documentation, and promotes rapid learning and consistent use of the solutions.

4 Solutions and Business Packages

SPO's template solutions are composed of business packages that address one or more specific work processes. The following sections describe each solution and the work processes covered in each.

4.1 SPO Core Solution

The SPO Core Solution includes business packages covering key work processes relevant throughout the facility lifecycle. This solution provides a common information integration hub for all SPO work processes, and is a prerequisite for the implementation of the following SPO solutions:

- SPO Project Execution Solution
- SPO Operating Plant Solution
- SPO Requirements Management and Traceability Solution

The following business packages are currently available as part of the SPO Core solution.

4.1.1 Core and Plant Breakdown Structure (PBS)

Establishing the plant breakdown structure[2] and organizations involved with an asset – such as disciplines, contractors, O/O organizational units, suppliers, etc. – is a fundamental activity required to manage the design basis of any plant. The Core and PBS business packages enable the bulk load of the PBS (system, area, unit, etc.) from Microsoft Excel®.

4.1.2 Work Breakdown Structure (WBS)

The Work Breakdown Structure business package manages development projects, turnarounds, modification projects, and the breakdown of work into packages. A generic work package capability allows users to create different types of packages and sub-packages (such as turnaround package, fabrication package, and maintenance package). Packages may be linked to each other to provide a WBS hierarchy, and linked to tags, documents, and elements in the PBS to facilitate activity planning, as shown in Figure 5. Work packages can be placed on workflows for review, approval, and implementation. Work packages are also used to assemble tags to be published as a tag allocation package from SPO to SmartPlant design tools.

[2] A plant breakdown structure is the systematic subdivision of a plant from multiple perspectives, e.g., by area, system, discipline, fire area,

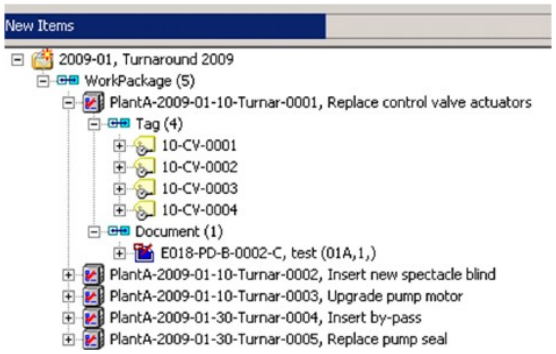

Figure 5: This example of a turnaround package shows an associated document and tags.

4.1.3 Document Management

Effective and consistent management of documents with auditable traceability is essential for operations to demonstrate regulatory compliance and manage the vast numbers of documents that describe a complex process facility. Projects require a comprehensive document management system to manage the enormous volumes of generated design, vendor, and administrative documents and to organize these for a structured handover to operations.

The Document Management business package comprises a comprehensive set of work processes for document management, including the central allocation of document numbers, capture of document metadata, file archiving, distribution/review, subscription, check-in/check-out, and online approval and transmittal of documentation, both internally and externally.

This business package supports full revision history and linking of documents to the PBS, tags, referenced documents, contracts, disciplines, and more to facilitate flexible location and retrieval. It also covers the management of engineering documents/drawings, vendor documentation, and non-revisable administrative documents such as correspondence.

4.1.4 Microsoft Office Integration

To simplify the use of SPO solutions, Hexagon PPM provides close integration with Microsoft Office applications (Word, PowerPoint®, Excel, and Outlook®). Users can drag-and-drop their Microsoft Office files, including Outlook emails with attachments, onto the SmartPlant Foundation Desktop Client to initiate the capture of a document. They will be prompted to enter document metadata, and any attachments will be automatically captured.

An “add-in” to Microsoft Office applications allows users to save documents to SPO or retrieve from SPO without using the SPO desktop client. When saving a document, users will be prompted to enter the same metadata they do when interactively creating a new document in SPO, and the file will automatically be checked into SPO. When checking out a document, users will be prompted to identify the type and class of document before receiving a list of documents from which to select.

4.1.5 Transmittals

The Transmittals business package manages the receipt of incoming documentation, internal distribution of documents within the owner operator organization, and distribution of documents to external parties. This includes out-of-the-box incoming, internal, and outgoing transmittal letters and electronic workflows.

Document distribution matrices ensure a consistent distribution of documentation and recording of whether documents are sent as hardcopy attachments or via electronic notification. The workflows provide a permanent, auditable record of the documents distributed and acknowledgement of receipt or approval, as required.

4.1.6 Electronic Dossiers

O/Os manage many complex dossiers or data books, including:

- System operating manuals
- Commissioning dossiers
- Vendor data books
- Manufacturer record books
- Fabrication record books

Traditionally, these are hardcopy compiled documents, which makes it difficult to locate information and are laborious and expensive to maintain. Converting these hardcopy manuals to electronic scanned PDF files does not help, and even makes maintenance and locating information more difficult than with hardcopy dossiers.

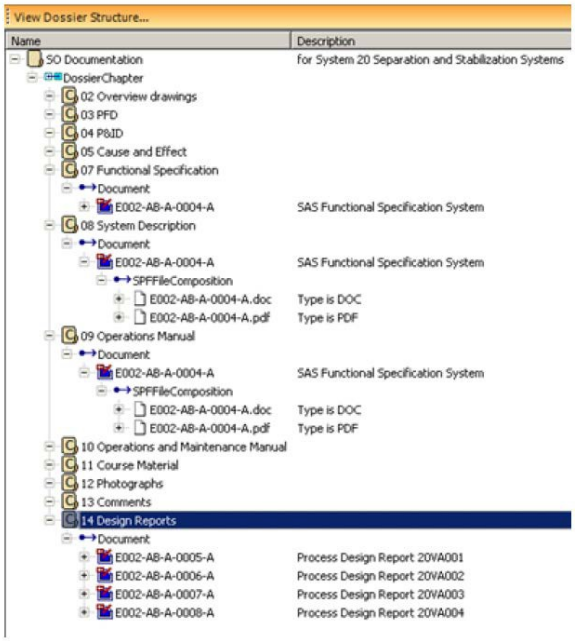

Figure 6: This is an electronic dossier structure with chapters and documents.

The SPO Electronic Dossier business package includes a simple generic capability to manage structured documents that contain sections or chapters, which contain other documents. Each dossier can be made up of one or more chapters, and each chapter can have child sub-chapters, sub-sub chapters, and so on without limit. Each chapter or sub-chapter may be associated with one or more documents, or alternatively, files may be attached directly to a chapter. The user may determine the sequence of both chapters and documents shown within a dossier.

As shown in Figure 6, the resulting electronic dossiers faithfully reproduce the structure of an equivalent physical dossier. The simple hierarchical structure of chapters and documents enables users to quickly find the information they need. Electronic dossiers are integrated into the engineering design basis, enabling dossiers and documents within chapters to be quickly located through many alternative routes, including Plant Breakdown Structure, PO/Contract, Tags, etc.

Maintenance of dossiers is simplified by being able to reuse existing documents as dossier content. The need to update multiple dossiers in different physical locations is eliminated by having a central, common electronic dossier accessible by all users.

Another innovation to reduce the effort in maintaining dossier chapters is the introduction of dynamic or static chapters. Dynamic chapters will automatically always display the latest current version of a related document. For example, if a System Operating manual has a chapter for P&IDs, we will typically want to see the most current revision. Static chapters will always show the specific revision originally related, even if the document is revised subsequently. For example, in a completions dossier where a record of inspection is made, we will always wish to see the specific record related to the completion performed.
PDF renditions of dossiers can be produced for ease of distribution, these include intelligent contents lists with bookmarks linking to the relevant chapter for fast, simple navigation.

4.1.7 Risk-Reducing Measures

Managing risk is all about the mitigation of identified risks by reducing their severity and/or the likelihood of occurrence. Emergency preparedness analysis starts in the early stages of facility development to ensure risks are identified and mitigating measures are put into place. This helps avoid major, costly changes at a later stage.

A risk-reducing measure (RRM) is employed when a hazard is identified through processes such as Hazard and Operability study (HAZOP) or Failure Mode, Effects and Criticality Analysis (FMECA), and the risk evaluation concludes the risk is unacceptable. RRMs involve reducing the probability and consequences of risks, or finding inherently safe solutions to identified risks. Risks can never be eliminated completely, but residual risk should be as low as reasonably practicable (ALARP). ALARP is based on reducing risk to a level at which any further reduction in risk would involve costs grossly disproportionate to the benefits gained. As low as reasonably achievable (ALARA) is an alternate term used by the U.S. nuclear industry for the same concept.

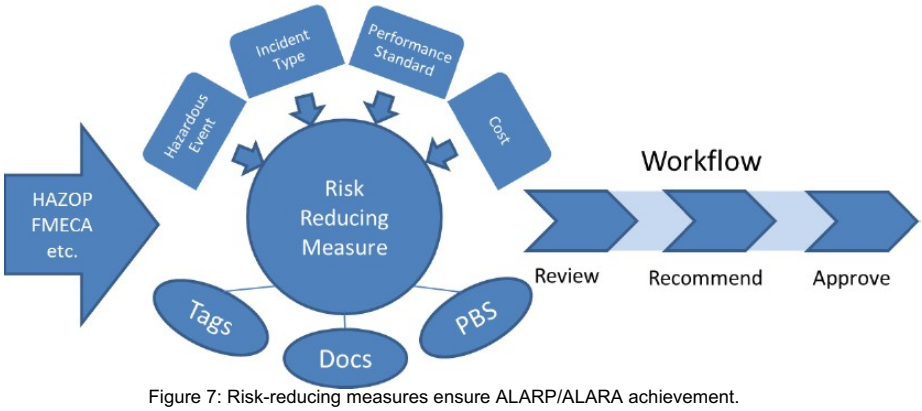

Figure 7: Risk-reducing measures ensure ALARP/ALARA achievement.

As shown in Figure 7, the RRM business package in SPO enables the registration, review, and approval of risk-reducing measures. Information such as incident type/danger classification, hazardous event classification, and estimated cost are captured, along with explanatory attachments. A template workflow ensures a consistent review and approval process is followed and a permanent record offers auditable traceability. The process is tightly integrated with the engineering design basis, which enables the RRM to be related to elements of the PBS, tags, and documents. This means that the impact of changes to the design basis on RRMs can be identified and assessed. When RRMs result in project changes or non- conformities, they can be related to the RRM to provide a complete audit trail.

4.1.8 Action and Issue Tracking

During the execution of projects and operations, thousands of tasks need to be performed, some by individuals and some by groups working in collaboration. The completion of tasks, including the ability to provide documentary evidence and auditable traceability for key tasks, is important to be able to demonstrate compliance to regulatory authorities.

Tasks may be related to activities such as Process Hazard Analysis (PHA), Audits, Incidents/Accidents, Minutes of Meetings (Technical Committee Meetings, Site Meetings, etc.), and many others.

For management, it is important that a clear overview is available of the status of all open actions and items and issues on hold, and that timely reminders and notifications are issued.

Companies typically manage actions and issues through a manual Minutes of Meeting Process, Microsoft Excel spreadsheets, or, in some cases, dedicated Action Tracking software. These tools do not provide for integration with the engineering design basis or other processes.

In SPO, tasks may be classified as Actions or Issues, as defined below:

- Action – A task assigned to a person for resolution which can be completed and has a defined deadline for completion. Action items may be a subset of an issue or may be a stand-alone item (e.g., an assignment as a follow-up to a meeting discussion).

- Issue – An issue is a point or matter in question or in dispute, or a point or matter that is not settled and is under discussion, or over which there are opposing views or disagreements. Issues may be highly visible, involve external stakeholders, and have critical deadlines.

NOTE: Items that are “normal” day-to-day tasks related to a person’s normal job duties are not considered issues or action items.

For both actions and issues, it is important that the results and rationale for decisions are effectively captured and retained for inspection.

The SPO Core Action and Issue work process takes a task through creation by the originator and identification of an Assignee and a Verifier who approve the completion of the action or issue. A workflow guides the action or issue through the process of execution through to verification, providing auditable traceability. During the execution, collaborators may be identified who can provide input to the resolution of an action or issue (see Figure 8).

Actions and Issues are linked to plant configuration items such as the PBS, tags, and objects in other SPO solutions such as changes, completions, non-conformities, etc. to provide further traceability and support to these processes.

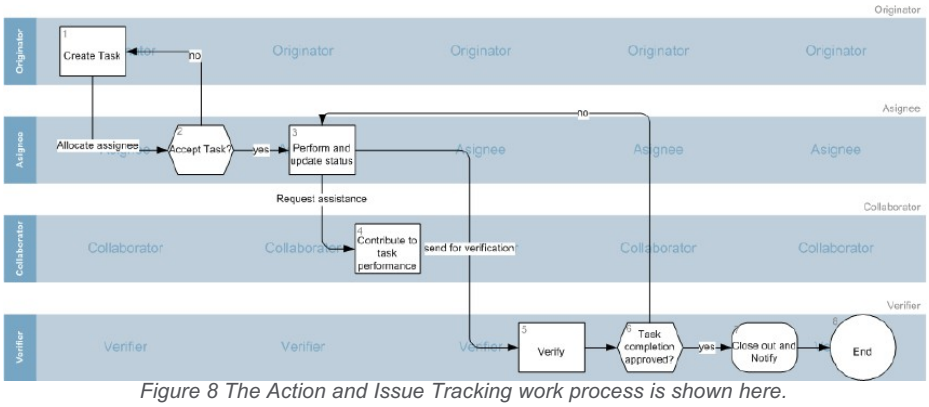

Figure 8 The Action and Issue Tracking work process is shown here.

4.1.9 Tag Management

An essential activity during all phases of the plant lifecycle is the consistent and accurate allocation of tag numbers in accordance with the plant engineering numbering system. The capture and maintenance of design properties in tag indexes is equally important. Managing tag number allocations during major development projects can be especially onerous, because errors are very costly to rectify.

The Tag Management business package provides the centralized allocation of tag numbers in accordance with a pre-defined engineering numbering system, the maintenance of tag data and the publishing of tag details (as supported by existing SmartPlant adapters) to SmartPlant Enterprise design tools. The engineering numbering system is extremely flexible, enabling configuration of a wide range of tag formats. Tags may be allocated one at a time, or a range of tags may be allocated in a single operation. Manual override of the sequence number can be provided when required. The central allocation mechanism can accommodate legacy data and take this into account when allocating new tag numbers.

Users may relate tags to each other to provide a tag hierarchical structure or to indicate to/from connectivity between tags. Tags may also be related to elements of the PBS, work packages, documents, and to other processes in SPO Core and other solutions such as actions, risk-reducing measures, changes, non- conformities, and many more.

4.1.10 Manufacturer, Asset, and Models

Managing relationships between tags (design intent), models (typical materials), assets (serial numbered equipment), and manufacturers is very important for plant owners. If these relationships can be established during a greenfield/brownfield project, they provide an excellent basis for establishing the plant asset structure required in the plant's computerized maintenance management system. Ensuring cross-references to the existing material catalog in SAP® Materials Management (MM) or another catalog provides a basis for achieving Maintenance, Repair, and Overhaul (MRO) inventory reduction.

The cross-reference of vendor documentation describing the installed equipment to models and assets and linking only vendor design information to tags provides a number of benefits. This approach:

- Reduces effort by package-responsible engineers during projects to review the same documentation received from different packages
- Improves access and reduces effort in maintaining plant documentation during operations
- Leads to a major normalization of supplier documentation

Hexagon PPM has received reports of more than 60 percent reductions in the volume of vendor documentation for complex equipment packages, such as compressors, where this has been applied.

4.1.11 On-Plant Engineering and Design

Maintaining the dynamic design basis in-line with plant design modifications during the plant lifecycle is a critical, demanding activity. SPO is based on Hexagon PPM's integrated SmartPlant Enterprise platform and is fully compatible with all SmartPlant tools. SmartPlant Foundation performs the role of both an integration hub between the design tools and third-party applications, and a highly flexible repository for plant data and workflow engine. Design tool integration ensures consistency of information between disciplines and design tools. It also supports the automated publication of design outputs in the form of documents and drawings into the central common repository, providing a common, authoritative source for the latest released documentation of an asset. Discrepancies between the information published from design tools can be highlighted for resolution.

4.1.12 Data Loading

Typically not all data and documentation in SPO for a facility comes from Hexagon PPM design tools. The Data Loading business package includes Excel templates to facilitate the control and loading of data and documents from third party sources to SPO. Embedded macros generate load files that can take a completed Excel worksheet and generate load files that users can easily import into SPO.

4.2 SPO Operating Plant Solution

The SPO Operating Plant Solution builds on the SPO Core Solution, and provides business packages supporting common, critical work processes for the operating plant.

The following business packages are currently available as part of the SPO Operating Plant Solution.

4.2.1 Management of Change in Operations

Maintaining the accuracy of essential plant engineering, maintenance, and operations information is vital to safe and efficient plant operations. Managing plant change is a safety-critical process. Traceability of plant changes and auditability of the management of change process are essential to demonstrate compliance with regulatory requirements.

Hexagon PPM designed the Management of Change in Operations business package to provide rigorous management of change (MOC) of engineering information with full traceability and audit trail.

The preconfigured MOC process includes an electronic workflow for managing the review, authorization, design, and approval of changes in the engineering design basis, and optionally the notification of maintenance to perform changes by creating notification records in the plant maintenance system (SAP PM).

> This business package also covers the impact assessment of engineering change. During the planning of engineering change, plant engineering must anticipate the implications of planned plant change. The linking of affected plant items (tags, documents, and parts of the PBS) to changes facilitates the assessment of change impacts with other ongoing or pending changes to identify, for example, potential synergies or conflicts between change requests.

4.2.2 Synchronization of the Engineering Design Basis with Third-Party Systems Including CMMS

Plant configuration data resides in the CMMS and other operations systems such as ERP inspection, reliability systems, etc. Keeping this data updated with changes in the engineering design basis is essential to ensure that equipment is properly maintained and inspected and that other processes, such as procurement, have access to the correct data when purchasing replacement parts. Most O/Os depend on manual processes to ensure that plant design changes during operations are reflected in the CMMS. Unfortunately, these processes often prove unreliable, resulting in:

- Gradual degradation of quality of information in operations systems
- Reduced plant reliability
- Increased frequency of undesirable incidents
- Errors in procurement

SPO addresses this problem by providing an automated interface to synchronize changes in the engineering design basis with other operations systems that depend on this data.

The process provided by SPO is generic and configurable. The data sent to each system can be tailored per tag type. SPO offers out-of-the-box, end-to-end synchronization for SAP PM (see Figure 9). But the mechanism is flexible and can be rapidly applied to other systems. The interface can either make use of direct API to API integration or connect via middleware such as SAP NetWeaver or MS BizTalk.

4.2.2.1 Out-of-the-Box Integration with SAP PM

Where tags are created, updated, or terminated in the design basis, the synchronization mechanism will trigger an automated creation or update of the corresponding functional location in the plant maintenance system. In practice, not all tags will be sent to SAP PM as functional locations; each owner has its own rules as to which tag types at what lifecycle states should be transferred to SAP. For example, most owners do not send cables or signals to SAP PM. Similarly, most owners do not send tags to SAP when they are first reserved, but rather only when they have reached a planned or as-built status. This is to avoid the creation of redundant functional locations in SAP. To manage the many and varied rules owners have regarding which tags should be transferred to the CMMS at what status, this process includes a mechanism that filters out non-required transactions and transforms the tag number into a functional location according to an owner's requirements (e.g., adding a plant prefix or removing faceting characters). Data sent to SAP PM can vary according to tag class. For example, data required for a pressure vessel can be different than that of a manual valve.

Likewise, where equipment is installed or replaced against a functional location in the plant maintenance system, a process will trigger an update of corresponding data in SPO, which holds links between tag, functional location, and equipment.

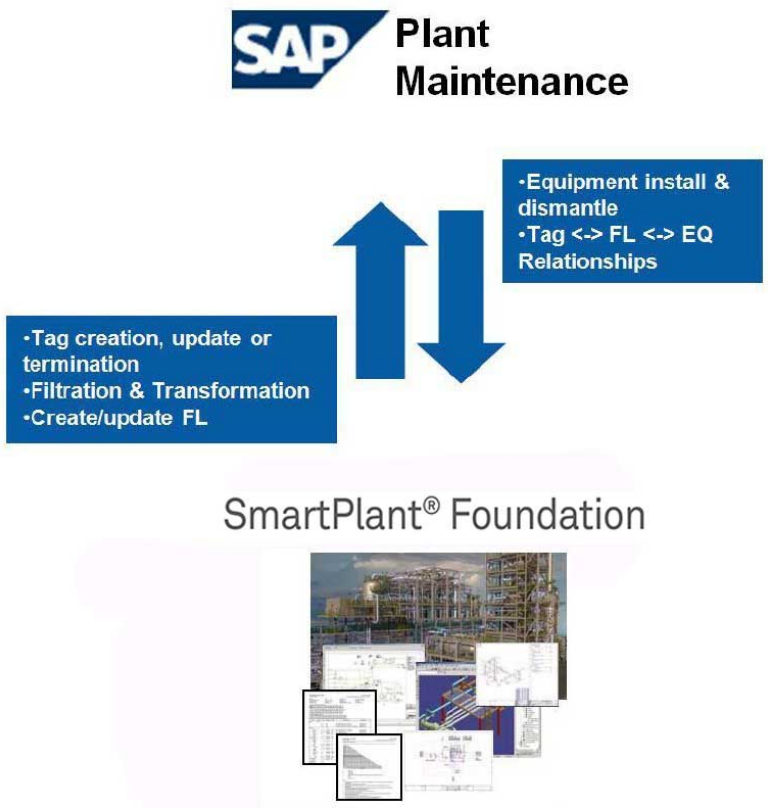

Figure 9: The engineering design basis is synchronized with the CMMS.

Information held in SAP will not be duplicated in SPO. It will hold the relationships between the tag and the functional location and equipment in SPO, facilitating the retrieval of information from SAP for presentation in SPO (see Figure 9). Further details of our SAP integration offering, including our SAP certification, are available in a separate whitepaper, “Bust through barriers with HxGN SDx™ Connector for Plant Maintenance”.

4.2.3 Inspection Assistant

Regular inspection of critical equipment, piping, and structures is crucial to ensure safe, predictable production at the lowest sustainable cost. O/Os are coming under increasing pressure from regulatory authorities to provide documentary evidence of equipment inspections. Insurers and finance companies are also demanding that inspection records be provided related to claims made by plant owners. So plant owners are increasingly adopting process safety management and asset integrity management programs in which planned inspection programs, which provide auditable traceability of inspections performed, feature prominently.

SPO Inspection Assistant helps plant owners meet increasing regulatory demands for demonstrable compliance with requirements for equipment inspection. As shown in Figure 10, this process provides full auditable documentation of all inspections by managing the:

- Scheduling of equipment inspections
- Identification of the tag number and, where appropriate, serial number of the equipment inspected
- Capture of inspection parameters like who, when, and how an inspection was performed

The process is closed by capturing inspection results and deviations. These are followed up as punch items.

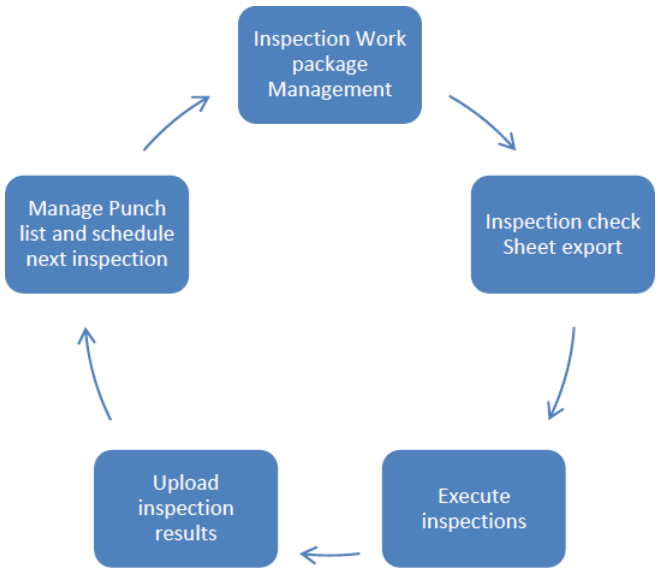

Figure 10: This shows a simplified work process of the SPO Inspection Assistant.

The process is aided by an electronic workflow to provide auditable traceability of the entire process. For each inspection, multiple inspection check sheets are generated automatically, one for each inspection point. These inspection check sheets can be completed directly in the field, offline on hand-held devices[3], and then uploaded to SPO when network connectivity is available. When unsatisfactory results are obtained, punch list items are raised and followed up in the system, supported by electronic workflows as well. The date of the next planned inspection is set by rules that are dependent on the inspection type according to rules and regulations.

[3]For details of mobile support for the Inspection Assistant process, please refer to Section 4.8.

Reports can identify overdue and upcoming inspections. Results can be presented as graphical reports superimposed on intelligent 3D models/laser scans or intelligent P&IDs to assist the inspector in planning and executing inspection activities.

SPO Inspection Assistant does not perform risk-based inspection (RBI) but provides a complementary capability in which integration with third-party RBI systems can be used to schedule inspections to be executed within SPO.

SPO Inspection Assistant can provide the necessary demonstrable compliance to regulatory authorities by leveraging the engineering design basis. This provides a permanent record and full auditable traceability of the inspection process. Check sheets can be completed offline in the field, offering better accuracy of records and saving the time associated with transcribing results in the office from field notes. Punch list items are followed up in the system to ensure recommended actions are taken.

4.3 SPO Project Execution Solution

The SPO Project Execution solution provides business packages that support important work processes for the management of greenfield and brownfield projects. These processes include:

- Management of project change
- Management of non-conformities, including waivers and deviations
- Interface management
- Technical and site queries

Hexagon PPM's SPO Project Execution solution is built on top of the SPO Core solution (see Figure 11). This enables the SPO Project Execution processes to refer to the underlying plant structure and affected plant items, such as tags and documents. This is a very powerful capability because it provides the ability to investigate any part of the plant – changes, non-conformities, queries, or interfaces that apply – allowing users to identify conflicts and synergies.

SPO Project Execution solution processes are not isolated, and can impact one another. For example, a technical query may give rise to a request for a change that may be rejected and result in a non-conformity and/or impact an interface item. This is taken into account in the SPO Project Execution solution. All processes may refer to each other, providing seamless traceability between the project execution work processes.

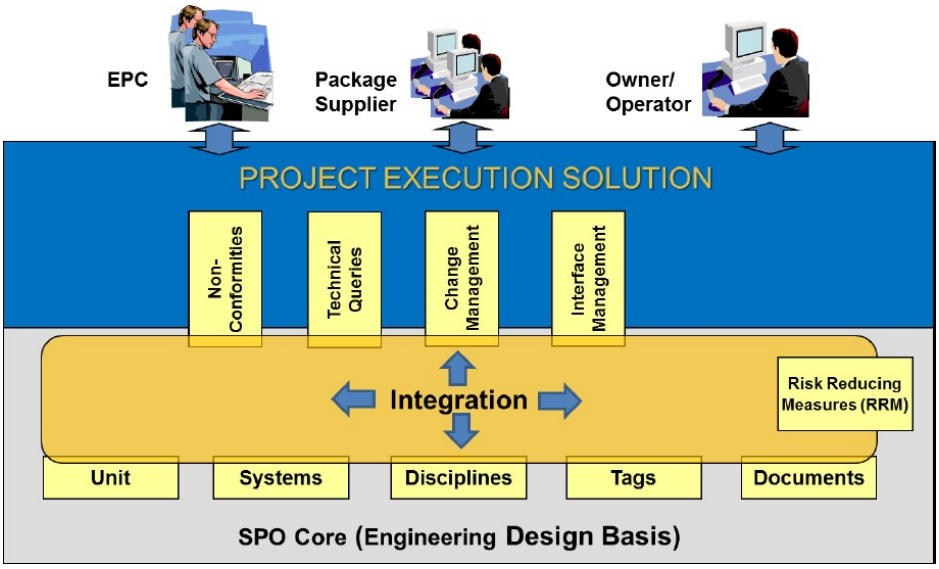

Figure 11: The SPO Project Execution solution is built on top of the SPO Core solution.

The following business packages are currently available as part of the SPO Project Execution solution.

4.3.1 Management of Change in Projects

In any major greenfield or brownfield project, there are typically thousands of engineering changes that need to be managed. Projects need to be managed as a closed system with a tightly bound scope, schedule, and cost representing the project baseline. Meaningful measurement of progress can only be made where scope, schedule, and cost are under close management.

Requirements creep is probably the single greatest influence on project costs and schedule. Therefore, it is essential that all proposed changes are captured in advance and subject to an appropriate level of scrutiny before being approved or rejected. Undisciplined implementation of changes undermines the technical integrity of the facility, causes confusion, threatens the successful outcome of the project, and potentially creates safety hazards.

Lack of a good change management process is a major drain on project executive resources and can jeopardize achieving project schedule, budget, and safety targets. The need to distinguish changes within the existing project scope (design development) to changes additional to scope (design change) is a crucial concept any management of change solution must accommodate. The management report shown in Figure 12 is divided horizontally to show changes within scope (upper half of the report) and outside scope (lower half of the report).

CHANGE SUMMARY REPORT
Plant/Installation : Main West
Project : Explore
Date/Time: 02.05.08

Design/Commercial Development within scope/budget

	Total Number	Total Value (1000 $)	Changes being handled						Changes completed						
			Status: Registered		Status: Ongoing				Status: Rejected		Status: approved		VOR		VO
			No.	Value	No.	Value	VOR No	VOR Value	Number	Value	Number	Value	NO	Value	Value
Project Changes	299	1364000	65	273000	98	148000			19	356000	117	587000			
Site Changes	417	1750000	89	245000	115	485000	274	485000	41	334000	172	686000	320	786000	786000
Design/Commercial Changes outside existing scope/budget															
Project Changes	446	352200 (9%)	125	110000	180	114000			45	54200	96	74000			
Site Changes	533	588800 (14%)	172	144500	192	155000	302	155000	67	82500	102	206800	171	206800	206800
Total Change	1695	4055000	451	772500	585	902000			172	826700	487	1553800			
Budget ref.		5200000													

Figure 12: The change management report provides visibility of the change process.

This business package facilitates the traceability, auditability, and management of changes from the initial change proposal, through the review, approval, and implementation cycle in both greenfield and brownfield projects, including turnarounds. Template workflows ensure consistent handling in accordance with project procedures and delegation of authority mandates.

The linking of changes to the plant breakdown structure and affected tags and documents facilitates the assessment of change impact against other changes being evaluated or approved, allowing an assessment to be made of whether there are potential conflicts or synergies. These cross-references also enable retrieval of the change from SPO via multiple access routes. Linking of changes to incoming technical queries and non-conformities allows for total traceability of technical case handling.

Change management overview reports provide visibility of the change process in a project and a valuable control mechanism for project and corporate management teams.

4.3.2 Non-Conformities

Non-conformities (deviations and waivers) to laws, regulations, corporate best practices, and project specifications all need to be closely managed. The process is closely linked to the management of change process and is required to demonstrate compliance with regulatory requirements. The capture of non-conformities, including the granting of permanent or temporary waivers and linking of these to the affected parts of the plant, provides a powerful tool for helping to reduce the risk of incidents. Where incidents do occur, the rapid presentation of all relevant documentation to the investigating authorities, including non- conformities, will enable a rapid return to full production. The main benefit of this process is that the preparation-for-operations team and operations personnel are provided with high visibility access to non- conformities and waivers. This enables the teams to take account of these during the planning of commissioning, maintenance, and inspection activities.

The avoidance of incidents arising from non-conformities contributes to preserving the health and safety of plant workers, and avoids damage to the physical plant, the environment, and corporate reputation. Pre- defined work processes will ensure consistent handling and auditable traceability through the approval or rejections of non-conformities. The linking of non-conformities to affected plant items will facilitate the traceability of non-conformities through the total plant lifecycle, enabling a permanent record for traceability purposes.

4.3.3 Technical and Site Queries

On any major development project, thousands of technical and site queries arise that need to be addressed and answered within a tight schedule to avoid claims and delays negatively impacting the project schedule. The technical/site query work process is closely related to the management of interfaces, change, and non-conformities.

Template workflows and management reports ensure consistent handling and follow-up. The linking of technical queries to non-conformities, interface items, and changes allows the complete handling of complex technical issues to be traceable and auditable. Exception reporting will allow project management to take remedial actions prior to delays impacting project schedules.

4.3.4 Interface Management[4]

Conflicts arising from interface issues between project stakeholders can have a major impact on project schedule and budget. A capital development project will typically engage multiple EPC contractors, all of which have hundreds of technical issues to resolve with each other and the owner operator. Other interfaces on a project may include major package suppliers, design institutes, and authorities. CAPEX projects today are increasing in size and complexity, with many stakeholders often distributed globally across many time zones. A typical CAPEX project will have 50 to 100 interfaces along with 10,000 to 100,000 interface items to resolve, depending on the size and complexity of the project. Today, interfaces are still often managed by individual interface-responsible engineers via ad hoc Excel spreadsheets, which lead to a lack of consistency in reporting and visibility to project executive management.

This business package provides a common, consistent method of registration and mechanisms for proactive follow-up of delayed interface item clarifications. Both physical and soft interfaces are managed by the process. Users can link interface items to affected plant items, allowing retrieval via multiple search routes. Interfaces on a project are broken down into a three-level hierarchy to simplify location of individual interface items and reporting.

When all SPO Project Execution processes are employed on a project and include the referencing of affected plant items, then it is possible to identify the impact of project changes or non-conformities on interface items. This is a powerful tool for executive management to use as part of the decision-making process on projects.

Status and exception reporting, as shown in Figure 13, provides project management with an overview of the current status and potential problem areas, allowing the team to take remedial action before problems impact project schedules.

[4] For further details of the SPO Interface Management process, refer to the white paper SmartPlant Enterprise for Owner Operators – Interface Management

Interface Relationship Party (IPR) Summary Report								
Interface Party Relationship (IPR)	IPR Description	Interface Item (ICI)		Interface Information Requirement (ICIR)		ICIR Schedule Status		
		Total Number	Closed	Open	Info Delivered	Critical < 1 week	2 weeks <> 4 weeks	> 4 Weeks
ProjectA-WP-FVC	PMC <-> Subsea Intervention Valves	0	0	0	0	0	0	0
ProjectA-UAJ-SCC	Details of subsea cables for template design	1	1	2	0	0	2	0
ProjectA-WP-UAJ	PMC <-> Subsea Contractor	3	0	11	4	0	0	6
ProjectA-OPR-WP	OO Project Team <-> PMC	4	2	7	0	2	0	0
ProjectA-WP-COF	PMC <-> Flexible Riser Contractor	1	0	0	0	0	0	0
ProjectA-OPR-OPD	OO PT <->OO Drilling	1	0	0	0	0	0	0

Figure 13: The Interface Relationship Party Summary Report helps prevent project delays.

4.4 Intergraph Smart® Data Validator (SDV)

Monitoring and maintaining data quality is a challenging task. It's even more difficult to manage when data is being moved from one source to another, like during project handover, brownfield data take-on, data loads, and migrations. Managing the handover of data and documentation from projects to operations is especially daunting. The volumes of data handed over are vast. Data and documents arrive throughout the project from multiple sources – often delivered with missing, incorrect, or inconsistent data. As a rule, data handover can easily account for 1.5% of total CAPEX costs and take a year or more to complete.

Intergraph Smart Data Validator (SDV) is a comprehensive data validation, transformation and migration platform that helps you significantly reduce the time and costs associated with ensuring the quality of information. Smart Data Validator supports the import, validation, and export of data, providing consistency and traceability of the entire data migration process. SDV is designed to manage structured data such as tag registers, document registers delivered in a structured tabular format and handover of non-structured deliverables.

SDV supports handover of both published deliverables from SmartPlant design tools such as P&IDs and 3D models and non- published data that has either been directly created in SPF or loaded into SPF, such as vendor data and registers.

SDV is a solution that enables users to check the correctness and completeness of data from multiple contractors, suppliers, or legacy data systems. Data is imported into a staging area where data is quarantined while being validated. Validation rules are then applied to check the quality of structured data before exporting to the target system.

Smart Data Validator is bundled with a pre-configured export adaptor to Hexagon PPM's SmartPlant Foundation (SPF), which means that it works out-of-the-box with any SPF-based system, including SPO. In these cases, Smart Data Validator will auto-generate a set of validation rules using the existing class, property, and relationship definitions of the target system. This means that you can validate your input data against the data structure of your target system simply by creating the mapping!

Subject matter experts with limited IT knowledge can easily set up additional rules that go beyond those that are automatically generated; for example, a rule that propagates an error related to one instrument to all other instruments in the same loop. In this way, you can ensure that a loop is only sent to the target system when all objects pass testing.

Established rules and rule sets ensure efficiency and consistency in testing. As a project develops and more data is available or as data quality improves, additional rules can be added to improve quality even further. A staging area captures all results from testing, providing full auditable traceability of what testing has been performed, by whom and when, as well as the results of the testing.

The results from the data validation may be returned to the originator for correction, or the user may choose to correct or complete data in the input file. When a job is approved, a flexible export mechanism initiates external loading programs for the specified target system, and a report is generated to with complete job statistics.

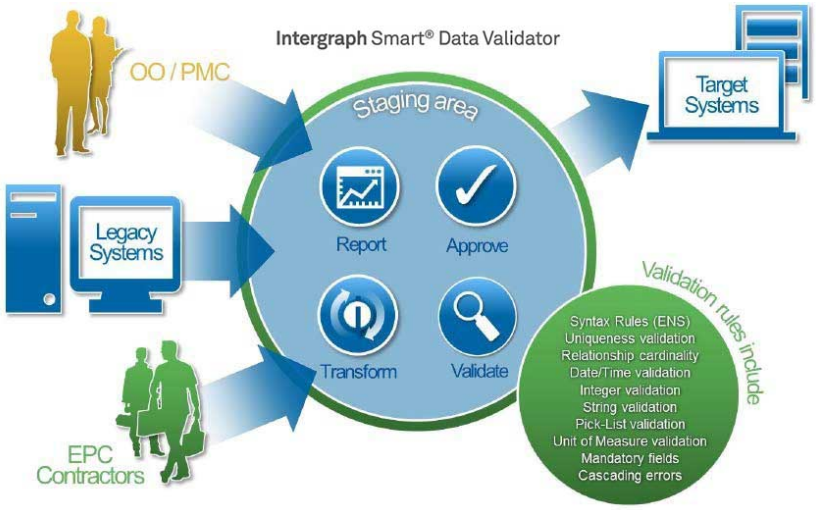

Figure 14: SPO data validation rules are easily configured by the SDV administrator.

4.5 SPO Requirements Management and Traceability Solution

Requirements management and traceability (RMT) is a process of ensuring that the expectations of the various stakeholders are met during the lifecycle of a process/power facility. Stakeholders can typically include:

- The owner for which the plant is being built
- Local and federal regulators
- Local and federal governments
- Non-governmental organizations (e.g., American Society of Mechanical Engineers) that may have codes and standards that carry near-legal weight
- Plant employees
- Local residents

Requirements management includes the identification of requirements from various sources, analyzing how they are met, and managing change. Traceability is primarily concerned with identification of the origin of each requirement and how each individual requirement is going to be addressed in terms of design specification and the ultimate plant configuration.

RMT has long been established in the highly regulated nuclear and life-science industries where regulators have demanded that plant owners are able to demonstrate how they comply with all applicable laws, regulations, international standards, etc., including management of change. There is increasing recognition of the need for RMT in other sectors of the process industry. This interest is driven by:

- The cost and complexity of process plants and the number of stakeholders involved in the design, development, and operation of process plants are increasing. CAPEX projects of $1 billion and above are now common where design, fabrication, and assembly are spread globally over many time zones.
- The number of regulations being enacted is growing in response to high-profile incidents.
- Regulators are becoming more stringent in their demands for compliance and the penalties fornon- compliance are becoming increasingly severe.
- Implementation of process safety management and asset integrity programs is growing.
- Managing change is of increasing importance to avoid re-work and cost/schedule overruns.

On major projects, it is not feasible to manage requirements through a simple spreadsheet or ad hoc database tool. There are many thousands of requirements with complex interdependencies; requirements are related to hundreds of thousands of documents and configuration items within the engineering design base for traceability; and management of change requires full auditability of all change to properties and relationships and identification of who has been involved in the review and approval of requirements and handling of all changes.

The SPO RMT solution is built on top of the SPO Core solution, providing seamless integration between identified requirements and the engineering design basis. This tightly integrated environment provides a direct “line of sight” between every requirement and the affected plant systems, structures, and components (SSCs) and their associated documentation. The impact of change in requirements, the plant design basis documentation, or physical plant configuration can be quickly and easily assessed.

4.5.1 Decomposition of Requirements Documents

A key requirement in any RMT solution is a tool to help users quickly identify and capture the thousands of requirements that must be managed for a process facility. A document may include many different requirements of various types, such as:

- Performance requirements
- Safety requirements
- Functional requirements
- Environmental requirements
- Regulatory requirements

Most requirements – such as laws, regulations, and standards – are embedded in documents. The SPO RMT solution includes a document decomposer to simplify the process of identifying actual requirement statements (see Figure 15). This tool is used by subject matter experts to identify discrete requirements within the body of a requirements document, such as regulations or a standard. The text representing a requirement within a source document is highlighted, the solution automatically allocates a unique requirement identity number, and associated properties such as requirement type and description are recorded.

The document decomposer accepts PDF files. Where a new version of a requirements document is issued, the document decomposer helps the user find and identify requirements that have carried forward to the new version unchanged, as well as requirements that appear in the subsequent version but appear to have changed in some way. The ability to assist the user in comparing two versions of a requirements document and identifying where requirements have changed is a powerful tool that can be a great help in any project stage when requirements can be constantly changing, as well as in the operating plant.

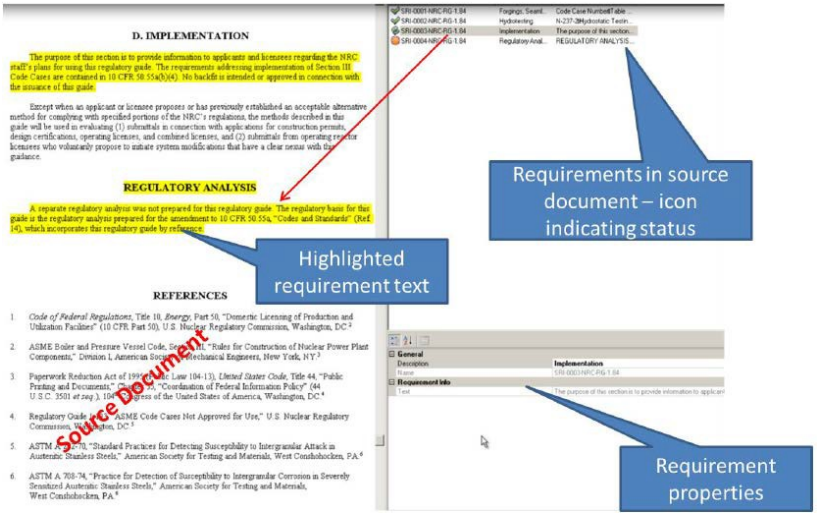

Figure 15: SPO RMT includes a document decomposer to assist in the identification and management of requirements.

4.5.2 Managing Requirements and Change

Stakeholder requirements are held in SPO related to their source document and version. Requirements items are also related to how they will be fulfilled; this fulfillment will typically be via a system, tag(s) or asset(s), or perhaps even a document (e.g., a procedure) and is managed through relations. As the design evolves, a requirement that initially may be related to a function identified on a process flow diagram may later be related to multiple tags on a P&ID. As the equipment is identified to be installed at these tagged locations, the requirement is finally related to the assets as identified by their serial number (see Figure 18). Gaps where requirements items are not covered are easily visible for management to take proactive steps to resolve.

Design specification documents or design control documents can also be decomposed in the same way as requirements documents to identify individual commitments in design specifications that can be related against identified requirements. Linking requirements, commitments, and the engineering design basis provides traceability and enables the tracking of the status of requirements and their fulfillment.

Both requirements and commitments identified can be grouped together to provide an aggregated requirement for commitment for follow-up.

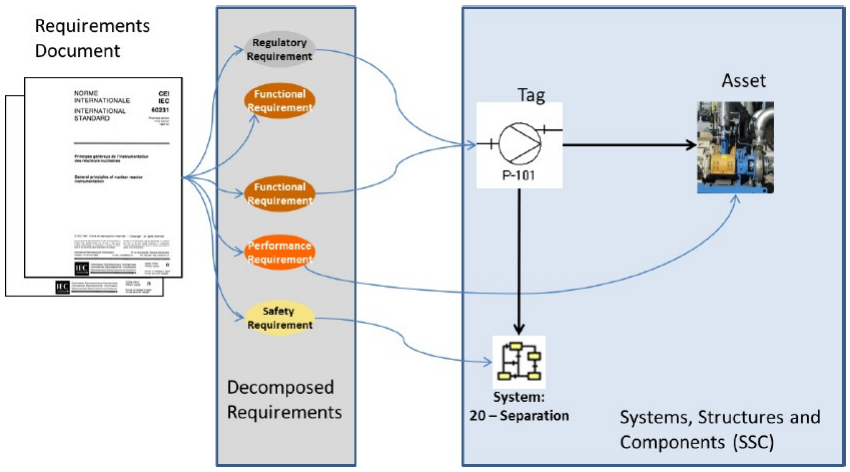

Figure 18: Requirements are related to plant configuration items.

To simplify reporting and tracking, both requirements items identified in requirements documents and commitments (design criteria) identified in technical specifications can be grouped together.

The relationships between requirements and design criteria and the plant configuration Systems, Structures, and Components (SSCs) also provide the basis for change impact analysis, as shown in Figure 19.

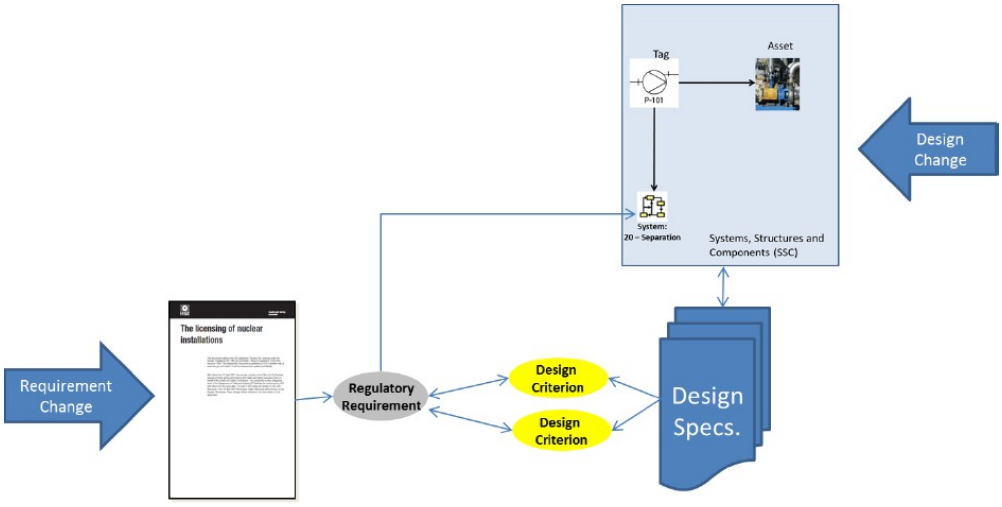

Figure 19: The SPO RMT Solution enables change impact traceability.

When change comes from the issue of a new version of a requirements document, the impact of the change on the existing requirements items and into design criteria and the plant configuration can be quickly and easily assessed by following the relationships managed in the SPO RMT solution.

When change comes from the implementation of a design change, the impact on requirements items, or perhaps, constraints that may be imposed by requirement items, can be quickly assessed and considered. The SPO RMT solution can seamlessly integrate with the SPO Project Execution solution to use the project change process during the CAPEX phase and the SPO Operating Plant solution for plant changes during the OPEX phase of the facility lifecycle.

4.5.3 Regulatory Compliance

Regulatory compliance demands a continuous process of documenting, analyzing, tracing, prioritizing, resolving, and controlling requirements with which plant or project personnel must comply. The SPO RMT solution provides an environment for requirements management that is seamlessly integrated with the evolving engineering design basis in SPO Core so that changes are immediately available for requirements management.

SPO also provides a complete history of all changes to both requirement items and related SSCs where all property changes and relationship changes are date/time stamped and identified by the user. In addition, by implementing the change management process in SPO Project Execution or Operating Plant solutions, complete auditable traceability is provided for the review, approval, and implementation of all design changes, providing fully demonstrable compliance. No spreadsheet or paper-based system for requirements management and tracking can provide a corresponding level of traceability to meet regulatory authorities' demands for compliance.

4.5.4 Benefits

The SPO RMT solution provides a fast and easy way for subject matter experts to identify and document requirements and relate requirements to both SSCs and design criteria. As shown in Figure 20, the main benefits of the solution come from leveraging the solution to assist in:

- Assessing the impact of changing requirements on the design basis or the actual physical plant.
- Assembling governing requirements and design basis needed to effect a proposed change on the physical plant or its information.
- Having dependable, auditable traceability to support demonstration of compliance to regulatory authorities.

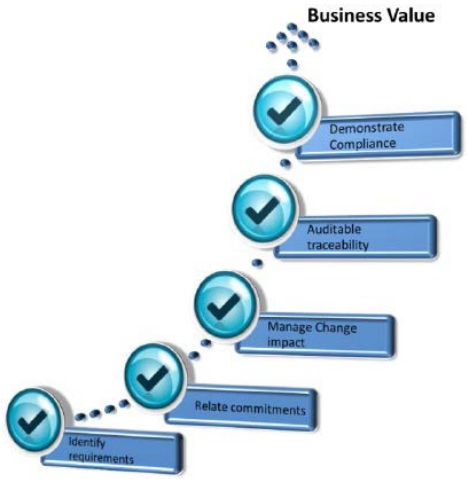

Figure 20: The SPO RMT solution offers many levels of benefits.

4.6 Hexagon PPM Mobility Solutions

To undertake activities on-plant and in the field, owner operators and their contractors need access to current information and documentation where online access to information is not possible. As shown in Figure 21, these include activities such as:

- Subsea intervention and workovers
- Inspection and maintenance of remote facilities such as pipelines, transmission equipment, and pumping stations
- Construction and completions activities
- Turnaround and modification activities
- Day-to-day maintenance, inspection, and associated lock-outs/tag-outs

Figure 21: For on-plant and field activities, online access to data and documentation is typically not available.

The traditional solution to support such activities has been to provide hardcopy printouts of relevant documentation and information. Paper printouts in the field suffer from being expensive and labor-intensive to produce and maintain. Plus, it is cumbersome and slow to find the relevant information. Handwritten markups made in the field under adverse conditions are often difficult to interpret back in the office.

A new generation mobile app using the Catavolt mobile application platform is planned to be available for both Android and iOS. This app will solve these issues by enabling data and documentation to be placed into an electronic “briefcase” that can then be downloaded to a tablet or phone, where information can be viewed and updated offline, with updates being implemented upon return to connectivity.

Quick and easy ways are provided to scope the contents of briefcases. For inspection packages, a one- click “export to briefcase” menu selection is all that is required to send all related documents and tags with associated data to the briefcase. Briefcases may also be scoped by simple drag-and-drop or “extended drag-and-drop” where, for example, including a tag or purchase order (PO) can be used to automatically include all associated documents.

4.6.1 Fast, Easy Access to Information

Field engineers and technicians want easy-to-use solutions to give fast access to relevant information with minimal training. SPO Mobile App will provide this through a highly intuitive graphical user interface where the user selects a briefcase for a work package or field operation and then is given direct access to relevant 3D models, laser-scanned images, P&IDs, etc. by simply choosing the relevant icon. Intelligent navigation capabilities that are available online are also provided in the offline briefcase.

4.6.2 Information Capture in The Field

Making markups on paper documents in the field is difficult, especially in windy and/or wet conditions. Poor legibility of markups can make them difficult to interpret back in the office, leading to incorrect as-built updates. SPO Mobile App will provide users with the option to create simple annotations, electronic notes, and take photographs in the field and link these to a document or tag.

4.6.3 Upload

Once network connectivity is available for the mobile device, uploading data from the mobile device is a simple, one-click operation. The notes and photographs are uploaded and linked to the relevant objects where they will be available for online SPO users.

4.6.4 Benefits

The case for SPO Mobile App is compelling. It offers:

- A new paradigm for information and documentation access by plant floor and field workers, increasing productivity.
- An easy-to-learn user interface that requires minimal training and eliminates costly, cumbersome hardcopy documentation.
- High-quality field capture of information, ensuring the legibility of records taken in the field.
- Simple one-click uploads of information captured in the field, facilitating reliable handover of field documentation.

5 Return on Investment (ROI)[5]

The ROI figures in Figures 25, 26, and 27 are based on a model plant with the following characteristics:

- A $1 billion CAPEX refinery project
- $5 per barrel margin
- 150,000 barrel-per-day production
- Average O/O costs = $80/hr

These cost benefits are only indications and Hexagon PPM industry consultants can assist in the preparation of customer-specific cost benefit cases.

[5] Refer to Insight issue 22, Q3 2008 pages 8-10, SmartPlant Enterprise for Owner Operators Offers Significant Value Proposition

Value Source	Benefit	Benefit ($MM)
Plant Breakdown Structure (PBS), Tag and Document Management	PBS and tag management giving improved consistency and reduced frequency of errors	340K
	Doc Mgt. Improved consistency, improved effectiveness in distribution and access to documentation	
On-plant modification design during operations	Integration between tools ensures consistency and key outputs (drawings) produced automatically	2.2MM
Turn around and Revamp project planning	Improved planning of turnarounds, location of material needed by turnaround contractor and ease of export of data and documentation	300K
	QC and loading of data from turnarounds	50-100K
Management of loop drawings and connection diagrams	Savings in maintenance of loop drawings	540K
	Savings from improved configuration management and reduction in unplanned shutdowns	750K
Annual OPEX Benefit		$4.2MM

Figure 22: SPO Core/SDV OPEX savings are significant.

Value Source	Benefit	Benefit ($MM)
Location of information in Engineering Browser	• Reduced time to find data to answer ad hoc queries	1.5MM
	• Access to latest online version of data	
	• Faster and more informed decision making	
	• Reduced time to prepare maintenance packages	
	• Eliminate unofficial archives of data	
Management of Change (operations)	• Reduced from automated handling of the change work process and automatic creation of audit trail	1.3MM
	• Reduce the need for physical verification of data in the field	1.3MM
	• Reduced effort in creating Notifications	120K
Synchronization of the engineering design basis with maintenance data	• Reduced effort in maintenance of Functional Locations	200K
	• Reduce procurement errors due to inconsistencies in data between the design basis and SAP EAM	480K
Annual OPEX Benefit		$4.9MM

Figure 23: SPO Operating Plant offers tremendous OPEX savings.

Value Source	Baseline	Improvement %	Benefit ($MM)
Management of Project Change Improved overview and process rigor	$200-300MM	5-10%	10-30
Technical Query Monitor design and constriction activities more effectively	150 weeks	2-3%	2-3 project labor 4-12 production gain
Interface control Proactive intervention in conflicts between contractors	10-20MM	50%	5-10
Non-conformity/Waiver Management -Avoidance of incidents - Quicker start-up after incidents	8-12 day prod loss per year OPEX	30%	1.9-3
Improved administration for all the above processes	2.8MM	50%	1.4
Total (One-off) CAPEX Benefit			$22.4MM – $59.4MM
Annual OPEX Benefit			$1.9-3MM

Figure 24: SPO Project Execution delivers compelling CAPEX and OPEX savings.

6 Implementation

6.1 Implementation Methodology

Owner operators cannot wait many months for an implementation to be complete before they can gain benefits. To provide the quickest possible return on investment and reduce risk of implementation, Hexagon PPM has implemented a standardized methodology for SPO Core.

The basis for a rapid implementation is a Pre-implementation document that includes Microsoft Excel load files and questionnaires. The customer completes the files (with Hexagon PPM assistance, if desired) before Hexagon PPM arrives on-site to perform the implementation. The information supplied also enables Hexagon PPM to begin pre-configuration of the system before arriving on-site. There is no need for lengthy workshops or delays while requirements, specifications, or functional design are written, reviewed, and approved.

This approach delivers a customer-specific configuration for each implementation. It is the recommended approach for most implementation cases. These configuration changes can be quickly completed without the need to customize SmartPlant Foundation or the base SPO solution and enables a first implementation milestone to be achieved quickly. Some customers may need further enhancements, additional solutions, or integrations that will require additional scope(s) of work.
As part of the implementation, a small sample of customer data is loaded and the customer core team is trained in the use of the system, including loading.

About Hexagon PPM

Hexagon PPM is the world's leading provider of enterprise engineering design software and project control solutions. By transforming unstructured information into a smart digital asset, our clients are empowered to visualize, build, and manage structures and facilities of all complexities, ensuring safe and efficient operation throughout the entire lifecycle.

Hexagon PPM is part of Hexagon (Nasdaq Stockholm: HEXA B; hexagon.com), a leading global provider of information technology solutions that drive productivity and quality across geospatial and industrial landscapes.