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PERMIT TO WORK: THE INTEGRATED SAFE SYSTEM OF WORK

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ABSTRACT

A permit to work (PTW) system is a formal system used to control certain types of work that are identified as potentially hazardous. It is also a means of communication between facility management, plant supervisors and operators, and those who carry out the hazardous work. The essential features of a PTW system are:

- **Clear identification for who may authorise particular jobs, and who is responsible for specifying the necessary precautions;**
- **Training and instruction in the issue and use of permits; and,**
- **Monitoring and auditing to ensure that the system works as intended.**

PTW systems are the key to ensuring safe execution of activities at site, yet there are many approaches to how permit systems can, and should, work. Each approach has its own merits and weaknesses.

Woodside recognised that, as part of its ongoing program to improve the safety of its workers, there existed significant scope for a new and better work management system. After many years of incremental evolution of the PTW and the fragmentation of the parent system as each facility developed its own variation, it was evident that a completely new system embracing modern technology would provide the best result, while simultaneously standardising Woodside with one common and centralised system.

The divergence of the systems over time caused increasing difficulty in managing changes to the PTW system across all sites and in benchmarking to determine best practice. A centralised system would remove accountability from facilities for the development of the business rules, and instead ensure they focussed on compliance with the rules.

The new system would adopt key learnings from the industry's history and address root causes of past incidents. It would also enable the ability to adopt future learnings and become a conduit for rapid integration into the working practices on all sites.

The Integrated Safe System of Work (iSSoW) developed by Woodside adopts best practices from permit systems worldwide and combines them with new innovative management features. The system is administered through a simple-to-use computer interface, with incorporation of many of the business rules into the software package.

The iSSoW is now in place on all Woodside facilities (platforms, not-normally manned installations, FPSO's and onshore plants). With nearly 4,000 users, the implementation has required careful coordination, and been supported by a comprehensive training programme.

The system has been demonstrated to be both effective and efficient. Effectiveness—the improvement of safety performance—was the primary objective. The system has raised work party hazards awareness, and has resulted in significant improvements in working practices company-wide. Efficiency was a secondary goal, and is made possible through streamlining in the user-interface.

The introduction of the new system complements Woodside's work to develop an improved safety culture, and brings consistency across all sites and all shifts—essential features as our industry struggles to deal with the growing scarcity of skills and experience.

The system is now being reviewed by organisations across many industry and service sectors in Australia, and has been implemented in the power industry.

This paper discusses the attributes of the system, the many challenges associated with development and large-scale implementation of such a core system, and the additional opportunities the system presents. Using a case study of implementation of iSSoW onto the Woodside operational facilities, it highlights the critical success factors of introducing iSSoW on a company-wide basis.

KEYWORDS

Permit to work, PTW, Integrated Safe System of Work, iSSoW, safety management system.

WOODSIDE'S BUSINESS REQUIREMENT

Prior to 2008, Woodside used a paper-based permit to work (PTW) as its safety management system for activities on all its facilities. Without centralised governance, each facility had tailored the core system to meet its own needs resulting in a gradual diversification of the systems over time.

Personnel moving between facilities were required to work in systems that were similar in appearance, but where subtle differences could lead to confusion. No process existed to drive a re-convergence of the systems or to benchmark the systems against each other. While each system was compliant with the Woodside permit to work standard, the intent of the standard had become lost in the divergence of the systems.

Incident investigations frequently revealed root causes that lay in the permit processes: either weakness in the system rules and structure, or in the application of the systems.

There was a clear need for something new to replace the various permit systems, to introduce a common set of business rules governing work management, and to make best use of the technology available today to assist in making the system both robust and simple.

It also presented the opportunity to bring greater clarity to roles and responsibilities, and to tidy up much of the supporting documentation.

The mission, therefore, was to develop a system that met the following three business criteria:

1. One common system designed for use across a wide range of facility types;
2. A robust system, designed to have a positive effect on safety performance, and to help protect the facilities from incident; and,
3. Minimal reliance on written rule sets, therefore reducing the opportunity for misinterpretation of the rules at any point.

In every aspect of the solution, our intent was to make it as easy as possible for people to do the right thing.

WOODSIDE'S SOLUTION

The solution to the problem was the introduction of the Integrated Safe System of Work (iSSoW) across the Woodside portfolio of facilities. The iSSoW was to be managed through a computer software interface, which would help the user navigate the system.

Integrated safe systems of work have been successfully introduced in other parts of the world, particularly the North Sea, for several years. In most cases, the iSSoW is administered through an electronic interface, which provides many functional benefits.

A single system with centralised control provides many benefits. For example:

- Each facility was no longer required to develop and maintain their system, but could focus entirely on meeting the requirements of the one system;
- Learning lessons across the organisation was simplified, with a single system becoming the vehicle for communicating and enforcing those learnings;
- Audit of the permit process was also made easier, with only a single system to evaluate. Effort could be redirected to audit of the application of that system across the Woodside portfolio;
- Benchmarking of the system internally was eliminated, allowing evaluation against other systems worldwide to establish and maintain best practice;
- The increased ability to move core personnel around the organisation free from system barriers, or the requirement to re-train; and,
- New facilities had a plug and play system, and therefore were not required to develop something new. Furthermore, the personnel staffing that facility would already be familiar with the system having seen it operating on existing facilities.

What is iSSoW?

The iSSoW is a safety tool designed to take a holistic and robust approach to risk assessment, isolation management and the issue of permits. The evolution of information technology (IT) over the years has enabled the development of this powerful, but simple-to-use electronically-administered system.

While iSSoW can exist in a paper-based format, many of the more useful features of iSSoW are best enabled through a computer-based system whereby the logic-based rules associated with the system can be replicated and enforced through the software, enabling the automation of many of the processes.

How does iSSoW work?

Any permit to work (PTW) system consists of a set of business rules. Typically these would be documented in extensive procedures that would need to be read, understood, remembered, interpreted and applied correctly by every person involved in the execution of that system. Inevitably, therefore, one of the greatest weaknesses in such a system is the human element.

The iSSoW rules recognise that the risks associated with the central task, the integrity of the required isolations and the issue of appropriate permits are all totally interrelated and bound together by that complex set of rules. An electronic iSSoW, therefore, harnesses the power of modern computer technology to ensure that many of these business rules are implemented in a robust, consistent and simple manner. Furthermore it allows more useful rules to be developed and applied, which were too complex to be manually and reliably implemented. It allows the incorporation of additional functionality that automate some administrative tasks and results in significant time saving.

Figure 1 helps to explain the main differences in work control philosophy between a traditional PTW system and iSSoW by using an analogy between road travel and rail travel. Car drivers have several degrees of freedom as they drive, and are free to change lane and speed at any time. They are bound by the rules of the road, but sometimes fail to do so. No two drivers manage their vehicles in exactly the same way, decreasing the ability to anticipate the behaviours of other motorists. There are deterrents against rule breaches (such as lane marking, speed cameras and a police presence), however these will not guarantee safe driving. Likewise the PTW system relies on compliance with written rules, a largely administrative control and is

Figure 1. An analogy of a traditional permit to work (PTW) system versus an integrated safe system of work (iSSoW).

very reliant on humans adhering to the procedures. The iSSoW is more closely aligned with train lines that guide the user safely to their destination using a structured predetermined and agreed route with defined decision points along the way and without providing an opportunity for deviation.

Building blocks of iSSoW

The iSSoW system consists of three inter-related elements, each of which is shown in Figure 2, and is described below.

RISK MANAGEMENT USING THE HAZARD IDENTIFICATION RISK ASSESSMENT (HIRA)

Central to the operation of the iSSoW is the hazard identification risk assessment (HIRA). This is a database containing lists of: work categories for activities commonly performed on the facilities; hazards encountered in the undertaking of that work; and the controls required to minimise or eliminate the risk associated with those hazards.

In the HIRA database, iSSoW allows links to be built between a work category, and any number of hazards. Likewise, each hazard can be linked to any number of controls. Thus an array of meaningful risk assessments can be built using quite generic terms.

The custodian of the system can easily add work categories if required (e.g., if new activities were to be undertaken) and thus create new risk assessment arrays in the database.

Work categories are written to be specific to a type of action (e.g., working at height, opening of low voltage (LV) electrical equipment, confined space entry) but without being specific to a task. Therefore a typical job may comprise of several work categories and hazards, and many more controls. The system prevents duplication of hazards and controls if more than one work category drives the same item, making for simpler implementation and cross-checking of controls at the worksite.

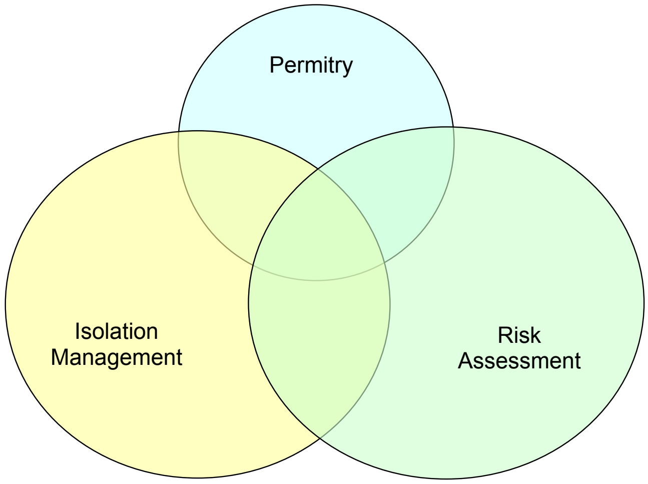

Figure 2. The three elements of iSSoW.

Each work category is configured to identify the maximum level of approval required before the permit can be issued, and the resulting permit type (cold work, hot work, or red hot work). The work category also drives the default requirement for certificates such as isolation certificates (although these can be overridden in exceptional circumstances, leaving a full audit trail of their de-selection) and any additional risk assessment requirements.

While HIRAs are mandatory for all activities, some jobs may require additional assessment. Level 2 risk assessments, which are similar to the more traditional job hazard analysis (JHA), are required for any new, complex or unique activities, or any work involving activities that historically have been the cause of a higher proportion of fatalities in the industry (e.g., confined space entry, man-riding operations).

ISOLATION MANAGEMENT

Mismanagement of isolations is a major cause of serious incidents in the oil and gas industry (e.g., the Piper Alpha disaster[1]). To ensure the safety of workers and facilities, Woodside's objective was to deliver an easily administered no-compromise solution to isolation management.

There has been much discussion of what is an appropriate level of isolation for particular scenarios. The technique used by iSSoW is the hazard factor assessment. This effectively allows a risk assessment of the scenario to determine the minimum allowable isolation requirement. It takes six factors that affect the escalation potential of an incident resulting from a failure of an isolation scheme, and uses a scoring system to determine the level of risk associated with the isolation. From this, the minimum isolation requirement can be determined.

Electrical isolations are not subjected to the same risk assessment, but instead the designated responsible person—electrical (RPE) is involved in the development and approval of any isolation scheme.

All isolation schemes must be developed by one suitably competent isolation authority, then reviewed and approved by another isolation authority. The iSSoW system is very strong on this independent review, and the onus of responsibility is placed on the reviewer to ensure a quality review is performed.

Isolation points are locked and tagged. The tags are printed using data already contained in the iSSoW system and is therefore a significant labour saving facility. Besides descriptive text, tags include bar codes that enable positive feedback to the system that an isolation has been implemented and independently verified. The isolation tags are made of robust material tolerant of most environmental conditions.

The software also ensures that an isolation certificate is not issued until all tags have been scanned, therefore reducing the risk of human error resulting in an isolation incident.

The safety system inhibit certificate is similar to an isolation certificate, but relates to safety-critical systems—that is, those systems required for the purposes of detection, protection, communication or escape in the event of an incident, and includes fire and gas systems, fire pumps, lifeboats. The site controller, who is responsible for the day-to-day management of the facility, must approve all safety system inhibit certificates.

PERMITS

The last of the three elements of iSSoW is the permit itself. The function of the permit is very simple:

- It gives permission for work to take place;
- It drives site endorsement by the area authority prior to starting work; and,
- It links together the risk assessment and certificates associate with the activity.

Permits exist in three types: cold work, hot work, and red hot work. Any hot work or red hot work requires authorisation from the site controller.

SYSTEM DEVELOPMENT

It was imperative for the development of the system to be carefully managed to ensure the end product was robust and secure, but also that the product was designed for the optimal uptake on the facilities. To maximise the benefit from iSSoW, the timeline for implementation was carefully chosen to ensure that implementation could begin as soon as a workable and proven system had been developed; however it was recognised from the outset that the software would not be in its final form at the time of the initial implementation and that iterative upgrades would be required.

The starting point—the 'standard' standards

The design and development of the entire iSSoW was dependent upon Woodside having a suite of standards that were clear and implemented without compromise. The alignment of the standards in the company took place three years prior to implementation of iSSoW, but was the bedrock upon which the system was built.

Once alignment was achieved in the standards, the supporting processes and procedures could begin to become aligned. Governance of systems became centralised, and as a result the change-management process was simplified.

As Woodside continued to expand and bring onstream new facilities, there was no requirement to develop a new set of processes. The iSSoW would simply plug and play into the new facility.

The importance of the development team

The iSSoW team itself was handpicked to be as small as possible, yet include competent representation from each of the Woodside facilities. This served three main purposes:

1. It provided a conduit for feedback of iSSoW progress to each facility, and ready-made champions for the implementation on that site;
2. It ensured that the idiosyncrasies of each facility could be catered for within the single system; and,
3. It provided personnel on a facility with ownership of the developments resulting in greater support for the facility implementation.

The team was also chosen to comprise a representative cross-section of the workforce and so was led by an operations manager and included a range of seniorities from technician to supervisor. It covered the spectrum of operational functions including mechanical, instrumentation, electrical and production disciplines. Each team member, however, had a good working knowledge of the principles of effective permit systems, but possessed the ability to think outside of the Woodside system with which they were familiar.

The IT group also needed to have a presence in the team, given the significant role that the computer-based tool would play in the success of iSSoW. They were able to advise on setting up an IT contract with a software supplier, the process of software development, and the necessary hardware infrastructure for each facility. The required level of IT involvement was too great to be managed on an advisory basis only, so a member of the IT team was seconded into the iSSoW team for the duration of the project.

While a small turnover of personnel was inevitable, the core of the team was to remain unchanged throughout the project. This would cover the system development, training, implementation and ongoing support phases, thus providing continuity to the system users while ensuring that the rationale behind key project decisions could be clearly explained to users in the implementation and support phases.

The team members would then remain on their parent sites following implementation, effectively enabling them to act as a super-user to their fellow crews.

Understanding the users

As marketing case studies clearly demonstrate, a key component in the development of a successful product is tailoring that product to the needs and capabilities of the end user. In developing iSSoW as a computer-based system, it was imperative that the computer software didn't serve as a distraction from the purpose for which it existed—risk management. The entire system needed to be developed to be as simple to use and intuitive as possible. The underlying business rules needed to be uncomplicated and logical, which was a challenge when dealing with Woodside's diverse facilities. The graphical user interface, which is the part of the software that the users see and interact with, needed to be clear, simple to navigate, and use meaningful language.

In setting the system up in this way, we sought to assist the users by delivering the desired outcome in the easiest manner, but also to reduce the extent of the training and familiarisation required to operate the system.

The system required clear accountability and responsibility to be defined in the system for issue of permits. This in turn required the core competencies of each individual in the system to be reassessed to ensure they were capable of fulfilling their role with accuracy and diligence.

Figure 3 shows the hierarchy of roles in the iSSoW.

Understanding the implementation climate

The iSSoW provides Woodside with a great opportunity to target some of the less tangible areas of our business. The implementation of the system coincided with the introduction of the Our Safety Culture behavioural model in the company, which clearly laid out the desired and expected safety behaviours of members of the workforce, supervision and management. The clarification of roles and responsibilities achieved in the development of iSSoW was closely aligned with this model. Furthermore, the implementation process of iSSoW on each facility required each person to demonstrate the expected behaviours in supporting the introduction of the new system.

The iSSoW also gave the opportunity to reinforce the Woodside golden safety rules—the simple rule set that is mandatory for all employees, and that are specifically intended to prevent major accident events and injuries. Many of the business rules in iSSoW relate back to specific golden safety rules and, therefore, an opportunity was provided to further embed the critical rules into the working environment.

Understanding the constraints

The design and functionality of the web-based system was constrained by the use of the Internet Explorer 6 (IE6) package Woodside was running at the time. Some features that were advantageous to include, such as the plot plans, could not be practically achieved in IE6 and therefore were delayed until later software releases.

Consequently, we needed to position ourselves for frequent upgrades to the software as we continued to implement. Changing the software on an operational facility without affecting the integrity of the system or the ability of the facility to continue work was a major challenge, and played an important part in the design of the software functionality. The target for the duration of the downtime of the system during software upgrades was set at 30 minutes for most changes, and one hour for the more complex upgrades. These were scheduled to cause minimal impact on each site.

Selection of the support services

With several iSSoW systems already in place around the world, we determined whether to piggy-back onto an existing system or develop something new. Our research soon identified that many of the existing systems lacked the functionality that we required, and that we could develop a purpose-built system that was flexible enough to meet all Woodside's requirements for less cost than buying in an existing system. This would also allow us to tailor the system to meet Australian legislation.

A number of service companies were evaluated in determining those most suitable for supporting the project. The areas where services were required were:

- Software development; and,
- Provision of isolation lockout hardware.

Factors that were included in the evaluation were:

- Demonstrated competence/track record;
- Proven ability to respond to client requirements;
- Proven ability to contribute to innovation;
- Future ability to service increased clientele;
- Shared vision for product;
- Price;
- Location (minimal time difference preferable to aid communication);
- Liquidity of service provider; and,
- References from existing client-base.

Sage Technology—a software development company specialising in safety solutions and based in Victoria—was selected to provide the software in line with Woodside's specifications. They were also involved in the development of separate mobile solutions software, which we saw

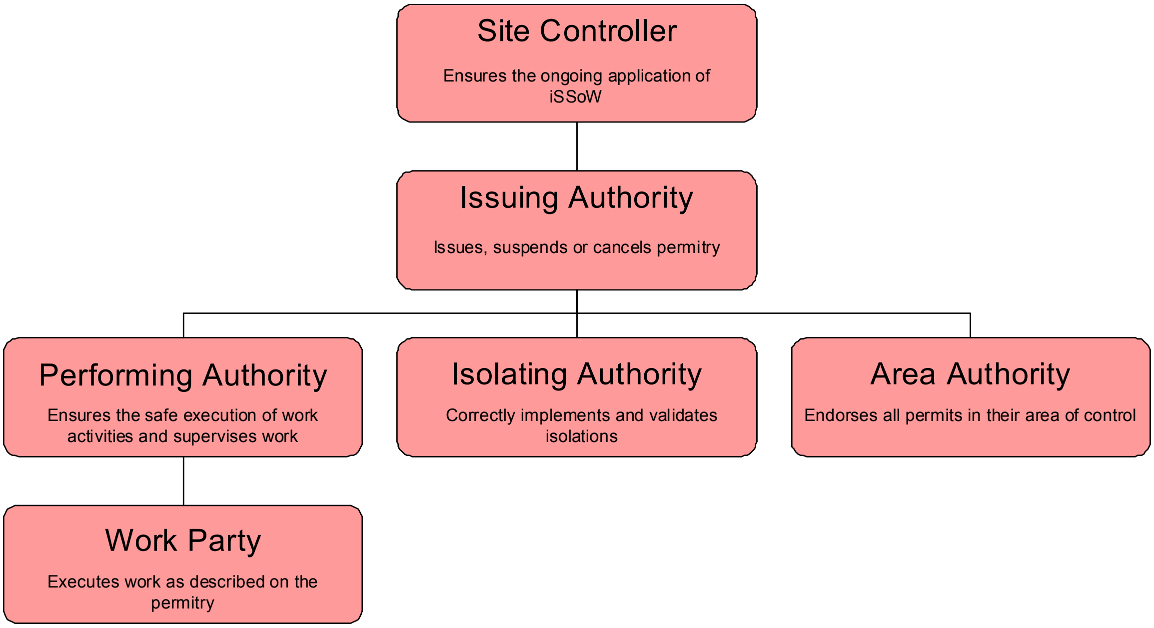

Figure 3. The iSSoW hierarchy of roles.

as having potential for inclusion in the iSSoW system in the future, particularly for facilities covering larger geographical areas.

The locking hardware was to be sourced largely from Masterlock—already widely used in the industry, and well known in Woodside.

Development of business rules

Much of the project's early work involved a review of systems already available. This involved engagement with peer companies and with software development organisations around the world. Case study analysis was carried out, and a comparison was carried out of the systems most commonly in use. From each system, best practice principles were identified and recorded and then challenged to identify if another new approach could be generated to bring further improvement.

The result was a list of unconsolidated principles that needed to be brought together into a single system. The business rules were the glue that bound the principles together. A vast number of business rules were created, and there was opportunity to filter out any deemed superfluous.

The next stage was to work with Sage Technology to translate those rules into a common language that could be understood by Woodside's project team and Sage's programmers. The system requirements documentation was the result—a large array of text, flowcharts and swim-lane diagrams depicting the required flow of the system.

Hardware

The system configuration used dual servers on each facility—one main server, and one constantly shadowing the main. Both servers were independent, and operated from the uninterruptible power supply (UPS) to provide maximum reliability, including in the event of loss of main power generation. Servers were located on the facilities themselves, which ensured the system would be fast, but also independent of communications systems outages. Ship to shore communications can be affected by weather conditions and vessel orientation, and is lost in the event that a floating, production, storage and offloading (FPSO) vessel disconnects from the riser (for example, on approach of a tropical cyclone); the communications system allows users away from the host facility to access iSSoW, and generate permits as though they were on-board. Permits can therefore be prepared and approved prior to a work crew arriving on the host facility.

No system can guarantee total reliability, so a final contingency is a paper-based back-up system. Blank paper copies of the permit documents were collated into a folder—known as the crash pack—and a simple two-page procedure governed the use of the paper-based system including the management of change-over from electronic to paper-based, and back again. The nature of this system prevents the use of the HIRA database for risk assessments, so any work that may need to be developed in the paper-based system must rely on Level 2 risk assessments. The system has been used during scheduled facility shutdowns where planned total power outages are sometimes required. In such cases and prior to the system downtime, the permits can be developed electronically using the HIRA database to assess risk.

The iSSoW can be operated from any facility PC. The control room PC, which would be required to access permit data in an emergency situation, is also powered from the UPS system.

Special tag printers were installed on each facility to enable the rapid production of isolation tags. Standard A4 colour printers were used to produce the permits, which were coloured according to the permit type.

Locking hardware consisted of padlocks with nylon shanks to minimise any risk of sparking if the locks were dropped. The degree of control provided by the tagging system enabled the use of group padlocks (one key fitting every lock in a set) to ease the logistics of applying locks. Group isolation locks were provided as singles, and in sets of varying sizes up to 50 locks, allowing even large isolation schemes of 300 points to be implemented using just six keys. The securing of the isolation keys was therefore made easier.

Coloured padlocks allowed the locks to be easily differentiated according to their function. As well as isolation locks (yellow), we required high voltage (HV) locks (black), permit locks (blue), certificate locks (teal) and personal locks (red). Each person on site is issued with a red personal lock, and they use that lock to ensure that an isolation scheme on which their work is reliant cannot be removed until they confirm they have finished working, at which point they remove their personal lock. This practice is in addition to the security provided by the permit/certificate hierarchy rules in the software, and has been used successfully in the mining industry for many years.

Permit boards are another important feature of iSSoW. Previously, permit holders would hold their copy of the permit at the worksite, but this restricts the visibility of the hazards to those involved in the work. The use of permit boards in specific areas of the facility allows all permits to be held together, and serves as a quick reference for anyone in the field to identify the work that is ongoing. It also allows any performing authorities to review all work taking place close to their activities, and satisfy themselves that any potential conflicts have been eliminated and interactions have been properly managed.

The permit boards in use at Woodside include a location for key hasps storage. This enables an isolation scheme to be secured, by locking the master key(s) into a hasp, while allowing the secured key to be portable. This provides efficiencies on sites of larger geographical area as it allows the hasp to be taken to an area permit board, and secured there. All work party members can then apply their personal locks locally rather than having to return to the permit office. As a result, system visibility is improved, and efficiencies can be achieved.

Functional requirements

The solution we were tasked with developing had to meet many functional criteria. It needed to:

- Provide good visibility on the permit status with a single click;
- Provide single-click access to data critical to emergency response;
- Provide secure access, with full audit trail;
- Enable named persons to be assigned to key positions;
- Automate the expiry of user access if a user's account is inactive for six months;
- Drive effective communication between relevant parties at critical stages in the permit process;
- Provide access to the system from anywhere in the Woodside network;
- Function similar to existing software to aid intuitiveness;
- Be capable of fully managing complex processes such as sanction for test;
- Allow centralised control of database content;
- Encompass a full lessons learned feature to aid continuous improvement; and,
- Track and manage the security of isolations and the execution of dependent permits.

Training

By the time implementation was complete on the offshore facilities, 1,900 people had been trained in the use of iSSoW. Each one of these people had been trained in a classroom environment. By completion of implementation throughout Woodside, it is estimated that there will be more than 4,000 users of the system.

Using classroom-based training for the first year of implementation allowed us to readily fine-tune the course content in response to trainee feedback and evolution of the iSSoW system. A year after first implementation of iSSoW, a computer-based training programme was developed covering the basic training requirements for work party members and performing authorities. It was felt inappropriate to attempt to train an entire workforce using computer-based training techniques at the point of introduction of a new system, as there would inevitably be a significant number of questions that could only be answered in a classroom environment.

The training programme was developed directly from the iSSoW manual—the 100-page document governing the use of the system. The definition of the iSSoW process and the roles and responsibilities formed the core of the training programme at the basic levels. The higher-level training for the key authorities in the system was more closely aligned with the software operation.

The training programme was developed as a modular course so that people would be trained only to the level at which they would be required to use the system. Key learning outcomes were developed, along with a competency assessment for each module. The course format was a blend of theory and practical activity, with assessment of the participants at every stage. Team activities were used to replicate the scenarios participants would face in the workplace and included the performing of risk assessments, pre-start toolbox talks, site endorsement and the process of generating a work request. The training took 1–3 days to complete, depending on the level of training being undertaken.

Participation in the training programme and being deemed competent in the use of iSSoW does not automatically give the trainee the right to act in that role. They need to be interviewed by their line supervisor to demonstrate their level of understanding, and they need to have performed any other training relevant to performing that role. An isolating authority, for example, will not be taught the technical principles of isolation during their iSSoW training, but only the aspects of isolation management that relate directly to iSSoW.

From mid-2009, a program of developing computer-based training (CBT) courses began in order to provide a sustainable means of training the trickle-feed of new users in future years. The CBT courses are available from a secure website, which allowed new personnel to train in the use of the system from any internet computer worldwide. This enables approved international vendors to mobilise to a facility pre-trained and without the lengthy delays required to perform the training in Australia.

Trainers with industry experience and familiarity with permit systems were used. They saw the opportunity to be involved with iSSoW as an important step in their training careers.

Development of the HIRA database

The HIRA database was developed over many months and involved bringing system experts together to perform manual assessments. Their knowledge was captured in the database, which allows less experienced users to access years of experience in a simple checklist format.

The system was designed to allow the capturing of lessons learned at a detailed level. In previous systems, changes to the system would tend to occur only in response to incidents or major audit findings. As a result, many simple but important lessons were lost. The remedial actions used previously focussed on changes to written rules or the education of system users, and typically took the form of memorandums or slide presentations. The problem with such actions is they rely on human memory and on employee retention. The iSSoW provided an opportunity to capture even simple lessons and hardwire the learnings into the system through changes in the HIRA database. Furthermore, the single HIRA system in place across Woodside ensured that any lessons from one facility were automatically effected across all facilities in a permanent manner.

Previous remedial actions following incidents frequently constituted setting up a checklist or another form of administrative control, however these types of barriers, while guarding against an incorrect course of action, also made it harder to do the right thing. The HIRA database allowed us to alleviate this problem by building realistic and simple controls directly into the risk management system, without the need for further documentation. In all, 35 separate checksheets from the Woodside facilities were eliminated as a result of introducing the HIRA database.

Development of the plant database

We identified that the plant hierarchy information initially contained in the database was not holistic. Therefore some key features of the system were not as effective as expected. The remedial work from this situation led to processing a large number of piping and instrumentation drawings (P&IDs) throughout Woodside in order to bring them in line with the iSSoW requirements. In the interim, users were capable of creating temporary plant items in the iSSoW system, but we could not guarantee the ability of the system to automatically check for isolation point conflicts and other cross references.

Data for the hierarchy had been sourced from many places, mainly the SAP maintenance management database. As a result, any data errors or omissions in the SAP system were carried though into iSSoW. As crews used iSSoW to prepare and manage their work activities, the errors in the hierarchy became apparent, and therefore highlighted information requiring correction within the SAP source data. Without iSSoW, these errors may have gone unnoticed for a significant period.

A peer review process allowed other operating companies a first look at the iSSoW concept in Woodside, and provided Woodside with an assurance check on the system up to that point.

The system concept was also presented to the industry regulator to provide them with assurance that the new system met all the basic requirements of a work management system and to discuss the minor changes to the facility safety cases.

Testing the system

Although we regularly tested the system performance throughout the development phase, we also needed to perform final assurance checks on the system before we could implement it into a live environment. Testing occurred on a number of levels:

- IT compatibility—to ensure that the software was entirely consistent with Woodside's IT protocols and free from potential for data corruption or system crashes. Additionally, we needed to confirm that the default settings for the IT operating platform (Internet Explorer) were correctly configured on all company PCs.
- IT behavioural testing—to ensure that data would not be lost in the event of a short-term communications failure. We also tested the link speed between sites was satisfactory.
- Software robustness—end-to-end testing of all scenarios to ensure business rules have been correctly incorporated into the software in line with the requirements specification.
- Incident testing—testing against past incidents that were caused by PTW breaches or failures. We needed to assure ourselves that iSSoW would address such scenarios and prevent repeat incidents.
- User interface—using people who had not been involved in the development of the system to test its intuitiveness. This was typically performed without providing any training to the testers in order to test the clarity of the user interface.
- Training—we tested the effectiveness of the training package to provide assurance that it was effective, and that we were genuinely assessing competence.

Figure 4 represents the process of developing and testing the iSSoW. With information sourced from as many opportunities as possible, a process of screening and evaluation was used to form the final system. A thorough independent peer review combined with thorough testing of the system processes, hardware and software resulted in the finished product. A similar process was used for the development of subsequent enhancements and upgrades to the system.

IMPLEMENTATION OF ISSOW

Preparation

The ground-work for implementation began about 12 months before the introduction of the system. The project manager delivered a series of presentations to each of the facilities. More than 90 presentations were delivered in total including those in the Perth Headquarters. The purpose of the presentations was to:

- inform stakeholders of the nature of the new system;
- help future users understand how it will affect their working day and to come to terms with the change;
- ensure stakeholders were clear why Woodside needed iSSoW;
- demonstrate how iSSoW was consistent with other changes in the business (e.g., alignment);
- build expectation and develop a hunger among users for the new system;
- help users understand the potential capabilities of the system;
- provide an opportunity for people to ask questions and to voice any concerns;
- allow users to highlight any specific requirements they had of the system;
- put a face to the project, and to ensure stakeholders felt involved in the development of the system; and,
- demonstrate the management endorsement of the system and commitment to making iSSoW a success.

Additional media were used to communicate updates of the system development, such as the Woodside quarterly magazine and a dedicated intranet site. By this time, iSSoW terminology was becoming more familiar in the company, and the barriers to change were being eroded. It was receiving regular airplay in management briefings, and the increased system awareness resulted in iSSoW considerations being discussed in operational meetings.

Implementation schedule

With eight sites earmarked for implementation of iSSoW, a schedule was developed. This schedule needed to take account of the following:

- A preparation period was required for each facility, between the arrival of the implementation team at site and the implementation of the new system.
- All persons on the facility required training before they could work in iSSoW.
- The training programme targeted the time between training a person in iSSoW, and them using the system for the first time to an average of less than three weeks. Shorter gaps were preferable to maximise the effectiveness of the training; an accurate training schedule was critical.

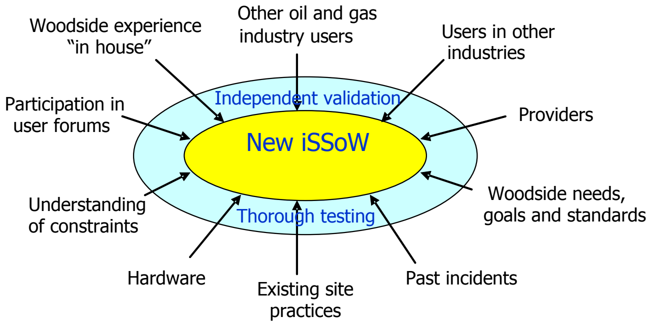

Figure 4. A summary of the development process of iSSoW.

- The implementation on each facility was scheduled to avoid periods of high intensity activity, such as shutdowns. Furthermore, the implementation could not be scheduled within three months prior to a shutdown, as all activity preparation for the shutdown would have taken place in the original PTW system.
- Sufficient implementation time was required with a full-time presence of the iSSoW team on board to allow users to gain confidence in the use of the new system, and to provide mentoring where required. The iSSoW team therefore remained on each facility for a period of eight weeks, or longer where the implementation was more complex.
- The iSSoW team also required time to gather feedback from the users on the uptake of the new system and ideas for improvement. This was formalised and fed forward into system development sessions, allowing solutions to be identified and actioned.

The iSSoW team consisted of 3–5 people at the time of implementation. With the work-shift rotation, this equated to 1–3 team members at the facility at any time. Having a small, dedicated team assisted with the communications in the group, and was sufficient to manage the implementation end-to-end. This same team was responsible for the ongoing system development and continuous improvement, software testing, assisting in shutdown preparation, delivery of training, provision of day-to-day system support, and overall project management.

The schedule allowed for one site at a time to be migrated over to iSSoW, resulting in a timeframe of 24 months for all Woodside's sites to be completely cutover to iSSoW.

The first facility to adopt iSSoW was the Northern Endeavour FPSO, located in the Timor Sea. This facility was deliberately selected to pioneer the system for a number of reasons:

- Relatively small number of personnel on board;
- Activity levels were generally less than on other Woodside facilities; and,
- The crew had previously demonstrated a positive attitude to adopting new processes.

Northern Endeavour did, however, presented additional challenges that needed to be considered, such as:

- Communications with the facility were the weakest of all the Woodside sites as a result of its remoteness and bandwidth limitations;

- Helicopter and boat access to Northern Endeavour was infrequent, making it essential to have all the required materials and consumables on location and fully checked well ahead of time; and,
- Facility crew members predominantly live interstate, making the logistics of convening the crews in Perth for their training in the weeks prior to implementation challenging.

We referred to the implementation at Northern Endeavour as a 'roll-out.' The description of 'pilot' used by some people implied a temporary or trial basis, and it was important that this perception was corrected to ensure full commitment from the facility crew. With a system as crucial to safety as iSSoW, we needed to be totally confident of its robustness and security prior to implementing at any location.

A seven-day period between mobilisation of the team to the facility and going live with iSSoW allowed time to perform final preparations, including:

- Setup and testing of the computer hardware (e.g. servers, printers);
- Installation of the locking hardware (e.g. keysafes, lockboxes, locking storage);
- Preparation of the crews (e.g. ensuring expectations were aligned and roles were clear);
- Definition of the new daily routines required to make iSSoW a success;
- Performing refresher training where required; and,
- Distribution of supporting material around the facility (e.g. posters and booklets to assist personnel to use the system accurately and consistently).

The cutover from PTW to iSSoW also needed careful management. The process involved the natural running down of the original permits and the generation of any new permits in iSSoW. As a result, there was a period of six days when both the original and the new systems operated in parallel, with each system operating to a different rule set. A formal temporary operating procedure governed how this process was to be managed to avoid incident.

Going live

On 13th October 2008, the first permits were issued in iSSoW. A rigorous audit process was put in place to ensure full compliance with the new rules. The system checks were reinforced after every crew change to ensure the oncoming personnel were also fulfilling their roles properly.

Despite the thorough testing that had taken place in the development phase of the system, it was inevitable that the use of the system in the live environment would highlight new issues. These issues were captured and fed into the continuous improvement process to drive the next batch of system enhancements or small procedural changes, which could be implemented rapidly.

Human factors

Monitoring the quality of the permit process helped identify that a minority of users believed that the computer-based system would do everything for them. Clearly, the message was that the software is merely the tool used to assist in the preparation and issue of permits, but it is not capable of doing everything. Users needed to remain engaged with the system as they developed their work packs and work in harmony with the electronic interface to deliver the right results. Some further software enhancements were put in place to make the system more intuitive with improved functionality and screen design.

Some users became disorientated in the new system, creating rules of their own. In the majority of cases we found that the user had underestimated the degree of difference between the old system and the new, and they were simply trying to apply old system rules to iSSoW. The two processes function in totally different ways, and personnel were advised to forget the old system rules entirely to avoid confusion.

The ease of implementation varied widely between sites. We believe this was due to a number of factors, including:

- The preparedness of staff for the change;
- The level of engagement between the site focal point and the crew from their facility in the lead up to implementation;
- The time lag between training and implementation—the hardest introduction we carried out began early in January, which was up to five weeks after the training had been carried out due to the Christmas break;
- The level of support from facility management—it was essential that the site controllers were vocal in their endorsement of the system, and ensured their crews worked appropriately to make the implementation successful;
- The understanding of the purpose—those users who saw a clear link between the introduction of iSSoW and the potential for improvements in safety performance demonstrated an excellent uptake of the system. The minority of people who considered it to be an administrative change only were weaker in accepting the change. A re-calibration of behavioural expectations was required in some cases;
- The completeness of the system data—where the source data for the plant hierarchy database was unconsolidated, gathering the required information from which to build a holistic database was difficult. As a result, some users found the system required a greater manual effort than they had envisaged. Once gaps in the data had been addressed, their engagement improved;
- The perception of time constraints—some new users attempted to rush through the process of creating work requests, which resulted in errors or inadequate preparation. When their work was reviewed and rejected, there was a perception of increased time pressure, often leading to a greater rush and more re-work;
- The adherence to a workable plan—having a firm work plan was essential to achieving success in iSSoW, just as it is in any work management process. An unrealistic plan, however, tended to reflect poorly on iSSoW, which was occasionally seen to be the source of the problem.

Subsequent implementations

During each implementation, learnings were collated and the documented process was improved for the next facility. Therefore we quickly developed an implementation recipe that was well tested and familiar. The team could take a regimented and efficient approach to subsequent implementations, and then focus additional effort on managing the subtle differences between facilities.

System support

Even with the system implemented on all facilities, there remained a requirement to provide support to users and to provide ongoing system development.

By far the most challenging part of the system support has been developing and implementing enhancements and system upgrades into a live operating system, while ensuring that data loss and corruption is eliminated. This has required an extremely good working relationship between the software company and Woodside's iSSoW team. It has also required a development roadmap to ensure the right balance was struck between the need for frequent upgrades and the potential risk and disruption caused by performing an upgrade. On average, we have upgraded the system every three months since implementation.

All system support queries are channeled initially through the IT helpdesk, who determine if the query is related to technical or business issues. The helpdesk deals with technical issues initially, while business issues are passed on to the iSSoW team.

Optimising the system

With the system in place and proven to be robust, we turned our attention to our secondary aim—improving efficiency. Analysis of the system identified several opportunities for streamlining and de-bottlenecking the system, as outlined below.

REGISTERED ROUTINE DUTIES

Registered routine duties (RRDs) are well suited to simple, low risk tasks such as basic planned maintenance routines, and supporting tasks such as erection of standard scaffolds. They are a valuable means of reducing the workload while ensuring consistency in the way repeated work is performed. These had always been available in a paper-based format but had not been widely used. The software provides the ability to generate RRDs and ensure they are approved by the site controller and remain valid for one year. The RRD consists of a procedure and a HIRA risk assessment, but requires minimal ongoing administration. Worksite endorsement of RRDs is required prior to starting work, just as is the case for permits.

PERMIT VOLUME

Since Piper Alpha, there has been an apparent trend in the oil and gas industry to use permits to manage smaller chunks of work. As a result, a task that needed a single permit 25 years ago may now require three or four permits to cover the same activity. While this has undoubtedly provided improved clarity over the ongoing work, the danger is that the increased administrative burden is distracting permit authorities from the effective management of work. The iSSoW, and particularly the HIRA functionality, enables several parts of a task to be assessed and controlled together, therefore presenting an opportunity for some recombination of permits where appropriate, and returning the permit scopes and volumes to their optimal balance.

MULTIDISCIPLINE WORKGROUPS

Multidisciplinary work groups might choose to use separate permits for each work disciple. In some cases a single permit could provide similar or even improved control while reducing the administrative burden. Simple campaign maintenance activities on a single unit of plant involving mechanical, electrical and instrument disciplines can often be adequately managed with a single permit, with a campaign team leader acting as the performing authority. This puts the onus of responsibility for coordinating the campaign team onto the team leader, rather than the permit issuing authority, allowing the issuing authority to focus on the management of other potential conflicts. Of course if there are valid safety reasons why the permit should be split to control the work, such as differing isolation requirements between the disciplines, this can be achieved.

ISSUING AUTHORITY ROLE

The introduction of iSSoW required the operations supervisors to assume the role of issuing authority on the Woodside facilities in order to ensure the profile of permits was raised and that a senior figure was taking the responsibility for permitting work to proceed. This placed an increased workload onto the supervisors, and besides those measures identified above, it was also necessary to identify alternative means of reducing their workload. Non-iSSoW activities were delegated or stopped where possible, and it was necessary to restructure their day. In addition, the introduction of the permit management feature allowed the responsibility for re-issuing permits to pass to the issuing authority's representative without any loss of control. The system would only allow them to re-issue permits if that had been agreed at the previous day's planning meeting, and any deviation from that plan would require the issuing authority's electronic authorisation.

THE PROCESS OF ISSUING PERMITS

We also analysed the process of issuing permits and found that the layout of the permit issuing desk influenced the time it took to issue a permit. On one facility, the issuing authority issued permits from his office and had to leave his office to go to the permit office to collect the printed copy of the permit or to manage isolations. The opportunity for the performing authority to sit down during this time turned the process of issuing permits into a social exercise as much as a business operation, and the time to issue permits became excessive. As soon as the issuing authority began to issue from the permit office window, issuing times were immediately reduced by more than 50%. It was important to dissociate the issuing authority's office from the issuing of permits to ensure that the defined permit issuing hours were adhered to.

THE 48-HOUR RULE

A business rule of iSSoW is that work requests must be raised at least 48 hours prior to work commencing, unless the work is emerging and high priority (such as breakdown of safety critical equipment). Ensuring disciplined application of this rule is essential to proper work management, ensuring sufficient time to review and amend the permits and running an efficient and effective permit system. Therefore detailed realistic work plans had to be developed well in advance, and this in turn drove an overhaul of Woodside's work planning system. The same rule assisted in managing the emerging priority work, as priority over plan (POP) work could pass rapidly through the structured system without disrupting all other work plans.

ISOLATION TEMPLATING

A key feature of Woodside's iSSoW system is the ability to save standard isolation schemes and recall them for future implementation. Therefore, there is no longer a requirement to develop an isolation scheme from first principles every time one is required. Instead a previous scheme can be accessed, reviewed for completeness and suitability, and the isolation tags printed automatically. Using such a facility has allowed the preparation time of an isolation scheme—which previously took six hours—to reduce to 15 minutes.

THE RESULTS OF ISSOW—SO FAR

While statistical safety performance continues to improve on Woodside's facilities, there is insufficient empirical data at present to reliably measure the correlation between the introduction of iSSoW and the reduction in incidents; however the evidence of permit-related shortfalls being root causes or causal factors in incidents has fallen from approximately 60% of incidents in 2006 to less than a third of that proportion in 2009.

Woodside has observed a general improvement in safety behaviours since the introduction of iSSoW due to renewed thoroughness around work planning, discipline of risk assessment, and the robust management of isolations.

A significant contributor to the integrity of the system is the requirement for face-to-face communication at the worksite and at the point of permit issue. Poor handovers and site communication had been causal factors in several incidents prior to iSSoW. Since the system was introduced there have been no incidents related to this cause.

We performed quality checks on the HIRA system by putting the HIRA risk assessments side-by-side with the equivalent assessments generated in the previous JHA format. In every case we found that the quality of the output from the iSSoW matched or exceeded that produced by the JHAs. On average, the HIRA system identified approximately 1.5 times the number of hazards as the equivalent JHA, and up to four times as many hazard controls. Despite using a quite generic database as the starting point, the HIRA assessments assisted in identifying hazards and controls that were being missed using the traditional risk assessment techniques. Furthermore, the time taken to develop an accurate HIRA was significantly less than the time to produce the equivalent JHA.

Efficiency gains are now becoming evident, with the ability to re-use an isolation scheme. This will continue to increase as system use increases. The recycling of isolation schemes with the appropriate review and approval is a significant time-saving feature.

The introduction of registered routine duties allowed simple tasks to be performed without lengthy preparation times, and ensured the tasks were executed consistently each time. As a result, productivity has increased for these tasks.

Building the business rules into the software and the standardisation of permit rules company-wide has enabled us to condense 5,000 pages of rules into a 100-page document—the iSSoW manual. This simplification has brought clarity to the process, further assisting with alignment.

The system has been proven in the high intensity environment of shutdowns where the complex isolation structure is difficult to control in a paper-based system. The iSSoW's visibility of permit hierarchies and the ability to plan work months in advance has produced good results in the overall performance of shutdowns.

The lessons learned from job execution has resulted in many updates to the HIRA database across the company. This has produced the desired effects of improving safety awareness and work control and encouraged feed back on lessons learned—even at a very basic level—to aid in continuous improvement.

EMERGING OPPORTUNITIES

It became apparent early in the project that iSSoW had the potential to benefit others beyond Woodside. Although the primary intent of the project was to meet the needs of Woodside, the project team and the software provider began to look outside the organisation to identify opportunities for the further application of iSSoW.

Recommendation #34 of Lord Cullen's Public Inquiry into the Piper Alpha Disaster[1] called for increased harmonisation of permit systems in the UK oil and gas industry as the many and varied systems in place there were the source of confusion by those people who operated between facilities.

The oil and gas industry workforce in Australia has a large transient component and may be employed across the facilities of many operating companies. The requirement for these personnel to be able to understand and comply with the rules associated with several companies is a concern in the industry. In recent years there has been a drive to achieve improved alignment in many areas in the industry. An iSSoW, by its very nature, lends itself well to standardisation and alignment of permit to work processes between organisations.

Furthermore, as the industry anticipates a period of increased activity but operates in a region where skills and experience are scarce resources, there is significant potential for safety standards to deteriorate. The economic climate, and in particular the present strength of the Australian dollar, will make it more difficult than in recent years to bring in foreign labour to help address the skills gap. This has two implications that iSSoW is seeking to address:

1. It is important that we use our people wisely. By standardising across the industry, we can avoid the need to reinvent the wheel in each company, and significantly reduce our overall training burden.
2. The author's observations indicate that personnel entering the industry tend to be technically trained and assessed, but have little awareness of permit systems. Woodside's iSSoW and the SageSURPASS software are therefore being incorporated into the TAFE facilities, a move that will ensure that industry trainees have greater knowledge of these systems from the start of their careers, and see the disciplined use of iSSoW as second nature.

Figure 5 depicts one view of the future potential of iSSoW across the Australian oil and gas industry, using a common system across several industry bodies in line with a common permit to work standard, and with joint ownership of the further development of that system. Once in place, the system could enable rapid sharing of information between operating companies, and acceleration in the pace of improving safety performance throughout the industry.

The system design, including the software, took full account of the potential for use throughout the oil and gas sector. It recognised that the principles of risk management are much the same in any industry, even though the hazards, activities and terminology may differ. From early 2010, the system will be in use in the power industry in Australia.

Using the same concept, we developed the system to be applicable at any stage in the life of a facility. Although primarily an operational work management tool, it is capable of being used equally effectively in the commissioning phase of a project. The same rule set can be applied consistently, and switching the system from commissioning to operational mode can cater for the small subtle differences in the types of work being carried out.

The ability to interface with the system from the worksite will provide multiple benefits. A mobility module has been produced as part of iSSoW, which will allow the use of intrinsically safe handheld computers to effect some key transactions directly from the field. Included are:

- Verification of correct valve identity prior to implementing an isolation point; and,
- Verification of valve identity prior to selective deisolation.

This technology could be extended to include:

- Electronic area authority endorsement;

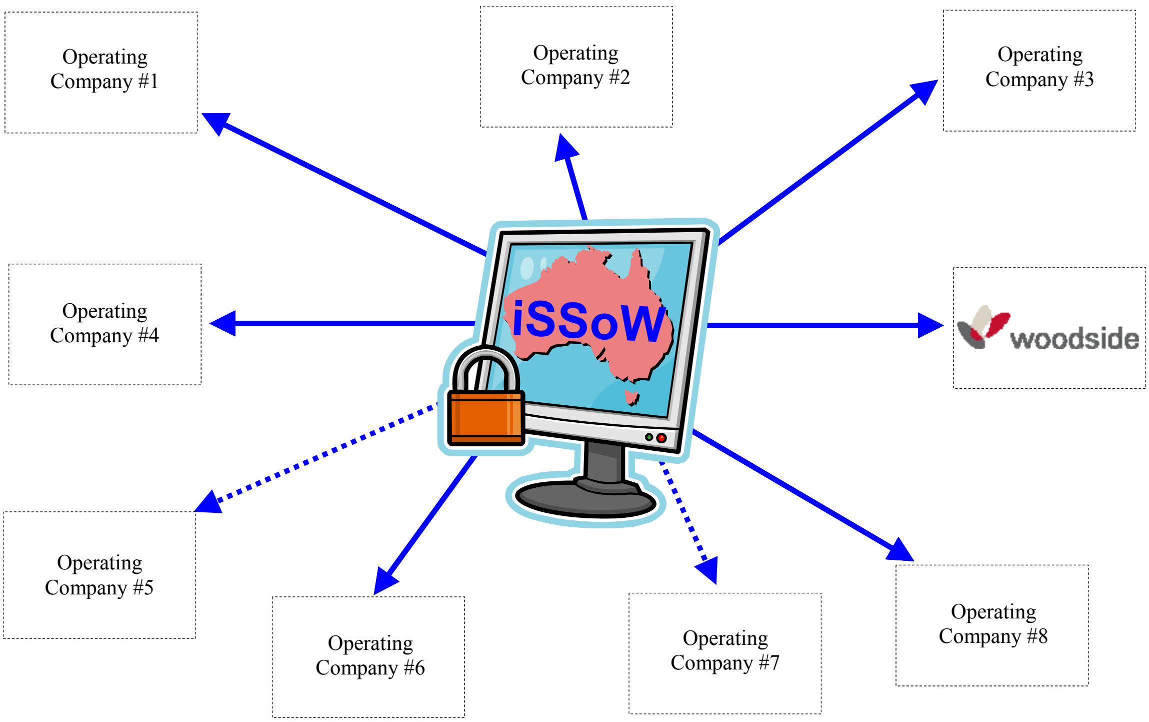

Figure 5. The vision of standardisation of iSSoW in the domestic oil and gas industry.

- Electronic logging of entry/exit for confined space entry;
- Bleed valve check reminder/recording; and,
- Gas test reminder/recording.

iSSoW lends itself well to electronic archiving of documentation, thereby eliminating the logistical cost and improving the retrieval speed of items.

An integral auditing and monitoring tool is being developed to ensure transparency of the audit findings, and the ability to disseminate lessons learned easily throughout the organisation. This tool will provide audit compliance statistics at the touch of a button and allow trends to be viewed, therefore highlighting areas of the system that require attention. The system will also ensure that audits are taking place on the appropriate percentage of total permit volume.

The system will be able to assist in managing potential conflicts, with diagrammatic plot plans showing the geographical distribution of work, and an ability to check for conflicting hazards in a predefined area.

Most of these areas of further development involve software enhancements and are designed to assist the iSSoW users manage their work more safely and easily. Our intention is to make Woodside's Integrated Safe System of Work the best in the world, for the protection of our employees and contractors; however we have also wanted to make the system so good that other operating companies do not want to emulate it, but instead to adopt it as it is. This is essential if we are to be able to achieve the standardisation the industry requires, and to provide the best working environment for all oil and gas industry workers in Australia. The key strengths, weaknesses, opportunities and threats of iSSoW are summarised in Table 1.

SUMMARY

The iSSoW has delivered excellent results to Woodside through internal alignment and improved safety performance. The system is embedded in operational facilities, and will be central to the way Woodside works for many years.

The iSSoW is consistent with Our Safety Culture model in establishing clear expectations of people in varying levels of seniority. It has played a significant role in the ongoing improvement of safety behaviours in the workplace.

It has removed ambiguity from the company's work management system, providing clarity of rules, responsibility and process.

It enforces the meeting of standards using a simple electronic tool, while assisting users to perform their duties within the permit system. By reducing the scope for human error in the preparation and performing of work, iSSoW has succeeded in making it as easy as possible for people to do the right thing.

NOTES

1. The Public Inquiry into the Piper Alpha Disaster—The Hon. Lord Cullen, London HMSO, Cm 1310, (November 1990).

Table 1. Strengths, weaknesses, opportunities and threats (SWOT) analysis of iSSoW in Woodside.

Strengths	Weaknesses
Proven robust simple system Provides excellent permit status visibility Enforces good permit discipline Simple effective risk assessment tool Proven in shutdown situations Suitable for many types of facility Can be used in production and commissioning phases Computer-based training available Ensures rapid continuous improvement across sites	Computer literacy may be a barrier Relies on accurate plant data to reap full benefit
Opportunities	**Threats**
Can drive widespread alignment between sites Can be used to shape organisational restructuring Can lead to significant time savings Can be used to reduce documents and manuals Enables additional modules to be added (e.g. mobility)	Fear of change (if change is not managed well)

THE AUTHOR

Ally Oliver is an operations manager with Woodside Energy. He is responsible for the development and implementation of the Integrated Safe System of Work in the company, prior to which he was operations manager for the North Rankin facility. He has 20 years experience in the oil and gas industry, and is experienced in drilling, well intervention and production operations. Ally has a BEng (Hons) in offshore chemical and process engineering and a Master of business administration (MBA).