PERMITS AROUND THE WORLD

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The hazards associated with maintenance are recognised on a worldwide basis. They can cause accidents ranging in scale from minor injuries to major explosions involving huge loss of life and massive financial loss.

One of the measures to minimise the chance of an accident occurring during maintenance activities is almost universally some form of permit to work system. These vary from basic to very sophisticated systems.

This paper reviews permitting and equipment isolation practices encountered during insurance risk surveys of hydrocarbon facilities around the world.

THE BASICS OF PERMIT TO WORK (PTW)

Permit systems are one of the most critical safety procedures in industry, with a role in preventing both simple accidents to personnel and major process safety incidents.

Whilst not always recognised, the permit procedure fulfils two purposes:

- Establishing a safe framework for work to take place by ensuring that hazards are minimised, safety precautions are in place (for example; adequate isolations, provision of fire extinguishers, decontamination, etc.) and correct Personal Protective Clothing (PPE) is worn.
- Ensuring good communication between all the parties involved in the maintenance work and, in particular, ensuring that there is clear agreement that an item of equipment is available for operation or under maintenance.

Most permit systems work on similar principles with a review of the task to be performed, making sure the site is safe, with appropriate isolations and other safety precautions in place before handover from operations personnel to maintenance personnel. After work is complete, the site is handed back to operations, in a safe condition, for production to continue.

The principles of PTW systems and isolation procedures are clearly explained in various industry guidance, for example the series of publications by the UK HSE[1,2,3]. Whilst simple in concept, there are numerous variations and the possibilities for error, either by misunderstanding or deliberate disregard of the procedure are demonstrated by incidents ranging from the minor to the catastrophic.

METHODOLOGY

CTT has been involved with insurance risk surveys internationally for well over a decade, using well established and detailed protocols to review large industrial facilities for insurance purposes. The surveys have covered a range of industrial facilities but the majority are related to power generation and the process industries.

Our survey approach identifies key features of the permit system which are recorded in standard proformas for inclusion in survey reports and, occasionally, for analysis on a wider scale. For this particular analysis, only surveys involving the hydrocarbon processing industries have been used. Whilst we have a considerable database covering other industrial facilities, the specific safety hazards are considered to be too industry specific for inclusion in an analysis of this type.

For each of the locations visited, the permit system is considered against a number of key parameters. The key ones are listed below, together with an indication of why they are considered important:

Permit to Work	Reason
– Types of permits	Specific permits are designed for specific hazards. Force fitting certain types of work to an unsuitable type of permit can cause problems.
– Training	Permit forms and procedures have become increasingly sophisticated. Inadequately trained personnel, particularly contractors are likely to make mistakes if not adequately trained and periodically retrained.
– No. of copies	To ensure that both operations and maintenance personnel are aware of the work being done, more than one copy of the permit is generally required.
– Handover and handback signatures	It is vital that operations and maintenance personnel are clear at all times, on the status of equipment which is being maintained or has undergone maintenance.
– Filing	Correct labelling and filing of permits is important to ensure that mistakes can be tracked and the current status of work can be confirmed – particularly in situations where work has been suspended in an incomplete condition.

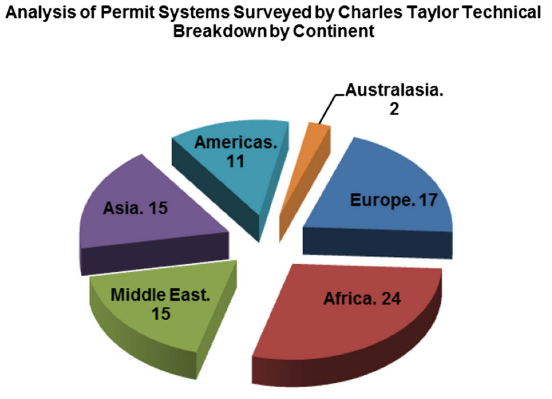
(*Continued*)

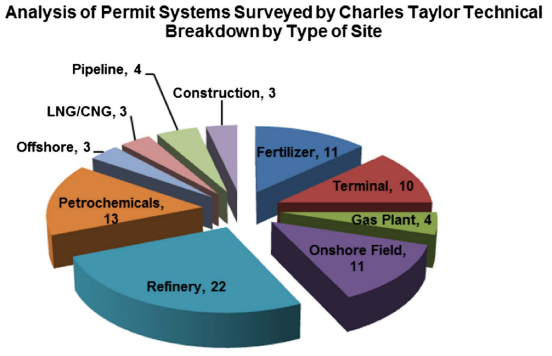
Permit to Work	Reason
– Auditing	Any system of work will degrade over time without inspection and corrective action. This is best achieved via regular auditing. Without regular auditing it is likely that degradation will only be identified when an accident occurs.
Isolations	
– Mechanical	Poor mechanical isolation can result in either leakage through passing valves or accidental opening of valves.
– Electrical	Poor electrical isolation can result in accidental operating of equipment, either resulting in the generation of sparks, short circuits, other electrical effects, or equipment operating without mechanical guards being in place.
– Instrument	Isolated process trip systems can result in the failure to shut down the plant when it reaches a hazardous condition.

Where possible, actual performance is also reviewed but during the course of most surveys, it is difficult to review more than one or two work sites.

SAMPLE SIZE

A sample of permit systems from around 90 hydrocarbon operating and construction sites around the world were included in the review. Since then, a significant number of other locations have been visited but due to time constraints it was not possible to incorporate them in the analysis.





VARIATIONS IN PRACTICE

Permit procedures and practices are continually evolving and new practices and permit procedures/isolation procedures are continually developing. A number of specific aspects are considered below:

TYPES OF PERMIT

Whilst some form of hot and cold work (sometimes combined) and confined space entry permit are common, there is a variety of other permits in use for specialist tasks. For example:

- Excavation — found in 46% of the sample
- Radiography — found in 20% of the sample
- Vehicle entry — found in 13% of the sample, although this is often covered by a hot work permit
- Working at heights — found in 5% of the sample
- Specific high hazard work — For example: diving and maintenance activities in areas handling hydrofluoric acid etc.
- Working at night

In some places, hot work permits are used for activities where there is no ignition hazard, but the work to be undertaken is considered to be particularly hazardous, such as breaking into process pipework.

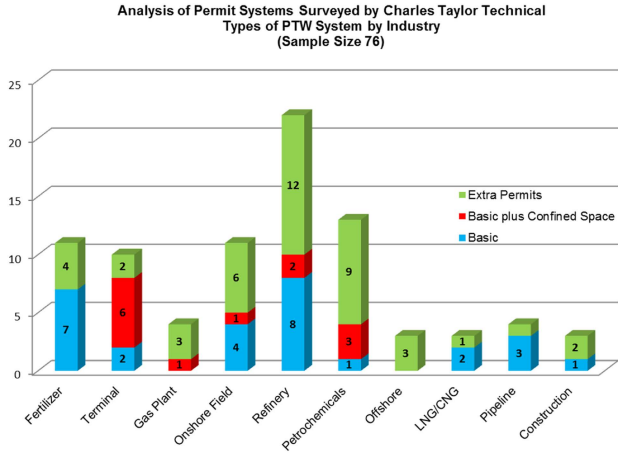
In a few particularly high hazard locations, a combined hot/cold work permit is used on the basis that all work is highly hazardous. A specific example is oil/gas production where high levels of hydrogen sulphide exist.

A recent development is the differentiation of hot work into "spark potential" activity and more traditional hot work such as welding and grinding. This is considered to be a positive approach to ensure adequate attention is given to activities that have a spark generation potential, such as the use of internal combustion engines and the use of temporary electrical equipment within process areas.

These activities frequently "slip between the gaps in the many permit systems and this new classification is considered useful.

VARIATION IN PRACTICE BY TYPE OF INDUSTRY

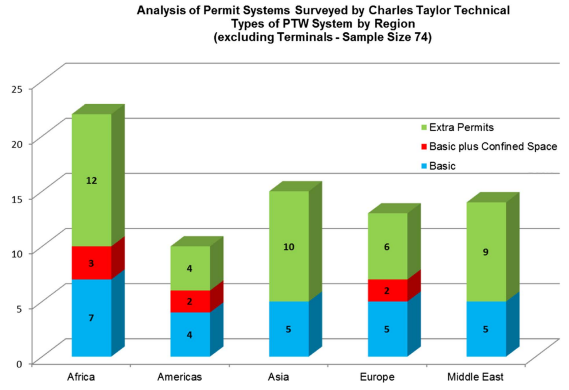
As would be expected, the level of complexity of permit systems varies with the hazard potential of the industry concerned. For liquid fuels terminals, where hazards are relatively low, simple permit systems are the norm with the basic permit types of hot and cold work (sometimes combined) and confined space entry being available. More sophisticated permit system are generally available in refineries and petrochemical plants, often with specific permits covering activities such as excavation; radiography; vehicle entry, etc. There is also a trend to covering working from heights under the permit system. However to be fully effective, this should be linked to a "ScaffTag"-type certification system.



VARIATION IN PRACTICE BY LOCATION

The review, which led to the production of this paper, covered permits throughout the world but with relatively few in Australasia. There is no clear correlation between the sophistication of a permit system and the level of industrial development of the country where it operates. Some systems in developing countries were to a high standard and some in the developed world relatively basic. The only area where procedures were generally poor and/or poorly applied was in some developing countries where construction projects using contractors with a limited international track record were surveyed. For these construction projects, problems were sometimes compounded by the fact that the permits were written in the language of the contractor's home country which may not be understood by the contractor's client or others. In these situations, permits may become a formality and not a means of ensuring safe working.

Occasionally, welding and cutting has been observed in process areas without a permit of any sort being issued.



CERTIFICATES VERSUS PERMITS

Regardless of the type of permit system in place, there is a requirement to ensure that equipment is in a safe condition for maintenance. An important requirement is to ensure that the equipment to be worked on is adequately isolated, both electrically and mechanically. Many of the procedures surveyed feature either a specific permit for electrical isolation or a separate certificate used in conjunction with a hot/cold permit. There is not generally an equivalent level of certification for valve isolations, although this type of permit (or checklist) does exist at some sites.

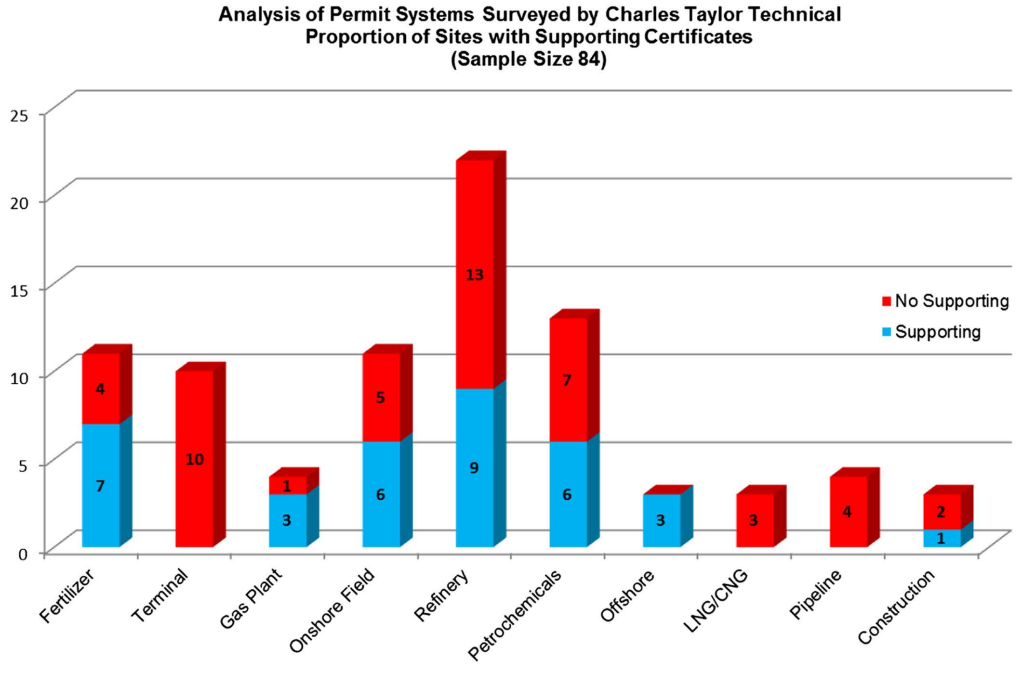
Whilst some permit procedures allow cross referencing with other documents, this feature is far from universal and can make it difficult to track that instrument/electrical tags, etc. are correctly installed before maintenance and have been removed at the end of the activity.

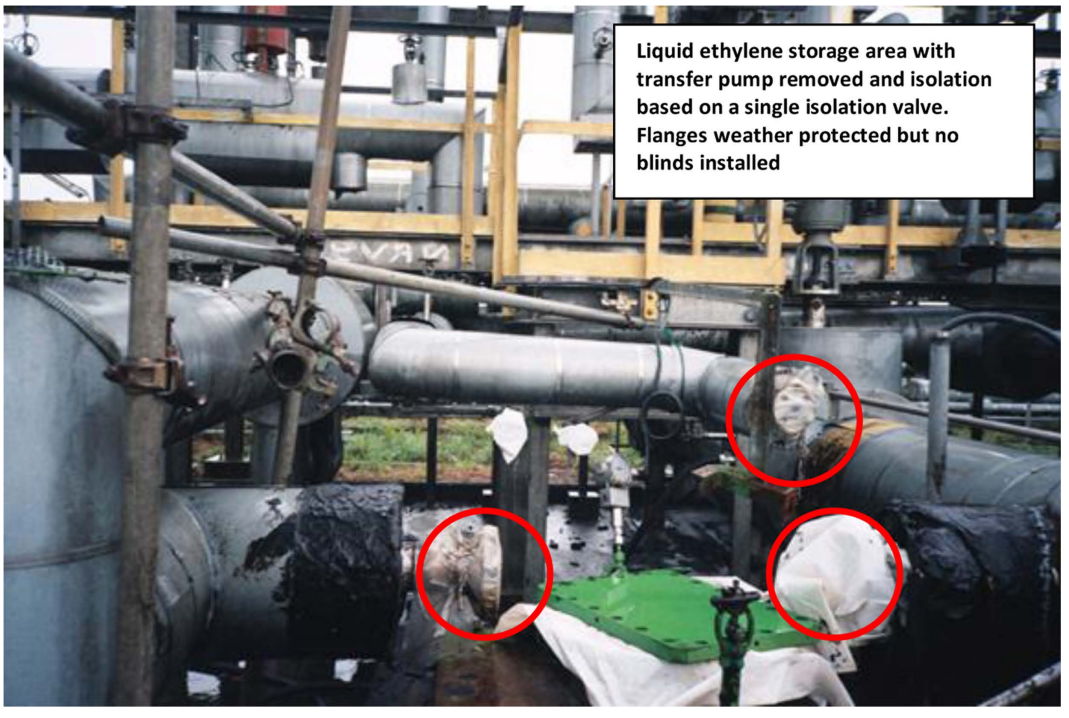
ELECTRICAL AND MECHANICAL ISOLATIONS FOR MAINTENANCE

Most electrical isolations require a form of positive lock off and a tag showing the equipment is out of service. Practice does not always follow the theory however and it is not uncommon, in some areas, to find that electrical breakers are tagged but not locked open. It is much less common to find a requirement for mechanical isolation valves to be locked and padlocked closed, although this is a requirement of the best systems currently operating.

Some systems do not even specify that fully rated blinds (rather than thin sheets of plate) are required where equipment is removed.

Many companies now have blinding procedures specifying the level of isolation necessary depending on temperature, pressure and hazard rating of process systems.





JOB SAFETY ANALYSIS

The requirement for job safety analysis is growing and many of the systems reviewed in recent years have some form of requirement for a job safety analysis. In some instances, this is only for non-routine or high hazard work with safety precautions being defined in standard work procedures.

Most PTW forms have checklists of safety precautions, with space available on the form to write in additional precautions. It sometimes appears that a tick box mentality

rather than thought and an appropriate assessment of hazards is applied to complete this. At some sites all permits had a special instruction to "work safely" but no other safety precautions specified.

CASE HISTORY – ASSESSMENT OF RISK

A standard hot work permit had been issued for welding in a confined area. The following defects were noted:

- The area where the work was taking place had not been recognised as a confined area, even though it was below floor level and access was difficult.
- The fire watcher appeared to be present only on a part time basis and there was no nearby fire extinguisher
- The hoses for the gas cutting equipment were laid where they would be exposed to hot metal splatter from the cutting work
- The gas cylinders did not appear to be fitted with flashback arrestors.

PERMIT REQUIREMENTS DURING CONSTRUCTION

The requirement for permits varies from site to site. On some sites, the requirement for permits only begins at the start of commissioning. At others, the requirement is in place from the start of construction. This can be difficult to enforce, particularly with an unsophisticated workforce but it has advantages in helping to ensure safe working practices. Particular attention is required where construction work is taking place next to, or within, operating plant.

CASE HISTORY – FIRE DURING CONSTRUCTION

Construction was at a late stage at a large gas plant. Steel work was complete and piping fabrication was underway. As hydrocarbons had not been introduced into the area, there was no requirement to institute the permit system. To try and recover lost time, painting and insulation was taking place in the same area as welding work. A stack of insulating material had been established in the area prior to the welding on the piperack above. The hot slag from the welding process resulted in a smoky fire in the insulation causing the site to be evacuated until the fire was extinguished. Whilst not a serious fire, construction was delayed for a period.

Hazards perceived during construction generally include, trench collapse, fire and dropped objects (from cranes). The latter is generally controlled by lifting plans for all major lifts but other aspects could be improved by simple permit systems. Examples of failings noted during construction surveys include:

- Hot work in live areas without any safety precautions
- Uncontrolled hot work adjacent to operating equipment
- Excavation work in trenches which were unsafe
- Use of substandard equipment

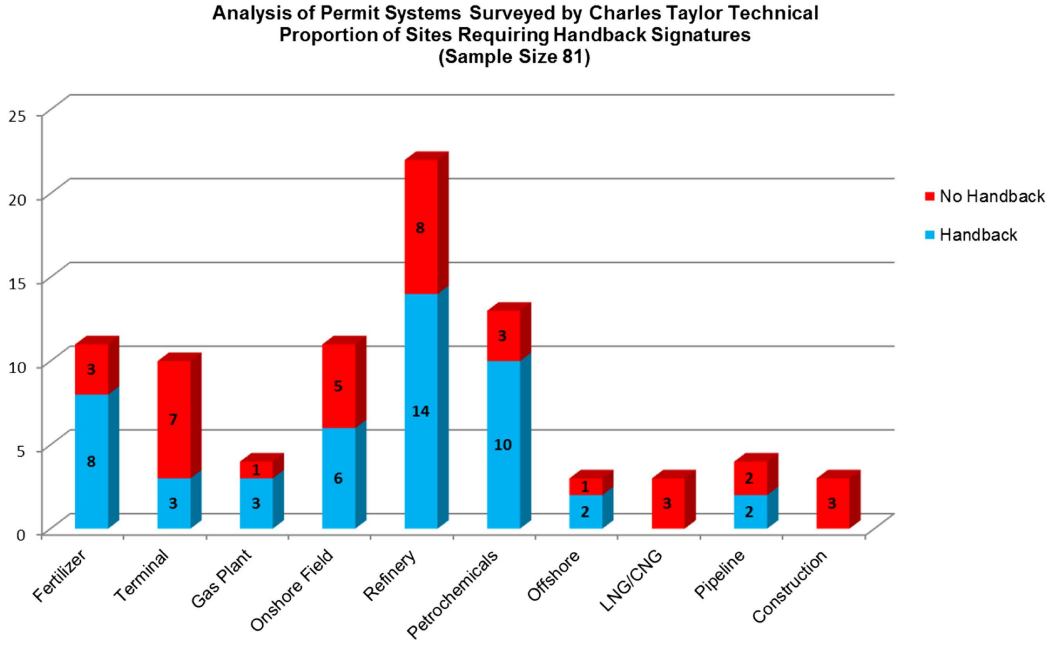
SIGNATURES AND AUTHORISATION

The minimum requirement should be that operations and maintenance signatures are obtained before the start of work and upon its completion. There are huge variations in the number and seniority of personnel involved in signing permits, both on the operations and maintenance "sides". Many procedures require signatures in addition to operations and maintenance. For example, often a safety signature is required, possibly to complete gas tests. However, the involvement of the safety department in routine permits can dilute the responsibility of the operating teams for ensuring safe working. At some locations visited safety personnel have commented that they are used as the final check that conditions are safe rather than checks being undertaken by operations personnel who have a more detailed knowledge of the site conditions.

It is critically important to establish who is the "owner" of an item of equipment or system at any point in time. This helps prevent the accidental operation of equipment which is under maintenance and the maintenance of equipment which is still operational (or capable of being operated).

A few systems require handback signatures to be completed by a different individuals to the one who provided the original authorization. In most organizations the permit acceptor is the maintenance or job supervisor and may not be the person completing the task. This runs the risk that the individuals involved may not have been briefed on the specific hazards of the task they are undertaking. This is particularly true in locations where there may be multiple languages used on site or cultural issues.

CASE HISTORY – POOR COMMUNICATION
Following commissioning of a hydrocarbon plant, teams of personnel were employed around the site to complete the installation of thermal insulation. As some locations were at height a cherry picker was in use. A single permit was taken out covering a number of locations. Individual personnel had not seen the permit and were not aware of any requirements limiting the use of the cherry picker in hazardous areas.



Whilst most permit systems require handback signatures there are a number of sites visited where this was not the case.

In addition, in a number of locations, although the permit procedure specified a handback process, the procedure was often not followed. Where handbacks were not required, the completion of maintenance was often recorded in work order forms, potentially causing confusion between the work order and permit systems and their respective purposes.

An essential requirement of a handback procedure is (or should be) a check on the condition of the site once work has been completed. This is often not done, resulting in the site, at best, being left in an untidy state and, at worst, a dangerous state.

CASE HISTORY – SITE LEFT IN A DANGEROUS CONDITION

As part of the maintenance on a hydrocarbon pump, a hose was attached to the drain point on the pump casing and used to drain hydrocarbon residues into a container. At the completion of maintenance, the pump was handed back to operations with the hose still attached. The site inspection had not identified that the drain valve of the casing was open and when the pump was flooded with hydrocarbon, there was a discharge to atmosphere in an area where a team of operators was working.

NUMBER OF PERMITS

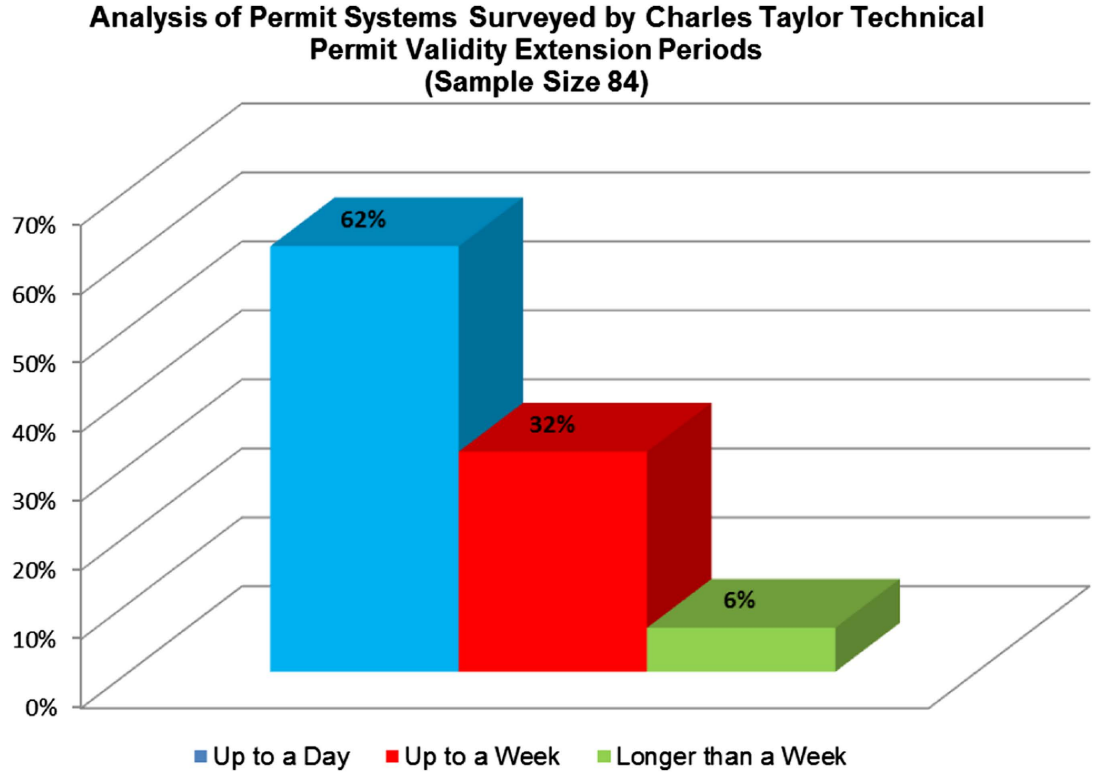
The number of copies of each permit usually varies between two and five. The most important recipients being the operations and maintenance functions. The ideal situation is for a copy to be available in the control room (or at least for the operators to be aware of the location and types of maintenance work being undertaken). The second copy should be displayed at the jobsite.

There is an increasing trend for work locations to be marked on a plotplan in the control room (often using different coloured marker). This is considered beneficial as copies of the permit may not be in the control room and in a number of organizations, it is standard practice for the permits to be kept in a supervisor's office or in a separate "permit office". This is particularly true for construction activities and offshore situations.

DURATION

Permit validity periods vary, generally between a shift and a week, normally with a requirement for revalidation every shift or every day. Occasionally permits with longer periods of validity, occasionally with no maximum period of validity have been encountered.

A fairly recent development is for permits with a validity for a period of up to a week or even a month where work may not take place continuously. Where this is the case, it is important that a comprehensive process for revalidation is in place.



FILING AND AUDITING

Most companies have some form of filing and auditing process for permit systems. Periods of filing vary and several problems have been observed during surveys:

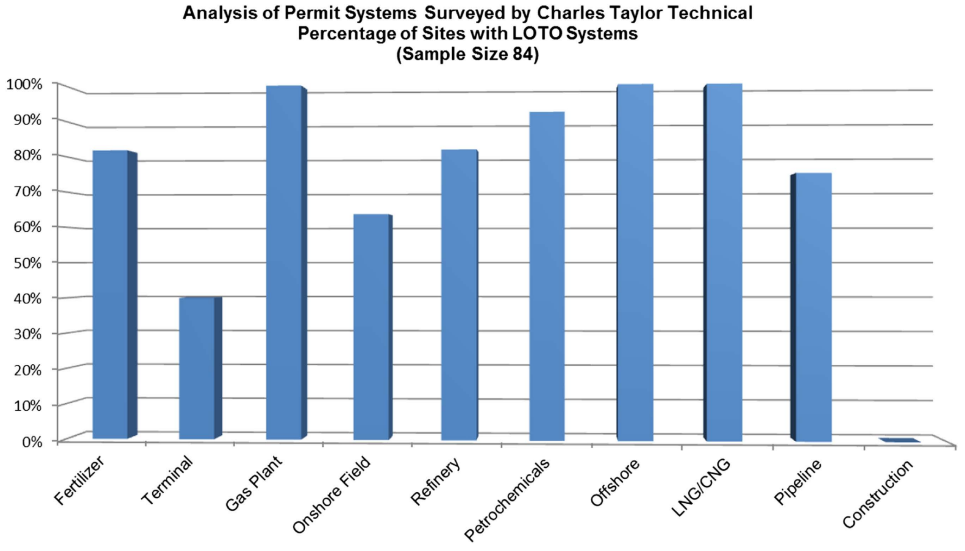
- Generally only one copy of the permit is filed, which may make auditing difficult as it is not possible to ensure handback of the permit occurred correctly
- Generally supporting documentation (blind lists, isolation certificates, etc.) is not filed, again making auditing more difficult
- Permits for completed and suspended work are filed together – possibly leading to incomplete work being overlooked.

Auditing can become a routine administrative process, rather than a check on the efficiency of the system. One company proudly reported the number of audits performed and appeared unconcerned that a high proportion of the permits were defectively completed in some way. Auditing of the completed forms should be supplemented by onsite reviews at individual job sites.

LOCK OUT/TAG OUT

A proportion of the sites visited had some form of Lock Out/Tag Out (LOTO) procedure. This was often run separately to the PTW system and, in one case replaced the requirement for a cold work permit.

The requirements for LOTO varied significantly between locations and in some cases, were not cross referenced to the permit system.



TRIP BYPASS ISOLATION

The importance of process trip systems is well known but there are occasions when process safety systems, as well as fire and gas systems, need to be isolated. The most obvious example is during maintenance or routine testing but bypassing may be necessary during start-up. It is crucially important that, where bypasses are made, they are recorded and re-established after maintenance activities are completed. In the1980s and 1990's there was only limited control of process trips and it was common to find instrument technicians using "jumper wires" (short bare ended wires) to bypass shut down logic. Where equipment to control bypassing was available, generally in the form of key locking bypasses, there was limited control over who bypassed a system. In the late 1990s, the establishment of a trip bypass register (separate from the shift log book) became relatively common and is still the primary method of recording and controlling bypasses at some sites.

A greater degree of sophistication has now being developed in two regards. Firstly, a specific procedure for trip bypassing, often utilizing a form signed at a senior level to authorize a bypass is increasingly common. Secondly the importance of maintaining a bypass for the shortest period time is supplemented by a requirement that bypasses extending beyond a fixed period of time need to be reviewed in detail and, possibly additional safeguards introduced. This review is often covered under the site's management of change system.

CURRENT TRENDS

Like most areas of process and occupational safety, procedures for the safe control of maintenance activities are constantly evolving with increasing use of standardised methods of work and job safety analysis.

Procedures are becoming more comprehensive and cover not only the original hot, cold and confined space entry requirements but also other risks such as electrical isolation, excavation and working at height. However,

cross-referencing between permits and other supporting documentation such as isolation certificates, blind lists, etc. could frequently be improved.

Isolation procedures in some companies now incorporate comprehensive tagging and locking but this by no means universal. Developments in escalating of process trip systems which are isolated for extended periods are to be welcomed but are by no means universally applied.

Surprisingly few companies in the process industries have moved towards a computer based permit procedure – even those operating new facilities. When designed and applied correctly a computerised system may offer advantages with planning of work and the availability of information regarding permits but can have difficulties due to the difficulty in controlling the number of copies of the permit and their distribution.

CONCLUSIONS

As the above information shows, there is considerable variation in permit systems between different areas, industries and sometimes between different sites within the same group or even sometimes different plants on the same site.

Nearly 25 years after the Piper Alpha incident, a number of the key learning points regarding the failures in the permit to work system have still not been implemented universally by the hydrocarbon industry. If the most comprehensive permit systems surveyed by CTT were universally applied across the industry, this would result in significant improvements in safe practice and consequently potential reductions in industry losses.

Updating and modernising procedures requires a significant expenditure of time in training the workforce (including contractors), and ensuring "buy-in" from all parties. Poor implementation of a permit system could result in a reduction rather than an increase in safety.

Depending on the level of hazard, a less sophisticated but well managed and audited system, will often suffice.

Regardless of the details of the permit system adopted, attention to human factors will always be paramount, including training, risk assessment and auditing.

REFERENCES

1. Permit to Work Systems (Iindg98), HES, UK.
2. Guidance on Permit to Work Systems — a Guide for the petrochemical, chemical and allied industries (hsg250), HSE, UK.
3. The Safe Isolation of Plant and Equipment (hsg253), HSE, UK.