Part F

ADVANCED MANAGEMENT SYSTEMS

Role of Managers in Safety and the Environment

F 1 Introduction

This part is a blend of ideas, which are closely intertwined but can also be treated as "free standing". It is an introduction to the Role of Management in Safety and Environment and is an attempt to show that it is an integrated whole and not a series of parts.

The main elements chosen are:

- Culture
- Why do people make mistakes?
- Defence in depth
- Role of Managers in Safety and the Environment
- Management of Safety/the Environment or The Generation of Safety/Environment Management Systems
- Management Systems at the Work Place
- Safety Management Systems (SMS)
- Testing of Protective Systems
- Management of Change
- Safety/Environmental Audits
- Accident Investigation
- Human Error

Each company has its own "*culture*" and in any professional role it is possible to sense different cultures within different companies. There is no doubt that there is an increasing recognition that there is a need for an analysis of the corporate culture and how it can impact on Safety and the Environment. This topic will explore this in more detail.

Even with good systems in place *people will make mistakes*. It is not inevitable but humans do appear to have a predisposition to make mistakes. This part will explore some of these causes, which will be expanded in Part G. The basis of all safety and environmental control is *Defence in Depth*, that is, a multi layer approach that ensures that there are many defences in place and reprised in F 4.

In the final analysis *Managers have duties* and a *duty of care* and must *Manage Safety and the Environmental* actively and not passively.

F 2. Culture

Culture is a complex idea and the definitions do not help - these include: -

A crop of experimentally grown bacteria or the like,

A particular civilisation at a particular time,

The total of the inherited ideas, beliefs, values and knowledge, which contribute the shared basis of social action,

The total range of activities and ideas, of a group of people with shared traditions, which are transmitted and reinforced by members of that group

Definition a. has a humorous significance but it is definitions c and d, which are most applicable. There is no doubt that "*culture"* in the safety and environment context is a blend of these definitions. Each company is based on evolved tradition and the way groups of people interact and perform their tasks or duties does differ due to both evolved tradition and reinforcement by managers and peer groups. The statement illustrates this: -

"*That person is a typical "X" company person*" Fill in the X and the meaning will become more obvious. Within even one nation there will be different cultures each believing that its traditions and beliefs are correct.

There is no unique corporate culture but a series of cultures. One company may believe in "empowering" its employees to take on responsibilities, another may require a detailed audit procedure before taking on those responsibilities, and another may request detailed supervision while taking on those responsibilities.

The differences in a corporate culture can be found in many areas. These are just some variants.

"No-Blame" Culture

A culture, which is perceived as "blaming" people for poor decisions, results in resentful, un-cooperative employees who are unwilling to make decisions and report any incidents. (Initially it was thought that this should say "***incapable of making decision"***. It was deleted but the message is there!)

The open, no blame, culture results in more open management with employees willing to report untoward events and then to discuss the way they can be eliminated. The employee does make decisions and is guided or tutored in this by his/her supervision. The "no blame" culture also results in easier personnel management.

Domineering Culture

There are some companies, in which the managers foster the belief that ***"they know best as they have more experience than anyone in that area."*** This approach has a dulling influence on creativity and puts the employee into a very subservient position. The end-point is that nothing changes and the company stagnates and starts to lose any competitive advantages.

A variation of this is the very clearly defined boundaries of "authority" where **only** persons of a certain level can make "real" decisions. This results in demoralised employees or employees are incapable or unwilling to take a lead in improvements in Technology or Safety. Worse still the employees are unable or unwilling to act for themselves, "keeping the head below the parapet". Once again the Company stagnates.

Club or Clique Culture

Some Companies have a very "cliquey" culture where they employ personnel from certain backgrounds or Universities. Rapidly employees realise that they have to become part of that club in order to progress up the structure or if they can not become a member of the club they have no option but to leave the company. This results in a self-centring of style, the company becomes prematurely old or "jaded" as there is a lack of innovation through outward vision and outward looking. New Companies with more modern approaches start to corner the Market and from a safety stand point the Company can not and will not learn from cross fertilisation of ideas.

Culture of Design/Specification

Some companies write very detailed design specifications for a design, based on their own experiences which the contractor must follow. Some companies go so far as to specify the finest detail (part of the "**we know best culture"**) but others specify the objective to be achieved and leave the detail to the contractor using international codes/standards. At the extreme, some companies may set the objective and allow a contractor to Engineer, Procure, Install and Commission the process (***E.P.I.C***)

Within some of the corporate specifications are to be found the reaction (over reaction) to incidents which occurred in the past (The Corporate Memory) and within others are to be found reliance on good personnel or procedures (The Corporate Culture). There are no rights or wrongs; each variation is the result of culture or evolution.

Culture and Procedures

There is a wide range of detail in procedures, some companies go to the finest detail and others give a general outline of the steps and objectives to be achieved. There are strengths and weaknesses in both approaches; with good skilled personnel it is arguable that the steps and objectives are better than the finest detailed. The corporate culture must therefore match the quality of the personnel to the quality of the procedure. At the end of the day a good Surgeon does not need a detailed description of an operation, however most car owners expect the Car Mechanic to follow the Workshop Manual when carrying out an overhaul, including the torque limits on bolts.

It is necessary to recognise that some procedures may actually be the written decisions of a Manager. The Standing Instructions (later) are the record of what the Manager wants to happen when he/she is not there. This could reflect a culture with a low level of devolved responsibility; on the other hand the instructions could be written in such a manner that the user has some scope for responsible actions. These procedures will include not only the routine but also the handling of Emergencies and upset conditions.

Once again the detail should be appropriate to the need. In effect there is no need for anyone to "make a decision" as it has already been made for him/her. On one plant which was rather prone to process leaks it was found that each Supervisor had a completely different set of criteria for making the decision for a plant shut down. A rule set for the decision process was written (***an expert system***) which the Supervisors could follow and react accordingly. This resulted in a consistency in the decision making process but in reality the decisions had already been made for them within the rule sets!!!

There are other procedures, which need to be recognised. Into this category would fall such as: -

Audits of Systems

Audits of Procedures in general

Management of Change

Permit to Work

Design Procedures

Review of Procedures

Control of Procedure Revision

Control of Drawing Revision

The list is not meant to be complete but indicative and each must be treated on merit. All of the above would be written in some detail as will be outlined in F 8.

Training/Knowledge

There are a range of Training and Knowledge requirements, which again reflects culture. Some companies employ honours graduates, others are less specific. Some companies require Continuous Professional Development and others do not. Some companies require refresher training for all operating personnel and others do not. The depth of the training and detail of knowledge is again tailored to the culture and inclusion in this list is again only meant to be indicative.

Supervision

The level of supervision varies between company and the task to be performed. New graduates will normally be heavily supervised and the level of supervision relaxed with gained knowledge. Special tasks may always require detailed supervision to ensure that a procedure is fulfilled to the letter yet others may not be supervised. This is appropriate during stressful conditions such as a start up or shut down.

It has been claimed that incidents seem to have a periodicity of 10 years. This is of some debate as it appears to be shortening to nearer 8 years. In many Companies the average tenure for a Manager is about 3 (three) years. It is not difficult to see that there will be 3 new Managers in 10 (ten) years. If each Manager only passes on 75% of what they were told when they had their initial "hand-over" by the end of the 10 years the "corporate memory" will be more than halved, unless of course the "memory" is re-enforced by some real events. It is not coincidental that the "return" time for "major" events is about 10 years.

It is worth noting that structural changes in organisations do change that culture. Often the history and reasons for "***best operating practice***" are lost (that is there is a dilution of the "***corporate memory***"). In addition it is inevitable that with "***down sizing"*** there is a reduction in the level of supervision which in turn reflects a reduction in the day-to-day audit procedure. One other effect of "down sizing" is that there is a loss of "***Corporate Knowledge***" which in turn makes the company more vulnerable to the "***10 year Corporate Memory Half Life***". Recent trends in USA include the appointment of a "***Corporate Knowledge Manager***". Guess what he/she does? They collect the history of operating practices before an employee "goes down the road". Does this help to explain why the periodicity now seems to have shortened to nearer 8 years?

Summary

The culture of a company reflects its traditions, experience and evolution. It is passed between members of that company and is re-enforced by a common objective. It will vary between companies and reflect the needs of that individual company and the skills within that company.

It could be argued that no company culture is perfect but that it has evolved defences or systems to compensate for weaknesses in its culture (without realising what it was actually doing). It could also be argued that a root and branch change in a culture would be a disaster waiting to happen. In the final analysis it is the flaws and weaknesses in the culture that will create problems and identifying these flaws will not be easy.

F.3 Why Do People Make Mistakes?

This is based on personal experience and was written before the publication of HSG 48 *Reducing Error and Influencing Behaviour*

It is worth pointing out that HSG 48 identifies three main causes of human failure in its figure 2:

Skill based errors

Rule based mistakes

Knowledge based mistakes.

It is hoped that these notes cover these appropriately.

There is a general belief that some people are "accident-prone". This can be debated long and hard but it is more constructive to analyse some of the possible causes. These can be broken down into many categories the most common three are:

Experience and Skills

Psychological Make Up

Stresses

Experience and Skills

The training and knowledge of the person must reflect the job description but also that person must have certain extra skills, which will reflect the need and ability to make decisions.

A good Engineer will normally have a good grasp of his/her own discipline and also a good understanding of the needs of other Engineering disciplines. There is a balance between depth and breadth of knowledge - the knowledge of the individuals' discipline has to be deep but there has to be breadth so as to work with other disciplines and understand/interpret those other problems and needs. The good engineer has to have deductive skills to recognise where problem areas may arise and the technical skills to overcome them. If either is missing there is the risk of an error/mistake. This not only applies to the technical problems but also dealings/supervision/checking of members in the work group. In the case of Management of Hazardous Plant, the Engineer must understand how the process works and also understand the weak points in the process. These skills take time and training and require the ability to use deductive skills which convert technical knowledge into a practical application. (Most of this is "knowledge based".)

Operating personnel require similar training, knowledge and skills are still required but at a lower level. There may be situations that the operating personnel have not met or cannot analyse. If the operating procedures do not give clear guidance to the operating personnel, the personnel may make mistakes, as they will be forced to operate outside the envelope of their experience and skills. This reflects back to the concept of *culture* and forward to *Managers Responsibilities*. (This is skills based.)

This part is an attempt to give a broad overview and it is worth considering a new process plant start-up with novel features to illustrate the problems. The supervisors and operators were picked from an experienced group of personnel so the experience will be satisfied by years of training. However, the new plant had both unknown and un-experienced characteristics. The team were alert to their lack of experiences drawing on their previous experience and detective skills.

The operation of an Acetylene (Ethyne) Hydrogenation Reactor is illustrated to show that errors can arise from lack of experience (knowledge). The process involved passing a mixture of Hydrogen, Ethylene (Ethene) and Acetylene (Ethyne) across a fixed bed nickel/palladium catalyst at about 60^{o}C in a single pass. The reaction is of course exothermic and the catalyst is both *reactive* and *selective*, that is, it has to be raised to an initial temperature (60^{o}C) before the Hydrogen/Acetylene reaction takes place but beyond a threshold temperature the Hydrogen/Ethylene reaction also takes place and is favoured. There were two shifts of Managers each had experience of Hydrogenation processes. The first had experience of a simple mixed stream Hydrogenation process that was fairly unreactive but was very selective to Acetylene. The second had experience of this process and a direct Hydrogenation process. The first Manager raised the inlet temperature rapidly with an excess of hydrogen such that the reaction took place in a limited section inlet to the bed with a rapid rise in temperature, which produced reaction conditions selective to the hydrogenation of Ethylene and the Acetylene concentrations in the reactor exit were out of specification. The second Manager was more careful and ensured that the reaction spread throughout the reactor bed monitoring the Acetylene concentration exit the reactor as the inlet temperature was raised step by step. A steady reduction in Acetylene was noted with increased inlet temperature such that it was possible to predict the correct operating conditions for the total Acetylene conversion within a few hours. The first Manager came on shift and wrestled with the reactor for twelve hours. The second Manager returned to the shift and was convinced there was an error in the analysis. The only thing that had changed was the Gas Liquid Chromatograph which had been changed to a more sensitive coil. Was the fault in the G.L.C. or the reactor? Within the sensitivity of the analysis the first G.L.C. showed there was less than 10 ppm Acetylene exit the reactor but the second showed there was over 100 ppm. The solution was to seek a third G.L.C. and to test for rouges, which were masking the second G.L.C. The answer was rapidly found, the Acetylene concentration was masked and the rogue was Butadiene - the derivative of Acetylene and Ethylene.

There were obvious skills and knowledge used in this incident. Some of the skills and knowledge had been acquired in an industrial environment and some in an academic environment.

Psychological Make-up

There are two forms of psychological make-up worthy of note. The first is the person who cannot handle stress of any sort and goes into a panic at the first hint of pressure. This person is likely to be error prone. The second is the one who will not listen to guidance and will do what he/she wants to. This is likely to lead to errors of judgement.

Stresses

Stresses can be various and could include

Fatigue

Emotional

Work Related

The first two are self-evident; as the human becomes more tired the judgement becomes flawed and mistakes result as the deductive skills become flawed. Emotional stresses could arise from problems at home or personal who are set upon by a work mate. Feelings of oppression and inferiority can lead to judgement being flawed.

Work stresses are also understandable. The human performs best under a slight or low level of stress. High levels of stress can impair the judgement and deductive skills and low levels of stress can produce a lethargy, which ignores information and in turn leads to lack of judgement or response. But there are more insidious stresses caused by poor ergonomics. Aircraft designers have worked hard to develop the Head up Display (H.U.D.), which is also becoming used in cars. Without realising it, the personnel can be put under stresses by the layout of the pages on Distributed Control System Screen, the position, order; ease of recognition/reading is essential. (See also Part H - Texaco Refinery Explosion).

Don't blame an operator for making an error of identification if the order is A/B; A/B; A/C/B, there are *"expectations"* which will become *"rules"* in the mind of the operator. If an operator has to reach out over a handrail to access a valve it is human nature to ease the damage potential to the back by climbing over the handrail. The perceived risk of falling may be less than that of injury to the back and a precedent is set.

Human ergonomics, as a means to reducing "mistake potential" involves layout but also size/colour, postural position, eye position and many other important features.

There are a number of references to human reaction under pressure/panic conditions. Lars Weisaeth has written extensively on this topic, one worthy of more study is "Technological Disasters Psychological and Psychiatric Aspects" 7th International Symposium on Loss Prevention and Safety Promotion in the Process Industries Taormina 4-8 May 1992. In this, he discusses perception of risk after being put under stress such as Kuwait, Post Traumatic Stress Syndrome/Disorder - and “Flight from an emergency” (fight or flight); under these circumstances survival is more imperative than the logical correction of the fault.

F. Hearfield discusses a series of what might be called “Human Errors” under a paper “Hazards of Pressure Testing” 3rd International Symposium on Loss Prevention and Safety Promotion in the Process Industries BASLE 11-19 September 1980.

D.E. Embrey discusses “Human Errors” in a paper at the 7th International Symposium on Loss Prevention and Safety Promotion in the Process Industries. The best prediction is that all humans are “error prone” and the objective is to reduce the scope or the consequences of this error (flaw in make-up).

It is now recognised that what was called “shell shock” has some variations one being that of guilt. Guilt that “*your mate was killed but you were not*”. Guilt that you did not do enough to help your mate. “*If I had tried to save him he would be alive now*”, (forgetting that both would have lost their lives!)

The Brain

Some of the problems that can result in errors are to be found in the brain. There are a number of problems that are not easy to explain in simple terms.

Information overload

In Information overload the brain has TOO MUCH information and can not sift the critical or top level information from the low level unimportant information. In effect the reasoning powers are swamped by both essential and trivial information and so the outcome is that nothing is done. This can be analogous to a juggler - there is an absolute limit to the ability to handle objects and beyond that limit things get dropped.

The concept of Information Overload can be dealt with by two strategies. At one level the operators have sufficient resources to handle all of the work and at the other, the information is filtered and presented on a clear unambiguous form (skills and rules). In process plant it is not only the information but the size; on a small plant where the transit time may be small the supervisor may be able to handle more as there is less time used in moving from A to B to C in data collection. Above all the presentation of clear unambiguous data with the appropriate diagnostics in a Control Room is fundamentally important. The human can only accept a limited amount of information at any one moment and the message must be clear and unambiguous.

Training and background knowledge all help to reduce the potential for information overload as also does practices. There are no solutions or fixes; an understanding is required as well as the open mind and eye. The key question must be:

“How could I handle the problem/problems professionally and without error?”

Mind set

The person has a fixed idea and can not be convinced that there may be an alternative explanation or idea. It could also be called “tunnel vision”.

Cognitive Dissonance

This is quite difficult to explain. The mind tries to fix the evidence into a picture. Some does not fit so is rejected or reasoned away. The brain is quite convinced that the evidence is now consistent but ignores the fact that some key evidence may have been rejected or distorted due to some erroneous logic.

Panic

The person just can not make any decisions!

F.4 Defence in Depth See Part A (a reprise)

Introduction

Defence in Depth is the basis of safe process operation and is worthy of a reprise of Part A. The definition is not yet written and the interpretation is variable as it is a **concept** and therefore requires a little explanation.

Consider first of all the recommendations from an incident report; these will usually extend to the order of four to eight. This means that the committee felt there were four to eight elements which contributed to the incident and require corrective actions. Put another way the committee felt that there was no unique *cause* of the incident but a *number of causes*. The finer analysis is that the causes of most, if not all, incidents can be broken down into four categories.

Design/Specification (Equipment/Hardware)

Procedures (Software)

Training / Knowledge

Supervision

The categories are open to discussion but it is arguable that **all are the reasonability of Management**. Further when the initiation of the cause is examined it will be found that some were in place for some time but only when the final one was in place did the event occur. These have their parallels in the Accident Investigation (See later). The initial causes were part of the *build up* until the final cause *initiated* the whole sequence. Once initiated, defects in the system will lead to *escalation* and loss of (or poor) control. Each cause is a breach of a defence. (The Bow Tie Model Fig E 1.1).

There are no hard and fast rules, alternatively the model may be, that the more breaches in place prior to *initiation*, increases the *potential damage energy* in the incident. Then it is not a case of the number, but the sequence of the initiating event. If the initiating event was "number five" then an injury would result, if it were number seven a fatality would result. Whatever the model used, the evidence matches the traditional Heinrich/Bird Triangle.

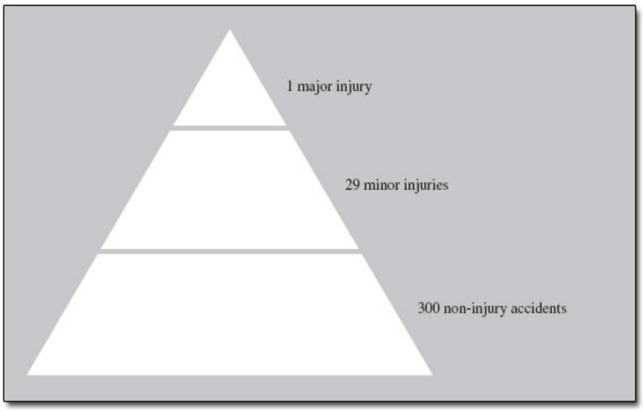


Fig F.4.1 Hazard Triangle

The ratios are open to discussion but generally follow a ratio of about 1/30, which is a typical human failure rate or failure rate of a protective system. Put another way, for a serious injury about 30^6

operations (10^9 operations) must take place. The probability is low but by a little attention to detail, the final probability can be significantly reduced. (A change in failure rate from 3.33% to 2.5% reduces the final probability of fatality by a factor of 7.49. Who would not want that level of reduction in their Accident Statistics?)

<u>It will be noted that all contributions are the responsibility of Management.</u>

Some studies have suggested that the causes or breaches of defences run to dozens this may be true but they are often subcategories of one more major breach. From my own observations there is a fairly clear pattern as follows:

Number of Major Breaches	Effect
1	Nothing
2	Nothing
3	Nothing obvious
4	Near Miss
5	Minor Injury
6	Serious Injury
7	Fatality
8	Multiple Fatality

It could now be argued that after five breaches there should be a "minor injury" and the breaches should be rectified at the "minor injury" level and there should never be a "fatality". In reality many of the breaches are latent, some come in very quick succession and some affect the ability to control a small event (injury) from escalating to a more serious event. The final outcome will depend very much on the phase of the incident where the breaches were found: -

Build up

Initiation

Escalation

Control

For example breaches in the control phase may not be evident until the incident is initiated.

The Flixborough accident and the Piper Alpha incident have been used in Part H to illustrate how and where breaches in the defence occurred. The itemised breaches may not be all that might occur but they are the more obvious ones.

A similar approach can be taken to the Environment - while the number of defences is less obvious it is clear that a single level is totally inadequate. It is right to consider what *Duty of Care* means. This means at one level that there is a duty to maintain the Environment, which is spelt, out in EPA90: -

“It shall be the duty of any person who imports, produces, carries, helps, treats or disposes of controlled waste or as a broker, has control of such waste, or to take all such measures applicable to him in that capacity as are reasonable on the circumstances

a) to prevent any contravention by any person of section 33 above;

b) to prevent the escape of waste from his control or that of any other person; and

c) on the transfer of waste, to secure: -

i) that the transfer is only to a person or to a person for authorised transfers purposes; and

ii) that there is transferred such a written description of the waste to avoid a contravention of that section and to comply with the duty under this subsection as respects the escape of waste.

At another level there is a duty on all Managers to ensure the Health and Safety of employees and the public as a whole (as defined in HASAWA).

There will be defences against losses at site and irregular disposal of waste.

F 5 Managers Responsibilities and the Role of the Manager in Safety and Environment

Introduction

There is sometimes a belief that certain roles are not the responsibility of Management - incidents such as the Clapham Junction Rail Accident and the sinking of the Herald of Free Enterprise have proved this to be untrue. Whatever the aspect or feature of safety, the areas, which contribute to accidents noted in ***Defence in Depth***: are all the role of the Managers.

The responsibilities above are all Management (or Managers). Managers have to ensure that the *objectives* are clearly set, that the personnel have the appropriate *skills* and *knowledge* to achieve the objectives and that the personnel *achieve* and do not deviate from the objectives. This is a formidable sentence, which it is hoped captures the *Role of Managers*. It is possible some will disagree, some will disagree violently and some will say “ROT”. Whatever the reaction they are a personal belief expressed in these notes.

The only way this can be elaborated upon is to develop a series of illustrative examples. Some serious thought was given to discussing:

Setting Objectives

Skills

Achievement of Objectives

Likewise some serious thought was given to discussing:

Hardware

Software

Training/Knowledge

Supervision

In many ways Hardware and Software are *objectives*, Training/Knowledge are *skills* and Supervision is *achievement* as there is a potential repeat only one list could be discussed.

In the end it was decided to amalgamate the two columns and treat *setting objectives*, *skills* and *achievements of objectives* as **<u>subheads</u>** *and Hardware, Software, Training/Knowledge* and *Supervision* as **<u>main heads.</u>**

<u>Hardware</u> (This illustration refers to an Engineering Department)

Setting Objectives

Are there clear Design Guides, Codes of Practice, and Engineering Specifications in place? Do they reflect the Safety Policy? Are they regularly reviewed to ensure that they reflect the changes in technology and thinking? Are calculations stored and recorded in the appropriate files? Are equipment specifications recorded in the appropriate files? Are P and I Ds always up dated and reissued?

Skills

Are the Design Team suitably qualified and trained? Are annual appraisals carried out to assess the skills/weaknesses/needs for continued professional development? Are personnel promoted by ability and not age or another artificial yardstick? (Metre stick?)

Achievement of Objectives

Are calculations and specifications independently checked/audited? Are project audits on the project carried out by independent teams? Do the Terms of Reference and Scope reflect the nature of the audit?

<u>Software</u> (This illustration refers to an Operating Site)

Setting Objectives

Do the Works Standing Orders (W.S.O), Permanent Instructions (PIs) and Standing Instructions (SIs) have clear guidance on Permit to Work/Hot Work Permits/other Permits? Do the instructions have clear guidance on the Management of Change? Are all Operating Instructions in place and regularly reviewed? Does the W.S.O. reflect the Safety Policy Statement?

Skills

Are the production team suitably qualified and trained. Are annual appraisals carried out to assess the skills/weaknesses/needs for special operating training/day release courses/continued professional development? Are personnel promoted by ability? Are some personnel frustrated and others overstretched? Are all software systems audited?

Achievement of Objectives

This can be verified by audits (see later)

<u>Training/Knowledge</u> (This illustration is general)

Setting Objectives

Are the skill matrices for various jobs defined? Does the annual appraisal reflect the need for training? Does the training/knowledge reflect the safety policy statement?

Skills

Are competent trainers (internal or external) used in training?

Achievement of Objectives

Are training and knowledge tested on routine by practices and verbal tests? Are the results fed back on the form of changes to software or training? Are training/knowledge needs reviewed/audited?

Supervision (This illustration is general)

Setting Objectives

Do all personnel know their exact role in the company? Do they know their lines of communication? Do they know their scope for responsibility and accountability? (The two may be different - one person may be responsible for carrying out a task and the supervisor (or senior person) may be accountable for the junior's actions). Do all personnel feel free to talk to their supervisors at any time? Do they feel confident in their supervisors?

[Note: Supervisors could mean Managers]

Skills

Do the Supervisors know what their juniors have to achieve? Do they have the correct technical/inter-personnel skills? Can they carry out a form of audit on their junior's capabilities?

Achievement of Objectives

Are the Supervisors tested on handling practices? Do the work team feel confident in their supervisors? Are supervisors audited?

The illustrative examples are just that. There are many more areas for Hardware - such as work shop/maintenance, Trip and Alarm Testing, Relief Valve "Pop" tests, Lifting Beam Tests just to name a few. Software could equally refer to computer programming, laboratory procedures, security checks, road access checks etc. The training/knowledge will change from role to role but the general model with variations will fit. The same is true for Supervision (Management). It would be wrong to think that for a major blue chip company the Chief Executive is beyond Objectives/Skills/Attainment of Objectives - the shareholders are the ultimate masters!

This topic was not written lightly or without a lot of thought. If there is a sense of emotion in the words it is because it was written with emotion. If Managers at any level "get it wrong" there is the possibility of injury/pollution/loss of revenue/loss of capital (or worse).

F 6 Management of Safety/the Environment

Or

The Generation of Safety/Environment Management Systems

Introduction

Most Safety and Environmentally conscious Companies have had Safety/Environment Management System in place for many years and actively manage their business to achieve a high Safety/Environment performance. Initially many of the Management Systems were good common sense and good business, and to a degree they still are. In recent years there has been a better understanding of the manner in which management systems can affect Safety/The Environment and they have been named Safety/Environment Management Systems S/EMS (and so gained an element of mystique).

There is no doubt that S/EMS plays a significant part in Defence in Depth. Not only is there a limitation to the benefits of hardware based systems but they are expensive, need maintenance/checking but also Management can be relatively cheap. (This may not be apparent in the recent wave of "downsizing"). For example Permits to Work (PTW) have been in existence for many years and the concept of Auditing PTWs was in evidence over 30 years ago (two Defences and two Management Systems).

There is no doubt that Safety and Environment standards are improving year on year but there is also recognition that it is *good business*. Injuries cost UK of the order of £10^{10} per year (yes ten billion pounds) there is also the added cost of lost production, lost sales potential and the remedial/repair costs. Environmental clean up can be extremely expensive - the cost for the clean-up of a major oil tanker spill are estimated to be in the range £10^{8} to £$10^{9,}$ that is £2000 to £20,000 per tonne spilled - for a product that has a sale value of £75 -100 per tonne (2014 prices). There is also a hidden cost resulting from loss of sales/revenue if the public refuse to purchase the product of the perceived "polluters". The loss of revenues to Shell resulting from the attempted dumping of Brent Spar is estimated to be of the order of £10^{8}. There is good evidence that dumping was the Best Practicable Environmental Option (BPEO) and involved the minimum risk to human life - but this was not perceived to be the case by the public and Green Peace. In retrospect, rather than dumping, on shore disposal may have been cheaper in the long run due to the adverse public reaction. Maybe the incident could have been *managed* in a better manner; this closes the loop and goes back to the start of the introduction.

Recent research has shown that there is a correlation between improved safety and environmental awareness at work, improved production efficiency at work and accident reduction in the home.

What are S/EMS?

There is a slight dilemma in these notes - which parts of S/EMS are relevant - All? Part? The following statement was published in the Chemical Engineer.

The Health & Safety Executive (HSE) booklet Monitoring Safety analysed 960 fatalities in all industries during the period 1981 to 1983 and determined the prime responsibilities). Recent major accident investigation reports have increasingly criticised management for failing to install and insist on safe systems of working. But is it fair to blame a manager when an operator makes a mistake leading to a serious incident? Is it reasonable to ask management to guard against human error? The answer to both these questions must be "Yes". The Figure below is a schematic chart of the major topics of loss prevention, which have characterised the last four decades. Like all chains, safety performances are as strong as the weakest link.

Responsibility for Fatal Accidents %

Senior Management	61
Local Management	3
Workers	17
Management and Workers	12
Others	6
No one	1
Total	**100**

System(s)

Is defined variously as:

1. A way of working, a method
2. A set of interconnected or interrelated parts forming a complex whole (what? FKC!)

Systematic

Is defined as:

A clearly worked out plan or method

Management

Is defined as:

The skill or practice of controlling something

Safety

Is defined variously as:

1. The quality or condition of being safe
2. A safe place

Safe

Is defined as:

Free from danger

SMS could therefore be defined as:

A worked out plan for controlling the freedom from danger of persons

(A similar approach could be added to the definition of EMS)

There are clearly defined features of any S/EMS, these are: -

- Commitment
- Policy
- Leadership/Targets
- Organisation
- Planning

Followed by

- Implement action
- Monitoring
- Audit
- Review

The S/E will now be dropped and the common words Management Systems (MS) used, again deliberately so, since we are discussing Management Practice within the S/E context. The initial description will apply to the body corporate and then more localised detail given. The headings chosen are the key features already given. The discussion, which follows, is meant to be at the higher, corporate, level.

Commitment

Any MS must start, and be seen to start, at the top and also be believed in by all levels of Management. It may be easy to install a tangible hardware modification but software systems have to be kept vital and real. In simple terms there has to be a commitment to them and to making them work by all levels of staff, top to bottom.

Policy

There is a requirement under HASWA for a company to produce a Safety Policy Statement. Increasingly many companies are producing Environmental Policy Statements. The corporate policy statements will be more general and longer term but will demonstrate commitment and give authority to the lower level (departmental) policies.

At the corporate level there is no benefit to "being the best" as it may be meaningless and impossible to achieve. The policy may be more general and be of the form, "to be the equivalent of the best in the field" or "to strive to improve standards". Corporate policy statements are usually to be found in the Annual Report to the Shareholders. There is no benefit to repeating or comparing company policies (as it will end up like a beauty contest) but most are short, crisp and full of impact.

Leadership/Targets

It is sometimes difficult to separate Commitment, Leadership and Targets, they are closely inter-connected. Once a team is committed someone has to set targets and take the lead. At the corporate level the leader(s) could be the Managing Director, the Chief Executive Officer, the Board of Directors or it could be the Corporate Safety Manager/Director. If there is commitment everyone becomes a leader but there have to be targets to ensure everyone is pulling in the same direction. In the era of acronyms, these must be **SMART**:-

- **Specific**: what must be achieved?
- **Measurable**: must be measured in a consistent manner which will demonstrate the progress to the target
- **Achievable**: must be realistic but a challenge. (If the target is too easy there will be no incentives, if it is too hard the team could lose heart - (Success breeds successes)
- **Relevant**: the team must be able to relate to the target
- **Timed**: the target must be time marked "DD/MM/YY"

It is self evident that corporate targets will be on a different and longer time scale than those of the local department and the corporate targets will be more general while the local ones will be more specific. The corporate and local targets must therefore be complementary.

At the corporate levels the targets could be of the form:

1. To reduce injury accident rates by x% by DD/MM/YY
2. To reduce carbon dioxide production by y% per tonne of product by DD/MM/YY
3. To reduce solid effluent disposal to z tonne/yr by DD/MM/YY

Naturally the targets must be *relevant* to the organisation, as indicated earlier, and therefore must reflect an area of the Safety/Environment, which the company believes *(commitment),* should be improved. There must be some research *(leadership)* into the following aspects of performance:-

Past Performance: Any previous performance can be bettered with the correct commitment. This may involve examination of performances such as Abnormal Incidents, Dangerous Occurrences, Accident Causation, Injury Accidents, Effluents, Efficiency.

Bench Marks: Benchmarks for performance may be set by another company in the same sphere of production. (If company A is better than company B, what does company A know that company B should know?)

Legislation: Legislation will be fluid for a number of years - it may be that this sets targets. (This already exists it "The Offshore Safety Case Regulations".) The progress (good or bad) to the targets will normally be reported in the Annual Report to the Shareholders. This also shows a corporate commitment as shareholders may view a poor HSE performance as a good reason for selling funds in that company - this reduces the corporate value and makes it more vulnerable to "take over". (The new Management will then "sort it out" with the inevitable loss of jobs in the previous company!)

Audits: The audit will probably recommend some actions for improvement.

Organisation

The HSE have given the characterisation of a good *organisation* under four headings:

Control

Cooperation

Communication

Competence

(Successful Health and Safety Management HS (G) 65)

Control: is (usually) a managers responsibility - the Manager must, by definition, be "in overall control or charge of" the Managers job functions, including SHE. This will involve establishing the *policy* and setting the *targets* to be achieved and *monitoring* the progress towards the target.

As part of the control process there should be an active identification (and if necessary quantification) of all risks and a planned review, measurement and audit of all safety activities. The control must be supported by active implementation and performance records. It is obvious that the words must be supported by *leadership and commitment*.

Cooperation: is the act of involving all groups of the organisation in the drive for safety - the team effort.

Communication: is the act of listening to concerns as well as informing all levels of the company of the drive for SHE.

Competence: is the act of having the correct people, with the correct skills and knowledge in the correct job functions.

Planning

Plan is defined as "a thought out arrangement or method for doing something".

The plan must be clearly thought out as there has to be a clear structure for achieving a change or else the change will only be partial and ineffective. It is to be hoped/expected that there will be a MS within the organisation but it will be assumed that a company has carried out a review and that the results of this review have produced the results "*we are good - but we* ***could*** *be better*".

The start of the planning process will involve three questions:

How good are we?

How good *could* we be?

How do we achieve the change?

It may be concluded that the answers to the first two questions require no change - would this still be true if a new operation was introduced? When drafting these notes there was a thought that the word "***could***" might be replaced by the word "***should***". This was resisted as the word ***should*** infer a standard less than the word ***could***.

The qualitative judgement of performance can be achieved by thorough analysis based on

Industrial Best Practice

Corporate Performance

Audits

Legal

Regulations

Approved codes of Practice

Codes of Practice

International Pressures/Trends

Inevitably this analysis will produce *targets* for future improvements. Once these are set, the resources and campaigns must be set in place. The campaigns must be appropriate to the organisation but should start with some risk assessment process. First the hazards must be identified and then assessed against best practice or other requirements. Following this, the improvements, be they hardware/procedure/controls, can be put in place. If the procedures do not exist - for example on a new site - this may be formidable task.

Finally, the procedures for ensuring the compliance must be devised and put in place. (See F 8).

Implementation

The implementation involves allocating the responsibilities for the execution of the plan. This will involve targets and the authority to carry out the appropriate changes (but consider also the ***Management of the Change*** as the change must be managed to ensure that it does not create a worse situation in the transition). The implementation should be appropriate to the organisation. (See F10)

Monitoring

The monitoring of the plan would be very finely tuned to the organisation and its needs - these will be discussed later but will generally involve measurement of compliance (See Audits F 11).

Audits

Naturally, one of the means by which compliance (and performance improvement) can be assessed is by the audit process. The audit could normally be part of the planning process so (hopefully) any follow up audit would be no more than fine tuning (See F 11).

Review

The whole change will have both a long-term objective and milestones. In the real world, some fine-tuning will be needed, some problems will be found that need resolution and there may be a need for more resources to reach the targets. This may result in a recycle back to Policy.

F 7 Management Systems at the Work Place

Introduction

There are many Management Systems which are common place and in general use. It would be wrong to ignore them in the total spectrum so there are no apologies for any repetition. This is, once again, a dilemma - to whom are these notes directed? If they are directed at a Senior Manager, there may be tendency to say, "I know! I know!" But, to a young manager seeking professional qualification, there is a risk of projecting them onto a high plain and producing a response "*That does not apply to me! What are you getting at?*"

This is a difficult topic. Is it *telling*, not *teaching* or "*This is what I believe*" or is it "*This is what should be done*"? This section of the notes is not meant to teach management skills but to give indications. The skills will be learnt elsewhere. This section should be read in this manner - it is not complete but some of it may make the reader think again or see something in a different light. At no time will any reference be made to legislative requirements as that is implicit and cross-referencing may result in the loss of thrust in the argument or the points being made.

Two reference organisations will be chosen to illustrate the work place – Design and Operator.

Design

The Policy

Any devolved policy statement from the corporate policy will inevitably be more focussed on the work scope, what can be achieved and what is achieved. The Policy will, however, complement the Corporate Policy Statement and reflect what that department can achieve to satisfy the Corporate Policy.

In a Design Office, accidents can still occur, even from lifting paper or tripping over a trailing flex. The Policy might reflect the need to use best design practice and the need to review/audit the work/design at appropriate times. The policy may also reflect the willingness of Senior Managers to help to resolve problems and the need to discuss problems - *"If in doubt, ask"*. A minor design error may have serious implications for someone else. (I know, one piping designer ran a pipe at 6ft 4in and I always caught my safety helmet on it. I am 6ft 3in tall and my helmet adds 2 inches!)

In an Operations Department, the policy may reflect the need for best operating practice and compliance with instructions at all times. The policy may also reflect that production is subservient to safety and that any untoward event must be reported and investigated fully. It is possible that the policy may be blunt and to the point. "***Violation of instructions will be result in disciplinary action***"

Leadership and Targets

Leadership

The leadership must come from the top but everyone can act as a leader. The leader must set the standard and reinforce the need for safety.

In the Design Office, the standards can be readily set but they must be seen to be meant. There must be the resources to handle problems and a willingness to respond to problems in an encouraging manner. There must be a clear monitoring process for all work carried out.

In the Operations Department, the leadership can be more positive. The manager must be *visible* and be seen to be paying attention to safety detail, even if it is reading shift logs, walking round the plant and talking *safety* to the operators. Above all, the leader must demonstrate the highest standards of safety, both by action and reinforcement.

Targets

The targets for a Design Office are less clearly defined but could be at one level to reduce minor injuries and at another level to have targets to carry out design reviews by (a date) and to have follow-up work carried out by (a date). It would be fairly easy to devise other appropriate targets such as percentage compliance on audit and training for engineers on a specific skill or legislation.

The targets for an Operating Department are more readily defined. These could be an injury frequency rate on a moving, decreasing target year on year. Another target could be the audit of *x*% of all PTW with a target of *y%* accuracy/detail. Yet another target could be to reduce effluent rates or fugitive emissions or to reduce losses during a shut down/start up by z% against the previous achieved best. In yet another target, it may be that all personnel are given fire fighting training/refreshers once per year and another that all trip/function testing of shut down systems will be carried out within one day of the determined routine. The same might apply to maintenance and the timely inspection of equipment.

All targets are only examples but consider, for example: -

- Training in new legislation
- Training in preparation for equipment maintenance
- Review of operating procedures on a routine

The list in both cases is only indicative.

Organisation

Control

It is self-evident that all systems, be they management or a process, require a control system and, in the extreme, a “shut down” or disciplinary system.

The first level of control is to define the responsibilities and accountabilities of all members clearly, in the Design Office or the Operations Department. This would also extend to the scope for decision-making. In the case of Design level there will be a fairly defined task but at the Operations level, the responsibilities during the "Dark Hours" must be defined. Obviously, the Shift Supervisor will have some clearly devolved responsibilities, which should be well defined within the WGOs/SIs and PIs, but the Operator's responsibility must be to comply with instruction and to report any deviation from normal. In particular, the operations level operating out-with responsibilities or competence has every potential for a major upset so the definitions of scope and responsibilities are essential and equally so is the assurance that they are adhered to.

The next level of control is the standards and procedures, be these design standards or operating procedures. Naturally, these will require review and amendments in the light of evolving experience. These should be extended to contractors.

The next level of control is the resource for carrying out the HSE requirements. This may be monitoring the environment or contractors or even the performance of personnel in the office or department. The resources will be both manpower and finance.

The final level of control is the disciplinary process, which should be visible, but not a threat.

Cooperation

Cooperation is a two way process, which requires that all members work to a common good, and the capturing of ideas.

In the Design Office it may be that there is a new or better way of carrying out the design (however, ensure that the Management of Change Procedures are used properly). The Designer may perceive that there is a potential hazard and must feel free to discuss it with someone more appropriate.

The cooperation is very much common sense and, although more could be written on it. It was felt that it was only reiterating good management skills. The following are worthy of note:

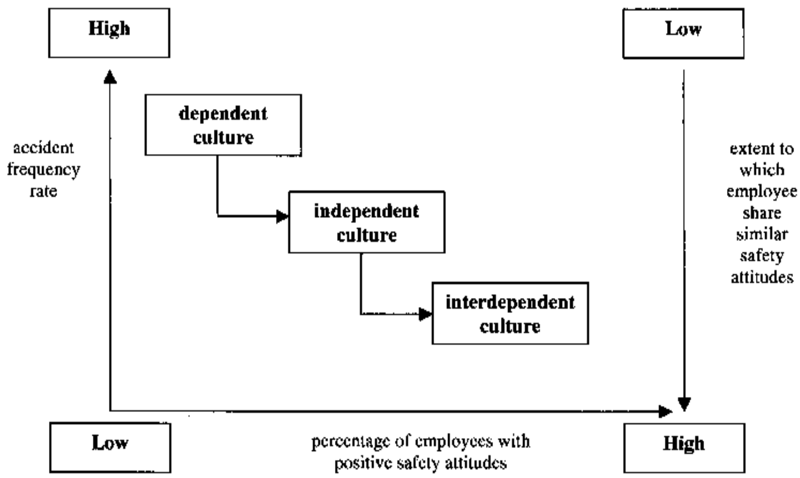
- Suggestion schemes
- Abnormal Occurrence Reports/Investigation
- Dangerous occurrence reporting
- Safety groups or circles
- Problem solving

The list is an essential part of task analysis.

Communication

One of the most important mechanisms for gaining commitment is by communication. There are also many examples of the need for communication. Communication is not only verbal but also written. At the verbal level, the communication could be simple day to day discussions of a piece of work, how it *could* be handled in a safer manner and how it *should* be handled to ensure a safe objective is achieved. Other forms of communication are obviously meetings, informal (sometimes called "tool box") or more formal in the form of safety committees. It must never be forgotten that if a meeting is considered to be only a talking shop, with the outcome resulting little progress or change, commitment will be lost. The verbal communication must be two - way and achieve progress.

The following map taken from the Chemical Engineer, 11 March 1999, shows the benefits of the dialogue such that all share the same attitude and have the same positive attitude. This is corporate culture.



Stages of safety culture improvement

Above all the role of a Manager in the team can lead to enhanced safety if the Manager listens and responds to suggestions as well as proposing changes. This results in a two-way information flow and a team building/confidence in both parties.

At the written level, there are obvious hard systems. In the Design Office, there will be design procedures/standards but also engineering design change procedures such that everyone can comment on any change. There will also be Quality Assurance procedures for records and communications. This will extend to revision of P&ID and other engineering drawings,

In the Operations Department, the written procedures become more vital. At one level, the shift handover log which is a permanent record of what happened, why and what was done (or should be done). There are many examples of failure on the handover system leading to a serious event. It is arguable that one of the direct causes of Piper Alpha was poor shift handover.

Another example of written communication is the Permit to Work system but more obviously the communication is in Operating Procedures, P&IDs, Data Collection, Hazardous Area Classification Drawings, Design Data/Philosophies - process operating parameters and analytical results. Various other thoughts on communication are the manner in which information is displayed and recovered. The information should be in the right place and readily recovered. This begins to impact on the Man/ Machine Interface which is essential on aircraft - why not process plant - because a greater level of disaster can arise?

<u>Competence</u>

There are two elements to competence. Knowledge is obviously essential but equally so are skills and experience. A graduate chemical engineer should have sufficient knowledge to be a process operator (avoiding the use of the adjective "good") but it may take years to acquire the skills and experience to be a "good" operator.

At the highest level, a University degree does not guarantee competence and, increasingly, Institutes (Institutions) of Engineering require Continued Professional Development (CPD). It will be noted that many courses and symposia now include a table giving the CPD "points" so that there is a form of measure on the total CPD in a year. The manager, at whatever level, must ensure that those below (and the managers as well) have the correct knowledge, skills and experience (skills matrix) to do the job "***fully and well***". This will involve reading, attending courses (internal or external) and exposure to new situations. Inevitably, an inexperienced member of the team will require some training and, following this, supervision until the member has demonstrated the appropriate skills and experience.

Annual appraisals are one obvious means of assessing competence but it would be wrong to ignore the spadework required to acquire the material to do this assessment/appraisal. This may involve sampling technical work, observing performances of juniors (at all levels), asking probing questions to "test" the member - but in a very casual manner. Such a technique is used during the interview when seeking Chartered Professional Status (IChemE). With good management skills using eyes, ears and feedback, a very accurate assessment can be made - but it cannot be done from a desk alone.

It is obvious that the assessment of the skills and knowledge of the operation group requires exposure on the site, walking and talking with supervisors and operators. No one can "teach" these skills but the experienced eye will spot short cuts taking place. The deftness of the control room operator and the ability to recognise faults is a skill, which can be readily recognised. Likewise, the manner in which a pump is started or an incident is handled by a supervisor or operator is readily recognised. This is "***Managing by Walking About***".

In the operating environment, the speed and skills of response to an upset are fundamental to safety and operation. If the operator/supervisor cannot handle the situations positively, it is essential to determine if the problem is due to a lack of experience and training or is it in the psychology of that person, if so a different action must be taken - one might be to put the person into a different job! The purpose of this section of the notes, which are directed at a Masters level, is to give indicators. These will be the final words on *competence*.

Monitoring

There is little use in having a plan if progress is not monitored and if the working practices are not monitored. Naturally, the progress towards any targets must be monitored to determine any need for adjustments to the safety/environmental plans but there are other monitoring techniques, which can be applied and in some cases come very close to Audits.

In the Design Office, there are many useful tools which include:-

Structured Project Safety Studies/Audits

HAZOP

HAZID

Relief Reviews

Hazardous Area Classification

Design Standards

Design Guides

Risk Assessment

The results of all of these become part of the Safety Dossier (see part A)

In the Production Department/Environment, the monitoring is less high level but more down to earth.

Incident Investigation: Where the CAUSES determined and controls or procedures put in place.

Abnormal Occurrence Investigation: Where an unusual event which might have created an incident is investigated to identify the corrective actions to eliminate the causative problems.

Site Tours: Where the site is visited and compliance with procedures and performance of the personnel and the process are verified by observation.

Plant Records Review: Where the plant records are checked to show that the process and equipment is performing as intended. Is there any evidence of slow, systematic shift/drift?

Plant Analyses: Does the record show the product quality is consistent and not overly pure? (This will usually mean excess energy is used in separation.)

Plant Yield: Is this monitored and recorded?

Plant Efficiency: Is this monitored and recorded?

Equipment Performance: Does any piece of equipment have a poor reliability and require endless maintenance? (Maintenance may involve plant intervention, which can itself be a source of hazards.)

Function Testing Protective Systems: Are the tests carried out on time and in the correct manner? Does the performance match the required performance? (Poor performance can lead to a hazardous situation.)

Personal Protective Equipment: Is it used properly and is it in good condition?

Are PTW issued correctly, followed correctly and are deficiencies identified and corrected speedily?

Do operators feel uncertain about some phase of the operation and can improvements be devised?

Are changes subject to management procedures?

Are trip hazards removed in a timely manner? (Why were they there in the first place?)

Certain clearly identifiable environmental monitoring tools might include the following:

Are samples taken correctly?

Are drains/vents blanked off?

Is all process drainage captured and recovered?

Are drums of oil stored correctly and handled correctly?

Is a maintenance site tidied up after the work and no waste left on the site?

Audits

Audits are discussed in F 10. Audits should be carried out on routine to identify areas where change may be appropriate. These will compliment the routine, monitoring procedures, and will also reinforce the *leadership* and *commitment* to safety.

Review

The performance targets must be kept under constant review. This will involve not only the progress towards the safety and environmental targets but also a review of the detail of Audits and the need for changes. This in turn must be *communicated* to all so that all are aware of their own achievements.

Performance Indicators

As part of the M.S. there should be performance targets and also indicators. The process performance indicators could be yield, service usage per tonne of product but safety performance indicators need more careful review.

Safety performance indicators could include Injury Accident Rate, Protective System Reliability, PTW accuracy, VOC losses/dumping or any such indicator considered appropriate and meaningful.

F 8 Safety Management Systems (SMS)

Introduction

SMS are good common sense! However, they are not as simple as might be first thought and they are becoming the key drivers in improving safety/environment. This is evidenced by the reports on incidents/accidents which invariably have major references to deficiencies in the Corporate Management Systems.

There are so many possible Safety Management Systems that there is not enough time or paper to write on all of them. Design Standards are a form of SMS, as are Annual Appraisals and Training (Continuous Professional Development). Therefore it is easier to use illustrations, more particularly in the Production Environment, as this is where they are probably most important. (The general ideas are equally applicable to other working conditions.)This section may appear to a repetition of expectations with nothing new. Please read on and digest it, the main features of Management Systems are the thought and the detail that is in them; they are not simple in any way!

Part A outlined the operation of SMS and gave some limited examples, however, at any SMS large or small will have the following elements:-

Safety Policy Statement

Leadership and Targets

Communication

Co-operation

Audit/Review

There is a whole raft of legislations and legislative requirements which include the following small samples:-

Safety Policy

Safety Standards

Competent Advice

Safety Representatives/Consultation

Management of PTW

Supervision

Emergency Planning

Training/Competence

Health Surveillance

Biological Hazards

PPE

Machinery/Guarding

Pressurised Systems

Maintenance

Heating and Lighting of Premises

Electrical Supplies

Control of Access/Egress

Signs

Accident Reporting

Licences

Certification

Cooling Towers, (legionella)

etc.

The list might appear to show SMS is fully covered by Regulations, Approved Codes of Practices and Codes of Practice, this is not necessarily so. Reference to the above alone is not adequate in terms of Professional Development.

S.M.S. A Develpment

All SMS must ask two questions:

"Can it be done safely - and how?"

"Was it done safely?"

This thread will run through the following examples

The main elements or steps in answering these questions and applying SMS are to be found in Risk Assessment. There are:-

Identification

Assessment (Quantification\Qualification)

Control/Mitigation

Assessment - Verification

There is a recycle loop in SMS, which is not always carried out in Risk Assessment. In reality many Risk Assessments cannot be fully verified, but there are regulations in force offshore, Prevention of Fire Explosion and Emergency Response Regulations (P.F.E.E.R.), which request performance standards to be established and verified. That is, if the shut down system has to operate properly on at least 95% of all demands (FDT/PFD - 0.05), can this be demonstrated by testing? Nearly forty years ago a High Integrity Protective System, similar to that shown in Part D was designed to achieve a certain performance but the results of the function tests showed it was failing to achieve the performance targets. Certain detectors did not meet the required performance standards and were changed. There was a SMS in place even then!

As a means to demonstrating "Safe Systems of Work" - (HASWA) the following have been chosen for illustration:

Permit to Work

Procedures

Testing of Protective Systems

Maintenance

Management of Change

Training

Performance Monitoring

The following is a form of Management System in operation in Health Monitoring, as; this has to be managed by a mixture of Hardware and Software. The topic chosen is "Noise".

<u>Noise</u>

Identification

Carry out a noise survey on the plant/site and plot noise contours on the plot plans.

Assessment

Noise levels over 85 dB (A), have the potential for noise induced hearing loss following 8 hours per day exposure (82 dB (A) for 12 hours).

Control

Fit low noise equipment or fit acoustic booths around the noise sources and carry out a new noise survey. (It will be assumed that noise reduction was attempted through equipment specification and design and that further expenditure would have been prohibitive). However if it were possible to fit noise attenuation features it would be necessary to have another SMS to inhibit entry to the controlled zone.

Mitigation

Mark all noise zones over (say) 80 dB (A) with clearly visible and distinguishable markings.

Install clearly noise warning signs in the area.

Install signs requiring hearing protection to be worn in the area.

Issue a Works Standing Order (SI or PI) requiring hearing protection to be worn in noise areas.

Issue approved hearing defenders, free, to all employees.

Terms of contract should request adherence to warning signs - non-adherence to be a breach of conditions.

Verification

Carry out base line and continuous audiograms on all employees (see part G).

Check the adherence to procedures (audit).

Monitor changes in the site/plant noise profile.

Monitor any change in the audiograms for the employees.

Monitor the changes in Noise Legislation.

Finally, the commitment must be demonstrated by all Managers being seen to adhere to their own rules **without deviation**.

The main sections will now be addressed: -

Permit to Work

There are many forms of Permit and they also have different names but generally mean the same thing.

The following is a list in a descending order of Risk.

(Under Pressure break in)

Entry Permit

Hot Work Permit

Electrical Isolation Permit

Nucleonic Isolation Permit

Cold Work Permit

Excavation Permit

Roof Access Permit

Road Closure Permit

Scaffold Permit

The list is not exhaustive - the top was put in brackets as some companies may consider this to be a "special" permit. The order can be discussed and some may feel that the order of two could be reversed but entry permit does come exceeding high as there is a risk of asphyxiation and the risks are higher than for cold work. Do not forget humble scaffolding could create problems with lighting, valve access and means of escape and a road closure could inhibit access for the emergency services.

Identification of Hazards

On routine tasks there may be a written procedure already in use but for complex tasks it may be necessary to carry out a ***Task Analysis*** where each step is analysed in detail to establish the potential hazards of that step and the mitigating features that might be applied. The following "***guidewords***" are given to assist this task.

What are the tasks?

What are the hazards associated with the task?

What are the potential effects on?

Personnel Involved

The Process

The Environment

The Bystander

What are the secondary hazards of the task?

Noise

Impaired Lighting

Impaired Access

Impaired Escape

Fume

Leakage

What are the hazards in the area?

Noise

Hot Metal

Leakage

What are the means of escape?

What tasks are mutually incompatible and forbidden?

What must be done if the task cannot be carried out as intended/specified?

What should be done on sounding of alarms?

Does everyone know what is to be done and by whom?

The following are some ***guidewords***, which will assist in the identification of some of the hazards.

Under Pressure Break In

NDT

Finite Element Analysis

Metallurgical Assessment

Means of Escape

Handling Emergencies

Handling a Process upset

Communication

Authorisation of a Qualified Engineer

Entry Permit

Isolation Process:

Process - including purges

Nucleonic

Electrical

Instruments

External sources of hazard

Purging - gas freeing

Air Tests: How?

How often?

Where?

What for?

Accuracy/Relevance/Limits

Portable Meters:

0_2 Deficiencies

Flammable

Toxic

Means of Escape:

How?

Harness?

Stand by?

Lighting:

Impaired or requiring reinforcing

Change of working environment due to disturbed debris or sludge.

Spillage/draining of process fluids

Communication:

Routine

Health check

Recording entry/exit other permit in operation (compatibility)

Change in wind direction

Plant condition change

<u>Hot Work</u>

Isolation of all process fluids

Spill collection containment - drains and other

Spark suppression/control

Sources of spillage and leakage in the area. How can they be prevented/mitigated?

Tools

Other permits in operation (compatibility)

Monitoring the local environment for hydrocarbons, toxics or changes in condition

Access

Means of escape

Communication

Change in the working environment due to disturbed debris of sludge, spillage/draining of process fluids

Change in wind direction

Plant condition change

Isolation

Standard Task Procedure

Cold Work

Isolation - Process and Electrical

Draining

Preparation

Access

Tools to be used

Lifting hazards

Trapped fluids

Source of leakage

P.P.E.

Other hazards in the area

Means of escape

Communication

Change in the working environment due to disturbed debris or sludge, spillage/draining of process fluids

Plant condition changes

<u>Excavation</u>

Toxic or flammable gas freeing – can fumes drift into the excavation?

Piping/cables in the area

Consolidation of the sides of the excavation against inward collapse

Rainwater accumulation

Soil retention

Signs/barricades

Communication

Access

Means of Escape

Change in wind direction

Process upset

<u>Roof Access</u>

Work Below

Nets or roof ladders

Harness

Duck Boards/Roof Ladders

<u>Road Closure</u>

Emergency Services

Warning Signs/Detours

Runners

<u>Scaffold</u>

Access to/from

Load limits

Lighting

Valve access

Instrument access and possible damage

Change in process indicators

General Guidewords

Dropped loads

Fluid properties:

Flammable

Toxic

Flammable

Environmental Impact

Pressure

Temperature

Cold Work Permit

The following is a simple but usable cold work Permit and a covering Works Standing Order (PI or SI). It will be noted it calls for competence of all parties involved.

It is important that permits their control/supervision must be adhered to completely. There have been too many near misses recorded in LPB and other documents like it. Please read, "Beware the Unexpected" - IChemE Loss Prevention Bulletin No. 104.

YOU CAN NEVER BE TOO CAREFUL!

The following is a worked example of the operation of the PTW: -

Cold Work Permit for Pump Removal

Try to fill out the permit in full. The pump in question is driven by an electric motor and contained petrol.

Identification

Process Hazards

Leaking/Fluids

Flammable could damage eyes.

In contact with a potentially a toxic/carcinogenic fluid?

Low Pressure but could be pressurised by a leaking isolation valve (called trapped pressure)

Pressure and temperature in this case are not hazards in themselves

Electrical Hazards

Motor may rotate during removal and cause injury

Mechanical Hazards

Motor may rotate during removal and cause injury

Lifting hazards while removing the pump itself - back/hand injury

Piping should be supported correctly once the pump is removed.

Chemical Hazards

Petrol - potential fire and toxicity

Access

A lifting frame will be required for the pump

Access to valves and joints is acceptable

Lighting

Acceptable - plant lighting/sunlight

Ventilation

Acceptable - open air-wind blown

Other Hazards

None - no hot metal, drains are clear

Means of Escape

Acceptable

Communication

Tannoy

Quantification

Motor must be fully isolated, isolator to be open, fuses drawn and stored in a “safe”

Single isolation valves are acceptable at the process pressures on suction/discharge of the pump

Isolation valves to be locked CLOSED and the keys stored in a “safe”

Isolation valves to have tags fitted

Isolation integrity to be verified by a pressure rise/leak off test

Control

Motor isolated and fuses stored in a “***fuse safe***”, Motor isolation proved by a “***motor start***” and pump isolation standards (leaving valves leading to trapped pressure) by a pressure rise in the pump body

Access is acceptable

Lighting is acceptable

Ventilation is acceptable, keep up wind of the joint

Process fluids to be drained into the closed drain and the pump flushed with water

Non-sparking tools to be used for bolts

Mitigation

Goggles/Safety Helmets/Gloves to be worn by fitters

Area to be roped off

Piping support to be checked and props fitted if necessary

Fire extinguisher on hand

Prior to the work the Maintenance Supervisor and Process Supervisor must visit the site and agree the whole isolation is sound and access is clear

The joints are to be broken **away** from the fitter such that any leakage does not spray the fitter

Once removed open ends should be blanked off tightly - the blanks should have a “test cock” against valve leakage when refitting the pump.

The pump should be removed to a cleaning bay

A Cleanliness Certificate should be issued before the pump is removed to the workshop.

Verification

The work site should be visited by the Production Supervisor at least once to verify compliance with the P.T.W.

Summary

Electrical Isolation Permit

Isolation (process) Permit

Cleanliness Certificate

Cold Work Permit

Below are examples of a Standing Instructions and a Standing Instruction for the start up of a pump.

F 9 Standing Instructions or Permanent Instructions or Works General Orders or Operating Procedures

SIs, PIs and WGOs are the record o the expectations of managers. In a design office they may take the form of a Design Guide or Standard.

Two guiding principles will apply to any operating procedure.

Do not expect someone to do a task that you would not be happy to do.

Do not expect someone to do a task that you could not do as well - if not better.

The first principle is directed at ensuring all risks associated with the task are reduced *to **as low as is reasonably practicable***. (If there is any risk would you accept it?) The second principle is that the person doing the work must feel at ease with the task and have the skills and knowledge to carry it out fully and well. The procedure must follow the steps:

Identification

Quantification (Qualification)

Control/Mitigation

Verification

Standing Instruction Company A

Number 1

Title: Permit to Work

Prepared by: J Bloggs

Authorised: A Scouser

Copies to:

Records,

All Plant Standing Instruction Dossiers

All Plant Supervisors

Last Issue: 1 March 2014

PERMIT TO WORK

XYZ COMPANY

The following instructions and notes are given to those who use Permits to Work and those who are ***Performing Authorities*** in the XYZ Company.

It is the policy of the XYZ Company to issue <u>specific permits</u> for <u>each task</u> that involves a change from standard operation. Under the appropriate circumstance the Permit to Work may also require the following additional permits, which might include:

Entry Permit

Electrical Isolation Permit

Nucleonic Instrument Isolation Permit

Process Isolation Permit

Scaffold Permit

Roof Permit

Excavation Permit

Road Closure Permit

Only those who are fully trained, assessed and authorised as Issuing and Performing Authorities may sign the permit. Under <u>**no**</u> circumstances may the ***Issuing Authority*** and ***Performing Authority*** be the same person. If the Performing Authority is a contractor he/she must be fully trained and assessed and authorised to carry out the tasks.

The permit copies **MUST** be displayed at the work site. Routine audits of the operation and adherence to its requirement **WILL** be carried out without notice. If the work is not being carried out in accordance with the permit, the permit **WILL** be withdrawn and the work site returned to a safe condition.

At a shift change the status of all permits **MUST** be a part of the Shift Hand over.

The Main and Local Control Centre copies will be held on a special rack and be visible to all personnel for inspection and appraisal of the plant condition.

A copy of all signed off permits will be retained for inspection for a period of two years at the issuing centre.

A register of all incidents, which occurred during the operation of the permit, will be held in the control room. In particular all incidents which could be dealt with by improvements to this procedure will be recorded and actioned.

Standing Instruction Company A

Number 2

Title Instruction on Filling in the PTW (Cold Work)

Prepared by: J Bloggs

Authorised: A Scouser

Copies to:

Records,

All Plant Standing Instruction Dossiers

All Plant Supervisors

Last Issue: 1 March 2014

PLANT: The plant should be clearly defined by its name and location.

AREA: The exact area of the plant should be specified.

DATE: Self-Explanatory - day/month/year.

1. EQUIPMENT

The title should be exactly as the equipment is labelled on the site and P and I Diagrams. The Number should be a unique identification. The Serial Numbers A, B, C etc, **MUST** be specified. A tag number **MUST** be specified if there is any possibility of confusion.

2. TASK

2.1 The task must describe exactly what work is to be carried out - "Maintain the Pump" is **NOT ACCEPTABLE** - it should define **exactly** what will be carried out such as "*Remove Pump Rotating Unit - take to the cleaning compound - steam clean - await cleanliness certificate before taking the unit to the work shop*".

2.2 The limitations must describe what work **MAY** be carried out and what **MUST NOT** be carried out. For example, it may say, "*Inspect the pump unit - no joints may be broken without issue of a new permit*".

2.3 The tools must be carefully specified to reflect the local plant hazards.

3. PERIOD OF VALIDITY

3.1 The permit will normally last for the duration of the shift issuing the permit.

3.2 The renewal may extend up to but no more than 24 hours.

4. HAZARD IDENTIFICATION

4.1 There **<u>WILL</u>** be a structured identification of all Mechanical, Process, Electrical, Civil and Instrument and Chemical Hazards involved during the performance of the task. In the case of routine tasks this may be in the form of a standard sheet.

Attention will be paid to: -

- The means by which the equipment will be isolated from all sources of harm. This could include lock-closed valves, slip plates, blanks, electrical isolation, clamped shafts and protection from any moving parts.
- The control of isolations covered by more than one permit.
- The nature of the fluids/chemicals and their relationship to the Control of Substances Hazardous to Health Regulations (C.O.S.H.H.).
- The work at height and the means of primary and secondary escape.
- The work in confined spaces and the attention to access, primary and secondary escape.
- The need for Entry Permits.

In the case of the novel or unusual tasks a full ***task analysis*** (as in management of change) **<u>will</u>** be carried out involving assessment of the risks, loads/forces, site surveys, underground surveys.

The results of these assessments will be recorded as part of the task analysis and also in the permit. This section will be central to filling in the rest of the permit.

5. EQUIPMENT PREPARATION

5.1 The means of isolation will be specified, the isolation certificate number will be recorded, the location of blanks, slip plates and locked valves will be itemised.

5.2 The process preparation will be specified in detail such as "***Drained of process fluids and flushed with water***".

5.3 The residual fluids may include process; toxic acid/alkali or flammable <u>and</u> water.

6. OTHER HAZARDS IN AREA

This section is self-explanatory and could include steam mains, sample points, rotating equipment (guards must be fitted).

The section may also impose other limitations on other permits - for example, "***no other joints may be broken within 25 metres of the work site***".

7. AREA PREPARATION

This section should refer to the preparation of drains flushed, "***sand-bagged***", a roped off maintenance area where access is controlled, need for scaffolding for access, gas detection in drains or locally. Particular attention must be paid to access and means of escape from confined areas or work at right.

Consider if local environmental monitoring is required.

8. PERSONAL PROTECTIVE EQUIPMENT TO BE USED

8.1 This should include a detailed description of **ALL** of the personal protective equipment to be worn - this could include but is not limited to helmets, visors, hearing protection, eye protection, protective clothing, gloves, boots, and special suits. Consider also the need for harness and breathing air sets. The range is not meant to be complete and must reflect the hazards involved in the task and the site.

8.2 Site protection may include removal of trip hazards or protecting work areas where over-head hazards may exist.

8.3 The preparation could include locking off sample points.

8.4 Gas detectors may be required - but it is not normal for breaking of joints.

9. SUPERVISION

9.1 This may specify the need for special supervision of unusual work is carried out - (See also Hazard Identification).

10. WHEN MUST THE WORK BE SUSPENDED

Detail those conditions when work **MUST** be suspended. In particular specify those changing conditions or the goals, which **MUST** be achieved before the work can proceed to its next goal.

11. WHEN MUST THE SITE BE EVACUATED

Detail the alarm signals/warnings, which will require the evacuation of the site.

Note: Section 10 and 11 are closely related. The work **MUST NOT** be suspended or the site evacuated if it creates a hazardous condition.

12. ISOLATION CERTIFICATES

Detail those certificates, which will apply to the task to be performed.

13. OTHER CERTIFICATES/PERMITS

Detail those certificates/permits, which will apply to the task to be performed.

14. OTHER PERSONS WHO SHOULD BE NOTIFIED

The work may affect more than one area of the plant. Incompatible activities such as opening joints and welding must not be carried out in close proximity. If the notification is not detailed potential hazards may be created.

Consider the need to inform also the operators in the area/areas as well as the other issuing authorities.

HAND OVER

This **MUST NOT** be signed before both authorities have discussed the task, have inspected the site and are in **TOTAL** agreement with the contents of the permit.

HAND BACK

This **MUST NOT** be signed before both authorities have inspected the site and agree that the site has been returned to a safe condition.

LOCATION OF COPIES OF PTW

The copies must be clearly displayed as indicated. The work **MUST NOT** start until all permits are logged in the correct place.

Top copy to be held at the work site.

Second copy to be held in the main control centre.

Third copy to be held in the local control centre.

Fourth copy to be held by issuing authority.

FILING

The Control Room copy will be held in Archive for at least 2 years.

(The following permit has been condensed to save space)

It might be a useful exercise to fill one in the "laboratory environment"

PTW COMPANY A

<table>
<tr><td>PLANT</td><td>AREA</td><td>DATE</td><td>REF. NO</td></tr>
<tr><td colspan="2">1. EQUIPMENT</td><td colspan="2">TITLE
PLANT/EQUIPMENT NUMBER</td></tr>
<tr><td colspan="2">2. TASK</td><td colspan="2">2.1 EXACT DESCRIPTION OF TASK
2.2 LIMITATIONS OF SCOPE OF TASK
2.3 TOOLS PERMITTED</td></tr>
<tr><td colspan="2">3. PERIOD OF VALIDITY</td><td colspan="2">3.1 (TIME-DATE) TILL (TIME DATE)
3.2 MAY BE RENEWED Y/N?</td></tr>
<tr><td colspan="2">4. HAZARD IDENTIFICATION
(SPECIAL ENGINEERING FEATURES)</td><td colspan="2">4.1 MECHANICAL REVIEW
4.2 PROCESS REVIEW
4.3 ELECTRICAL INSTRUMENT REVIEW
4.4 CHEMICAL HAZARDS REVIEW</td></tr>
<tr><td colspan="2">5. EQUIPMENT PREPARATION</td><td colspan="2">5.1 MODE OF ISOLATION (INDICATE TAG NUMBERS)
5.2 DRAINING/PURGING
5.3 POTENTIAL HAZARDOUS FLUIDS IN THE EQUIPMENT</td></tr>
<tr><td colspan="2">6. OTHER HAZARDS IN AREA</td><td colspan="2">6.1 TRAPPED PRESSURE
6.2 SERVICES
6.3 OTHER PROCESS EQUIPMENT IN THE AREA
6.4 OTHER SOURCES OF HAZARD
6.5 OTHER PERMITS IN THE AREA</td></tr>
<tr><td colspan="2">7. AREA PREPARATION</td><td colspan="2">7.1 DRAINS
7.2 ROPING OFF
7.3 SCAFFOLD
7.4 OTHER ACCESS
7.5 OTHER</td></tr>
<tr><td colspan="2">8. PERSONAL PROTECTIVE
EQUIPMENT TO BE USED</td><td colspan="2">8.1 PERSONAL PROTECTION
8.2 SITE PROTECTION
8.3 GAS DETECTORS</td></tr>
<tr><td colspan="2">9. SUPERVISION</td><td colspan="2">9.1 SITE TO BE INSPECTED EVERY …….HOURS BY…….
9.2 PERMANENT STAND BY PERSON REQUIRED?</td></tr>
<tr><td colspan="2">10. WHEN MUST WORK BE SUSPENDED?</td><td colspan="2"></td></tr>
<tr><td colspan="2">11. WHEN MUST THE SITE BE EVACUATED?</td><td colspan="2"></td></tr>
<tr><td colspan="2">12. ISOLATION CERTIFICATE</td><td colspan="2">PROCESS: NO. INSPECTED BY …..
ELECTRICAL NO INSPECTED BY …..
NUCLEONIC: NO INSPECTED BY …..</td></tr>
<tr><td colspan="2">13. OTHER
CERTIFICATE/
PERMITS</td><td colspan="2">13.1 HOT WORK
13.2 ENTRY PERMIT
13.3 CLEANLINESS CERTIFICATE
13.4 SCAFFOLD CERTIFICATE</td></tr>
<tr><td colspan="2"></td><td colspan="2">HAND OVER
1. I agree the site has been inspected and is in accordance with this certificate.
2. I agree that the site is safe so far as is reasonably practicable.
3. I agree that the work will be carried out exactly as specified.
Issuing Authority Performing Authority
(Time ……. Date …..) (Time ….. Date ………)</td></tr>
<tr><td colspan="2"></td><td colspan="2"><u>LOCATION OF COPIES OF PTW</u>
Top copy to be held in the work site.
Second copy to be held in the main control centre
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Fourth copy to be held by issuing authority</td></tr>
</table>

Operating Instructions

The preparation of any procedure (a SI) is a team effort. The person who is to do the work has skills and knowledge, which must be accessed. That person may wish to carry out the task in a manner which involves risks or again the operator may know of a simpler and direct way of carrying out the task. If the person doing the work thinks the procedure is wrong, it is likely that he/she will do it "the way he/she thinks best"

The identification/quantification should examine every step of the process. The following guide words would assist this process:-

Too soon

Too late

Sequence

Timing

Identification

Warning signs

Verification of success

Warning of error

Communication

Access

This would be adequate for a routine task but a more detailed procedure should be subject to a HAZOP study.

The procedure must be clear and precise using exact terminology. Avoid terminology such as "***slowly open the valve***". What is the time frame for "***<u>slowly</u>***"? - What valve is being referred to?

The sequence of the operation must be clearly defined and the time frame defined. Valve numbers must also be clearly defined in an unambiguous manner. Where there should be appropriate warnings and guidance written into the procedures. These warnings should cover guidance on how the completion of each step can be verified and what should be done if the objectives cannot be achieved. A task left part completed is a hazard waiting to happen.

There is a balance between general tasks and the fine detail of each step of the task but the detail and sequence of operations may be critical and a general instruction such as "***start up***" is inadequate. Once the operation is written it should be discussed with the operating team to see if there is a better way of carrying it up - the instruction must then be polished to ensure it has built in "quality". The next step is to practice the procedure as a desk top exercise to ensure there are no difficulties associated with the operation. The final step is to train the operators in the instruction showing the operator what is required and how it is to be carried out.

There are two additional steps, which need to be followed through once the procedure is in place. The first is to speak to the operators to identify any difficulties in the operation of the procedure - if necessary it should be further refined and enhanced. If a new refined procedure is issued it must be formally issued, retraining carried out and the old procedure formally withdrawn. The review of the procedure must be carried out every year and if it is unchanged the procedure would be formally endorsed for the next year. Finally the operation of the procedure should be reviewed to ensure that it is carried out as intended and no hazardous short cuts are incorporated, that is the Audit Process.

All operators should be checked on routine to ensure compliance and new operation formally trained - preferably be a training supervisor not by the routine operator. There is the very real risk of errors being incorporated by "***hand down training***". The old story of the message from the 1st World War Front is quite appropriate. It started off as "Send reinforcements we are going to advance!" It ends up as "Send three and four pence ($^{1}/_{6}$ of a pound) we are going to a dance!" This is meant as a serious warning.

The procedure should be concise and accurate, written in detail, in simple language with no ambiguity or room for deviation but a check list approach can be used as an "aide memoir in parallel to the procedure". The start up instructions for a large process gas compressor ran to 20 sheets of paper but the restart following a "trip out" could be reduced to a 15-step check list.

In the final analysis any procedure is worthless if it is not improved and it is not complied with. It is an iterative recycle process. The final words on procedures are ones directed to ownership - if the operator feels there is a ***"better way of doing it"*** and the operator was not party to the work up of the procedure don't be surprised if the procedure is ignored.

Standing Instruction Company A, Plant B

Number 3

Title: Start up of Turbine Driven Cooling Water Pump No 123

Prepared by: J. Bloggs

Authorised by: A.N. Other

Copies to: Records

Records,

All Plant B Standing Instruction Dossiers

All Plant B Supervisors

Last Issue: 1 March 2014

Objective of This Standing Instruction

This Standing Instruction gives a list of all of the contacts to be made when starting up Turbine Driven Pump P-123. It also gives a list of the Pre-start up Checks, Preparation Tests and the final start up process. Within the introduction are found the operating envelope and the prohibited operating zone.

Pre start up checks

1. Ensure from maintenance records that the turbine over speed trip has been tested in the last 2 years. **If this has not been done the turbine must not be started.**
2. Ensure that the turbine lubricator is full of grade “xyz” oil and there are no oil leaks. In the event of any leaks contract the maintenance department before starting.
3. Ensure that the pump lubricator is full of grade “abc” oil and that there are no oil leaks. In the event of any leaks contact the maintenance department before starting.
4. Ensure the coupling guard is securely in place.
5. Ensure there are no slip plates in the process lines and start up blanks are removed.
6. Ensure the turbine exhaust Relief Valve is securely located and in place.
7. Ensure all valves are closed other than steam trap isolation valves. (See sketch 1.1).

Pre start up contacts

1. Contact the power station (telephone No. 123) and check that the correct amount of HP steam (x Kg/hour) will be available on demand in 1 to 2 hours also check that the same amount of steam can be admitted to the LP steam main. If this will not be possible stop the start up process until it becomes available.

2. Contact all control rooms on the plant (telephone Nos. 124, 125 and 126) and inform them that a new cooling water pump is to be brought in line in 1 to 2 hours time and that operators may have to adjust cooling water flows.

Preparation Tests

Reference should be made to Piping and Instrument Line Diagrams (P and I.D.) No 12 and 34 (Sketch 1.1).

1. Slowly open steam trap bypasses ST1, ST2 and ST3 on Steam Main LPS 123 over 5 minutes and blow out any condensate.

If condensate is found, blow the line until live steam flows then allow a small continuous escape of live steam to assist in the warming of the steam main.

2. Slowly open steam trap bypasses ST4, ST5, and ST6 on Steam Main HP 456 over 5 minutes and blow out any condensate, allow a small continuous escape of live steam to assist in warming up the steam main.

3. Open the Turbine Exhaust Steam Isolation Valve LPS 123 Valve 1 very slowly over 2 to 3 minutes and blow out any condensate from the Turbine Casing Drains. When live steam is detected, close the drains.

4. Open Pump P-123 suction valve CW123 valve fully and open the body vent valve 10 to clear (drive out) any air or gas. Close valve 10 when liquids are detected.

Notification

1. Notify the power station (Telephone No 123) that the pump will be spun in 5 minutes and started in 15 minutes at which times there will be a sudden draw of x Kg/hr of steam. Check if they expect any problems or require further notification.

2. Notify all control rooms on the plant (Telephones 124, 125 and 126 that the extra cooling water pump will be brought on line in 15 minutes.

Start up

1. Open the cooling water pump minimum flow valve CW123, Valve 3.

2. Blow out the turbine Casing Drains Valve once more to ensure that there is no condensation in the turbine. Close the valve.

3. Slowly open the steam inlet to the turbine HPS 456 valve 2 over 15 seconds to start the turbine spinning at a **minimum** of 200 RPM required to ensure adequate lubrication of the bearing. Do not exceed 1000 RPM as this is the approach to natural frequencies of the Turbine / Pump System. Use a hand held tachometer on the free end of the turbine.

4. Check the whole unit for excessive vibration and check that the lubricators are still full of oil. Control the speed on HPS 456, Valve 2.

5. Open the pump body vent Valve 10 over 5 seconds to check there is no gas present. Close valve 10.

6. Blow the turbine drains Valve 20 to check there is no condensate present. Close Valve 20.