IMPROVING THE PERFORMANCE AND CONSISTENCY OF HAZOP FACILITATION AND RECORDING

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Hazard and Operability Analysis has long been established as a preferred technique for risk identification and many firms incorporate HAZOP procedure into their approach to Process Safety Management. There are many practitioners of the technique as well as decades of use but little information about the pro's and con's of the technique from the operators perspective. This paper tries to address this issue at two levels, firstly details of the facilitation and recording of the HAZOP and secondly how the operator translates the paperwork delivered by the HAZOP study team into improved safety on the plant.

The paper reviews HAZOP worksheets and makes selections from a wide range of studies performed at different times and in different contexts where similar generic hazards were examined. Variability in key aspects such as the choice of parameter-guideword combinations, the approach to recording and the scope of questioning by the facilitator is shown to affect the quality of the output from the study and therefore the study benefit available to the Operator.

Because the subject is approached from the Operator's perspective mention is also made of ways to make a HAZOP record useful and "live" throughout the life of the unit. Even though a hazard could be, on paper, well safeguarded so no recommendations are felt necessary at the time of the HAZOP, it is important that the relevant safeguarding measures – whether they be engineering or administrative controls – are recorded in the HAZOP notes and get properly inspected and maintained. The paper discusses means to use the HAZOP to first establish these operating safeguards and then ensure that they are known, understood, and kept in "working condition" during the plant life cycle.

INTRODUCTION

Hazard and Operability Analysis has long been established as a preferred technique for risk identification and many firms incorporate HAZOP procedure into their approach to Process Safety Management. There are many practitioners of the technique as well as decades of use but little information about the pro's and con's of the technique from the operators perspective. During 20 years of work in this field, Arthur D. Little has worked with the HAZOP procedures mandated by numerous operators, both international majors as well as independent firms. Our work has brought us into contact with HAZOP studies conducted by others as well as the large number of studies which we have facilitated ourselves worldwide. What is apparent is wide variability in the implementation of these studies and in the benefits delivered in practice. This paper seeks to examine some reasons for this variability and to illustrate ways in which process plant operators can benefit more from the considerable time and cost expended during HAZOP study.

HAZOP DELIVERABLES

One deliverable from the HAZOP study is the HAZOP worksheet, a record taken in real time of the discussions held in the HAZOP team meetings. The worksheet summarizes the causes for deviations from design intent, the consequences which may occur and the safeguards present in the system under review. It is essential that the worksheet and the recommendations it contains are readily understood by both the contractor responsible for implementing the recommendations and the operator who may need to adopt some of the recommendations as changes to operating or maintenance procedures. Unclear or confusing recommendations cause a headache for members of the project team who have actions they need to discharge, but difficulty understanding what is required. For this reason clarity is an essential requirement of the HAZOP record.

The HAZOP record also acts as evidence to those not present at the meetings that a thorough and systematic study was carried out. This may be important for regulatory authorities seeking assurance that all potential hazards have been considered. For this reason the HAZOP record needs to be a complete account.

Finally the HAZOP record becomes an administrative burden if it is unnecessarily complicated or lengthy. It becomes more useful if it is concise.

This section of the paper examines extracts from a variety of HAZOP worksheets to address three questions

a) What evidence can be offered of **complete** and comprehensive hazard identification?
b) Are the records **clear** and convey assurance of systematic consideration of potential risks in the design under consideration?
c) Is the documentation **concise** or has it been unnecessarily elaborated?

Guideword / Parameter	More	Less	None	Reverse	Part of	As well as	Other than
Flow	High Flow (10)	Low Flow (10)	No Flow (10)	Back Flow (10)			
Pressure	HighPressure (10)	Low Pressure (10)					
Temperature	High Temperature (10)	Low Temperature (10)					

Figure 1. Parameter-guideword combinations used in all procedures in survey. *Source:* Study data drawn from project documentation and similar sources

These questions are addressed by reference to extracts from a variety of HAZOP procedures and studies carried out both by Arthur D. Little and other specialists.

COMPLETE, COMPREHENSIVE RECORDS

The claim for a complete, comprehensive hazard identification hinges on use of full recording with a complete set of parameter-guideword combinations. If the recording is by exception (meaning only discussions leading to recommendations are recorded) the reviewer/auditor has no means to know if issues were discussed and safeguards found adequate or if the issue was overlooked. Similarly if the parameter-guideword combination is not comprehensive, potential hazards may not be raised for discussion.

We have tested the extent to which HAZOP procedures use comprehensive parameter-guideword combinations by surveying 10 separate HAZOP procedures used in significant HAZOP studies of continuous refinery process plant by Major Plant Operators and International Contractors. We found all procedures used the parameter guideword combinations shown in Figure 1. Even in the key parameters, Flow, Pressure and Temperature not all of the guidewords (Part of, As well as and Other than) are used in all the procedures. 9 of the 10 procedures include level deviations and the deviation "contamination" as shown in Figure 2.

The basic set of parameter- guideword combinations in Figure 2 does not offer a complete picture of the possible deviations because it misses several parameters which are essential to a process description (as found for example in a heat and mass balance). The parameter 'composition' for example is missing. For some processes other significant parameters include 'reaction' and the material state or 'phase' and occasionally physical properties such as 'viscosity' may need to be considered. Duplication should be avoided; for example combinations such as composition – part of can be used to examine the extent of reaction.

In an attempt at being comprehensive, some procedures include many more parameters. Apart from those already mentioned the 9 procedures include parameters such as liquid/liquid interface, documentation and a variety of others illustrated in the lists shown in Figure 3 and Figure 4. These items are not parameters in the sense of process measurements (such as temperature, pressure etc). Start-up for example is a plant status and draining/venting is a maintenance activity. The inclusion of such parameter lists, together with the requirement that all deviations be considered and discussion recorded, results in an exhausting rather than an exhaustive process.

The HAZOP study leader needs to have the latitude to adapt the parameter-guideword combinations he proposes to use to the circumstances of the plant under review. The discussion so far has concentrated on continuous process plants but were a batch process to be examined then guidewords relating to sequence such as "too early, too late, too quickly, too slowly" need to be considered. They could also be used for studying start-up and shut-down. An alternative approach is to treat Start-up and shut down as states which the plant is (or should be) designed to accommodate. Rather than including these as parameter-guideword combinations (as in Figure 3) we believe the preferred approach is to consider deviations from design intent during normal operations and then separately during

Guideword / Parameter	More	Less	None	Reverse	Part of	As well as	Other than
Flow	High Flow (10)	Low Flow (10)	No Flow (10)	Back Flow (10)		Contamination (9)	
Pressure	HighPressure (10)	Low Pressure (10)					
Temperature	High Temperature (10)	Low Temperature (10)					
Level	High Level (9)	Low Level (9)	No level (8)				

Figure 2. Parameter-guideword combinations used in most procedures in survey. *Source:* Study data drawn from project documentation and similar sources

Guide Word / Parameter	More	Less	No	Reverse	As well as	Part of	Other than
Start-up / Shut-down	too fast	too slow			actions missed		wrong recipe
Draining / Venting	too long	too short	none		deviating pressure	wrong timing	
Inertising	high pressure	low pressure	none		contamination		wrong material

Figure 3. Example from operator's HAZOP procedure. *Source:* Study data drawn from project documentation and similar sources

GUIDEWORD	PARAMETER	EXAMPLES OF CAUSE
OTHER THAN		
	Relief	Pressure or thermal relief
	Instrumentation	Control, flow measurement, pressure relief, instruments, pump overheating due to closed control valves, location of alarms etc. temp indicators flow records etc.
	Sampling	
	Corrosion	
	Service Failure	Power, cooling water, inst. Air, steam, nitrogen etc.
	Maintenance	System drainage, isolation of equipment and preparation for maintenance, start-up and shutdown
	Commissioning	

Figure 4. Example from contractor's HAZOP procedure. *Source:* Study data drawn from project documentation and similar sources

commissioning/start-up and shutdown. For completeness, the basic parameter-guideword deviations can be applied to each operating state.

Functions such as Relief or Instrumentation are part of the design intent achieved by equipment included in the engineering design. Similarly tasks such as draining/venting, "inertising" or sampling are part of the intended procedures for plant operation. Deviations from design intent for equipment in our view are best considered as part of the main parameter-guideword combination affected (for example for relief consider deviations causing high pressure).

For operations one option is to consider "operations" itself as a parameter (as does one major operator). Another is to use the parameter "human error" to examine the potential hazards which might occur were there to be an operator mistake. A third option is to describe the task using a hierarchical task diagram and apply HAZOP deviations (action no, action part of, action as well as, action other than) to analyse the consequences of the various types of failure to follow the intended operating or maintenance procedure.

Service failures need not be treated using special parameters. Loss of instrument air for example can be considered using the flow deviations (high flow for fail open valves, no flow for air fail closed valves). Similarly loss of power can be considered under low flow (for a motor driven pump or compressor) or high temperature (for a fin fan). It is possible to deal with "loss of utilities" such as HP, MP, LP steam; cooling water, and so forth using the deviations Flow- No or Temperature- Low/High depending on which stream is under consideration. Some practitioners prefer to treat these as separate nodes at the end of the "normal operation" HAZOP where the impact on the unit as a whole can be considered.

In achieving the simplification we suggest, it is important for the practitioner to understand the complimentary relationship between parameter-guidewords (as discussed in the following section). Then the core set of parameter-guidewords for complete analysis in each node of a HAZOP study can be reduced to a manageable quantity as in Figure 5.

CLEAR, CONCISE RECORDING

In HAZOP training courses it is common to spend some time discussing which parameter-guideword combination to select for the "correct" location for discussions in the HAZOP worksheet. For example situations causing High Flow may also produce high downstream Pressure and

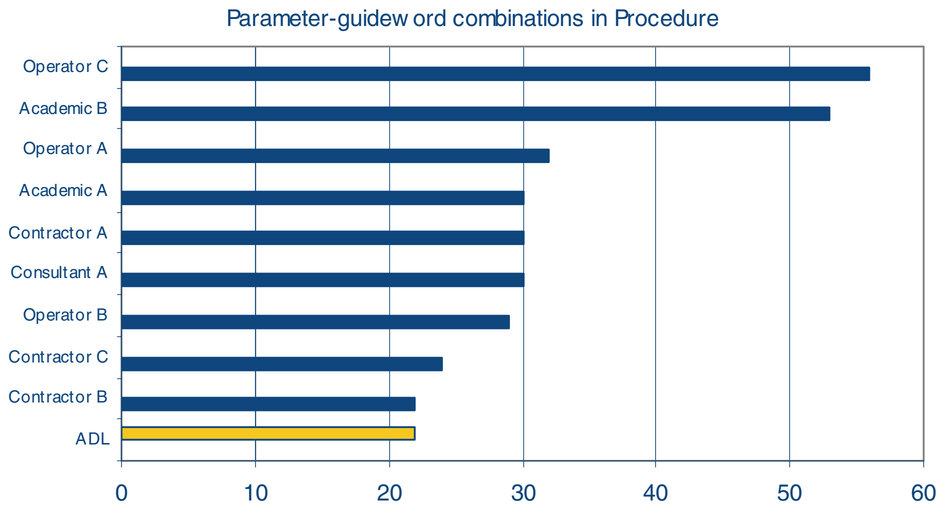

Figure 5. Number of parameter-guideword used in a variety of HAZOP procedures. *Source:* Study Arthur D. Little

could cause High Level downstream. If the equipment under consideration is a heat exchanger or a fired heater, high (or low) flow can be related to low (or high) temperature. In such cases there is no "right" place for the recording of discussion on causes, consequences and safeguards. Rather we think it is important for the practitioner to develop a coherent and consistently applied approach.

The contentious may argue that Flow deviations can be shown to underlie most of the others but recording as much as possible under the Flow parameter-guidewords does not produce a clear, concise record. As an example consider gas blowby from a high pressure vessel as illustrated in Figure 6. Discussion on gas-blowby could be put under High Flow (for example through failure or maloperation at the level control valve), it could be High Pressure (for example in the downstream plant section designed at a lower pressure) or it could be No Level in the vessel (the essential condition for gas rather than liquid to flow to LP plant). If the record is to appear clear and auditable for completeness we think the recording should record similar issues consistently and preferably against the same parameter-guideword combination. In this case our preference is to use No Level because this describes the essential condition for the potentially hazardous deviation.

However, a comparison of HAZOP records related to the hazards of Gas Blow-by illustrates just how different these approaches to recording can be. Figure 8 illustrates the style of recording facilitated by an engineering contractor. The record mentions safeguards by engineering tag without explaining their function (these presumably could be hunted down in other documentation if this were available) and implies that the safeguards are considered satisfactory with no recommendations for improvement. To someone who did not attend the HAZOP it is difficult to gauge the extent to which the proposed arrangements were challenged by the HAZOP facilitation. Given the interest of the contractor, it is conceivable that such questioning did not take place. The style of recording is certainly concise but is not comprehensive or complete.

The second example (see Figure 9) is a record of a comparable discussion used by two operators in their HAZOP documentation. These records are concise but the recommendations are unclear. The one in example 4 vague (it does not explain the criteria or the intention

Guideword / Parameter	High	Low	No	Reverse	Part of	As well as	Other than
Flow	Flow - High	Flow - Low	Flow - No	Flow - Reverse			Loss of Containment
Pressure	Pressure - High	Pressure - Low	Vacuum		Partial Pressure		
Temperature	Temperature - High	Temperature - Low			Cryogenic (Sub - Zero)		
Level	Level - High	Level - Low	Level - No				
Composition					Composition (Part of)	Composition (As well as)	Composition (Corrosion)
Phase	Phase More	Phase Less					
Operation					Operation (eg drawing error, wrong material selection)		Operation (eg sampling, maintenance, access)

Figure 6. Parameter-guideword combinations used in Arthur D. Little HAZOP procedure. *Source:* Arthur D. Little

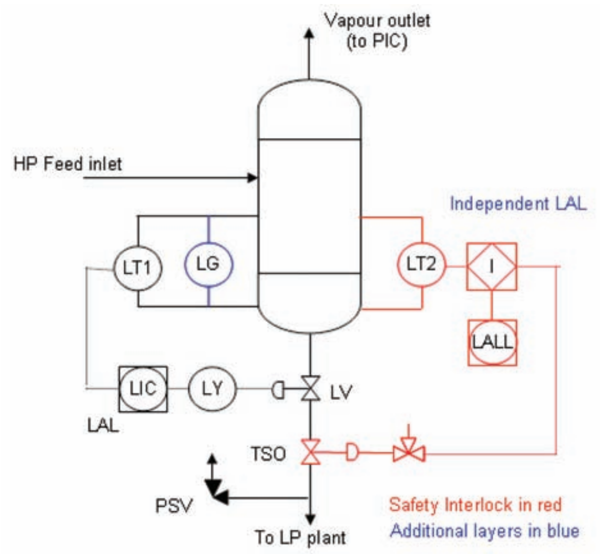

Figure 7. Illustration of Gas Blowby (liquid level in receiver is lost allowing high pressure (HP) gas to pass to low pressure (LP) plant). *Source:* Arthur D. Little

behind the proposed SV). The phrase "Safeguard: Design" scarcely indicates a comprehensive analysis (it refers neither to the aspect of design nor what exactly offers a safeguard). The recommendations in Example 3 are very detailed and imply concern with one bad experience (isolated or plugged impulse line) which the facilitator or a member of the team may have stressed. Two of the recommendations (concerning failure modes and lineout) could be considered part of normal operating practice and as such are normally taken as a "given". Of more concern is that there is no discussion on sizing of protective PSV in the downstream low pressure section. This is a critical safeguard and incorrect sizing has been the cause of at least one serious accident (as noted in Figure 13).

The next example (Figure 10) comes from a HAZOP we facilitated to comply with the Operator's detailed requirements. This example is clear and carefully tagged citing the failures causing the deviation as well as the safeguards. In this case the reader is given clues as to the action of the safeguarding instrumented systems and where alarms are cited, the time available for the operator to take action is discussed to indicate the relative effectiveness of the protection. However the additional wording relating to the consequences (*Potential to rupture downstream equipment*, *causing asset damage and personnel exposure)* is of a formulaic nature. Its inclusion extends the record so it is not as concise as it might be.

In the next figure (Figure 11) an example is given from a HAZOP we facilitated using our own procedures which we feel is comprehensive, clear and concise.

SCOPE OF FACILITATOR'S QUESTIONING

The style of HAZOP recording often reflects the basic intention of the HAZOP facilitator and this in turn derives from the study terms of reference. If the project considerations are uppermost and the desire is minimum disturbance to the project work flow, a record such as that in Figure 8 may result. Such records indicate that the facilitation has not sought to explore the full opportunity for technology transfer from the licensor to the operator. Such matters are of much more concern to the Operator and where this interest is foremost very detailed records can result for example that in Figure 12. At such a level of detail the record is no longer concise.

Often contractors HAZOP procedures are framed to inhibit this level of discussion because it is considered a design activity, the argument being that the HAZOP team should move on after outlining the concern. It can also be that such discussions are re-opening issues which the project feels it has already addressed and closed. The advantage of this level of discussion from the operator's perspective is that it allows extensive transfer of knowledge from the licensor on the details of the design and understanding for the Operator of the considerations underlying the chosen configuration of the plant. In setting the terms of reference for the HAZOP team, the operator (as client) needs to decide to what extent the HAZOP team (and especially the study facilitator) should be constrained to limit the scope of recommendations to provide the "what" rather than the "How". If issues comprising the "how" are

Example 1

No level V 8106 caused by opening 81-LCV-23 with consequence possible gas breakthrough. Safeguard 810-SDI-LCV 23.

Example 2

No level HP Separator caused by opening 81-LCV-4A/B with consequence gas breakthrough to V 8103. Safeguards include 2oo3 system 810-SDI-LCV 4A/B, Low level alarms 81-LAL-4, Possibility to close block valve.

Figure 8. Extracts from contractors HAZOP considering Gas Blowby. *Source:* Study data drawn from project documentation and similar sources

Example 3
Cause No/Less level caused by malfunction of LT-5 or plugged level leg.
Consequence: gas blow-through to Low Pressure separator.
Safeguard: Independent level transmitters for low level alarm and shutdown.
Recommendation: Review the need for separate level taps for the LAL/LSLL transmitters, review failure mode of level transmitters and car seal valves in level legs open.

Example 4
Cause: Level Lower/too low LCV517 fails or LC517 fails.
Consequence: Breakthrough of steam to V-84023 resulting in high pressure in vessel and low pressure steam line.
Safeguard: Design, LAL 519 (If not failed).
Recommendation: Consider installing of SV in low pressure steam system inside plant area.

Figure 9. Extract from consultant HAZOP considering Gas Blowby. *Source:* Study data drawn from project documentation and similar sources

Cause: More aqueous flow caused by 12LCV0011 open.
Consequence: loss of all liquid level inV1201 (DP 76 bar) with possibility for gas blowby to the amine regenerator C1102 (DP 5.2bar). Potential to rupture downstream equipment, causing asset damage and personnel exposure.
Safeguard: Flow through 12LCV0011 or its bypass has been considered in the sizing of the downstream relief valve 11RV19, 12LZ0012 LL acts to close 12UZV0301, LAL from either 12LC0011 or 12LC0013 warns operator to intervene to close 12LC0011 or its bypass (less than 3 minutes from HH to LL).

Figure 10. Example from independently facilitated HAZOP using operator's procedure. *Source:* Confidential data drawn from project documentation and similar sources

Cause No level if open of LV 006 caused by failure of the control loop, error of operation opening the bypass, or misset in manual mode.
Consequences: draining of sour water and naphtha to the sour water stripper and potential for loss of liquid level and gas blowby of H_2, H_2S at normal operating pressure 16.5bar into SWS operating at 1.5bar.
Safeguard: PSV on inlet to sour water stripper set at 3.6bar, Restriction orifice RO002 installed to limit pressure drop, LSLL 007 in separation drum activates ESD 008 which acts to close ESDV 006 on the sour water rundown and ESDV 007 on the HC side.

Figure 11. Example from Arthur D. Little facilitated HAZOP. *Source:* Confidential data drawn from project documentation and similar sources

Cause: Low level in V102 causes LT009 to close LV009 but the seat of the valve is damaged and the valve passes so the flow continues and the level drops further. Consequence: Potential for overpressure of downstream HLPS, V106 and lift of PSV 906 A/B on V106 which protects for overpressure in the downstream vessel.

Safeguard: LAL/L from LI010 and LAL from LT007 warning field operator to close the Y pattern globe valve. At normal level 5 min hold up in V102, 1 min during low alarm and 1 min more in LALL is not considered to be sufficient for the operator to manually close the valve. Special valve type has not been yet selected (e.g. Name of vendor).

Recommendation: Careful vendor selection to provide special valve type and provision of a motor driven valve on inlet to LV009A/B activated either by LT007 or for increased reliability 2oo3 voting from LT007/LT009/LT010. Motorised valve could be on common inlet to LV009A/B. If a motorised valve is selected, provide fire protected cables and ensure emergency power to drive the valve. Evaluate as alternative to motorising the globe valve whether it is preferred to install a pneumatically activated tight shut-off valve. Evaluate addition of a second Y pattern globe valve at the inlet of LV009B to allow this valve to be maintained when the plant remains on line.

Check the sizing of PSV 006 for the condition where V102 is depressuring and operator opens both LV009 A and B to manage high liquid drain rates from the reactor during shut down (downstream PSV is thought to be sized for flow from both LV's at 50% of design pressure).

Figure 12. Example from Arthur D. Little facilitated HAZOP. *Source:* Confidential data drawn from project documentation and similar sources

left just to the engineering contractor, detailed arrangements may not be to the satisfaction of the operator, commissioning staff or even licensor.

IMPLEMENTATION OF HAZOP FINDINGS

It is widely but not universally recognized that completing a HAZOP but failing to act on its recommendations puts the operator in a vulnerable situation. Particular sensitivity arises in jurisdictions where the HAZOP report is open to legal discovery in any proceedings following an accident at the site. Most contractors have well established procedures for extracting HAZOP recommendations into project documentation which allocates the actions and traces resolution to close-out. For operators, however, there are other ways to add value to a HAZOP study which go beyond the contractor's close-out report. We mention briefly two ways to add benefit from the operators' perspective.

MAJOR HAZARDS WORKSHOPS

In some cases operators decide to undertake a HAZOP on an existing plant as part of a programme to improve their Process Safety Management performance. Where the operator manages several refineries it can often be that the plant chosen for HAZOP study has comparable units on other refineries. After completion of HAZOP on one representative type of unit, we have prepared a workshop for the operators of these other units at which we presented our HAZOP findings. The purpose of the workshop is to review the major hazards found in the HAZOP study and to evaluate the safeguards available on the various plants across the group. The findings can be summarised in tables such as that shown in Figure 13 which allows the units to be compared to check the conformity of approach to the management of the main hazards found in the process type. The data in Figure 13 for 8 units carrying out comparable functions but at different pressures illustrates four levels of protection against gas blowby. All units included a Basic Process Control System (BPCS) managing the level. The level of protection rises as the normal operating pressure rises and the highest levels of protection are found in the unit operating at the highest pressure.

The review also examined the recycle gas treatment systems associated with the above units with the findings shown in Figure 14. It is apparent that the level of protection applied to the reaction section has not consistently been applied to the recycle gas treatment equipment, even

Gas blow by Protection	Refinery 1	Refinery 2	Refinery 3		Refinery 4	Refinery 5		
Pressure of HP Operation	38 bar	40 bar	54 bar	60 bar	67 bar	64 bar	74 bar	108 Bar
BPCS acting on LCV	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Independent Alarm	FI/FAH							
Trip acting to close LCV		LSLL on receiver	PAHH on LP separator					
LSLL acting to close EIV					Yes	Yes	Yes	
2oo3 voting LSLL acting to close EIV				Yes (closes EIV and LCV)				Yes
PSV sized full-open valve located on downstream LP section	PSV but sizing not known	PSV but sizing not known	PSV but sizing not known	PSV but sizing not known	PSV but sizing not known	?	?	Yes
Relative protection level	Level 1	Level 2		Level 3				Level 4

Figure 13. Example from major hazards workshop for protection against Gas Blow-by (Reaction section). *Source:* Confidential

though the pressure differentials and the potential for gas blow-by are comparable.

We suggest that these workshop deliverables serve to pinpoint areas requiring improvement in Process Safety Management. The information is provided across all the plants in a group indicating to management the relative importance of the findings for the business as a whole. However it is grounded on HAZOP study actually carried out in one of the group refineries so it is not the arbitrary imposition of some "international norm" but derives specifically from inconsistencies in the safeguards for hazards found in group plants currently in production.

OPERATIONS SAFETY INSTRUCTIONS

The HAZOP worksheet and the tabulations of recommendations which result contain a lot of information which is relevant to plant operations but in a form which is not adapted to operations requirements. For one operator for whom we had carried out a number of HAZOP studies on new build projects, we developed an "Operations Safety Instruction" (or OSI) which sets out the engineering and administrative safeguards proposed for the safe management of the plant. The OSI is intended to be a "living" document central to activities throughout the life cycle of the plant. The OSI is written by extracting from various documents available during the design, engineering and procurement phase of a project as well as the HAZOP worksheet.

- The basis of design requirements provided to the plant licensor/engineering contractor
- Documentation such as Process Description and Control Philosophy developed during the engineering phase
- The HAZOP worksheet which records safeguards proposed to control deviations from design intent
- Inspection and Maintenance instructions which ensure the plant Engineering Controls are maintained in working order
- Audit protocols used to regularly verify that the Administrative Controls are properly implemented

The HAZOP study forms an important opportunity to implement the OIS provided the study is conducted so as to challenge the design to see if there is scope for additional safeguards preventing the loss of control and containment. Other topics include scope for less piping, fewer valves, flanges, instruments and unneeded alarms and appropriate sparing of main equipment and necessary maintenance facilities[3]. We consider that guillotining discussion on these areas of concern looses value for the operator's staff. If handled clumsily, the banning of such discussion may unsettle the HAZOP team with disputes about study procedure and prove counter-productive in expediting the HAZOP study.

A start on the development of the OIS can be made if a HAZOP or Major Process Hazards review is carried out at an early stage in the design. To be effective for this objective the HAZOP needs to incorporate a broad consideration of the human, environmental, business and social impacts when processes fail to operate as intended. This may involve a challenge to plant designers and licensors to explain the trade-offs in their offerings allowing better understanding by the owner of scope for more economical or reliable operations.

Gas blow by Protection	Refinery 1	Refinery 2	Refinery 3		Refinery 4	Refinery 5		
Pressure of HP Operation	36 bar	40 bar	50 bar	50 bar	67 bar	55 bar	74 bar	100 Bar
BPCS acting on LCV	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Independent Alarm			LI/LAL	LI/LAL				
Trip acting to close LCV								
LSLL acting to close EIV					Yes			
2oo3 voting LSLL acting to close EIV								
Relative protection level	Level 1		Level 2		Level 3	Level 1		

Figure 14. Example from major hazards workshop for protection against Gas Blow-by (recycle gas treatment)

The Operations Safety Instruction approach serves two purposes:

a) It explains in a practical form to Operators the specific process safety management safeguards thought appropriate by management for each plant
b) It provides a basis for subsequent auditing of the facility to provide assurance to management that these requirements for safe operation are being implemented as intended

Once a firm foundation for Process Safety Management has been established through the roll-out of Operations Safety Instructions, it becomes possible to undertake Independent Audits to provide assurance that management intensions for ensuring safe operation are being appropriately implemented.

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