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OVERVIEW: Inspectors from the Health and Safety Executive were concerned to find that major hazard organisations were basing their manning levels on 'steady state' operations. HSE wanted to ensure that these organisations could demonstrate that they had in place the resources - staff, equipment and organisational arrangements - necessary to detect, diagnose and deal with any hazardous situation arising at their sites. HSE commissioned research to produce a safe staffing assessment method. This Safety information bulletin describes the method and a practical example of its application to a major hazards chemical site.

assessing staffing requirements for hazardous situations

Associated Octel recognised that proposed major organisational changes to the staffing of their chlorine plant could jeopardise safety if not adequately assessed. The company applied the approach developed for HSE to flush out areas of concern and develop pragmatic solutions. The approach enhanced a team culture and allowed operators to contribute to the development of their working environment. It also allowed management to determine what could be managed by changes to operational practices, or improved process control systems, and also to identify what changes were a change too far.

Staffing assessment method

1. Identify typical hazardous scenarios:
 - Shift team members, management and technical advisors list a number of hazardous scenarios. These should cover 'major' events (those with offsite consequences), 'small' events – which could escalate into a major event, and 'minor' events (e.g. that reduce staff ability to react to a major event).
2. Assess the 'physical' arrangements supporting operator response to the hazardous scenarios:
 - Work through eight physical assessment 'trees'. These determine whether alarms, communications systems, time, information and assistance available are adequate.

Figure 1 shows assessment tree 7 concerning communications. The assessment team will note where a 'fail' node is reached.

3. Assess the personal and organisational factors affecting successful operator response:
 - Use 'ladders' to assess. There are seven ladders to determine whether operators are mentally equipped to detect, diagnose and respond to an incident in time. Four additional ladders assess organisational factors that influence task performance: management of procedures, management of change, continuous improvement in safety and management of safety.
 - Assessors consider a number of statements and decide which best describes the situation in their company or on their particular site. The statements are on a 'ladder' from poor practice at the bottom up to best practice at the top. If the assessment places the company at level 'B', then there is room to improve up to level 'A' and the assessors record the reasons for the rating in order to indicate the specific changes required and how they might be achieved.

NOTE The method focuses on the staffing requirements for preventing and responding to hazardous incidents. It is not designed to calculate a minimum or optimum number of staff to control day-to-day processes, but to show where staffing arrangements may not be sufficient to detect, diagnose and recover from typical hazardous situations. A 'fail' rating does not always mean increasing staffing; other options are to reassign tasks, modify procedures or increase automation.

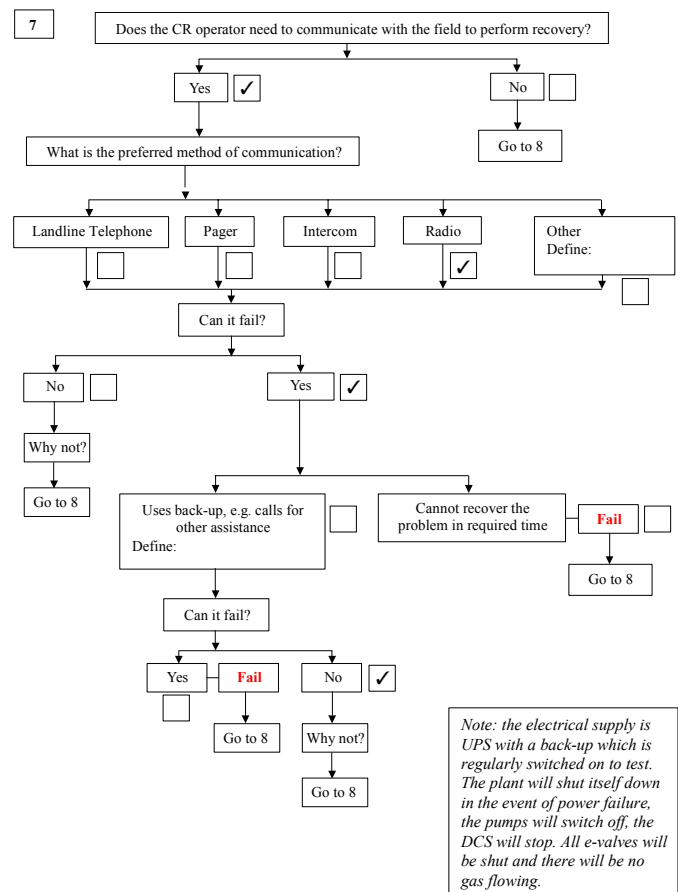


Figure 1 - Assessment tree 7 – Communications

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Physical assessment and ladder assessment summaries and actions

An extract from physical assessment summary table is given in Table 1. Although the company determined a 'pass' rating on this (and other elements), the assessment team identified useful improvement actions.

Table 1: Extract from physical assessment summary table

Scenario No.	Scenario description	Pass	Fail	Physical assessment failed on	Actions required
4	Small toxic gas leak with no obvious control screen indication (relies on third party detection)	✓		N/A	Additional detection on night shift as there is only the shift team to detect a leak. During the day shift there are numerous personnel moving around the plant who could detect a leak. Assess the maximum time it would take for the unit patrol operator to detect a leak on their unit and decide whether it is acceptable. If not, consider whether additional cameras would help.

The example assessment ladder in Figure 3 shows the type of statements that the assessment team should consider. The team would justify their rating in the right hand column (blank here) and propose actions to move towards best practice.

Ladder assessment			
Grade	Description	Explanation of progression	Rationale supporting assessment
A	Process/procedure/staffing changes are assessed for the required changes to operator training and development programmes. Training and assessment is provided and the success of the change is reviewed after implementation.	The training and development system is dynamic and integrated into the management of change process.	
B	All operators receive simulator or desktop exercise training and assessment on major hazard scenarios on a regular basis as part of a structured training and development programme.	Operators get a regular opportunity to practise major hazard scenarios through physical walk throughs or simulators or by desk-top talk throughs.	
C	There is a minimum requirement for a 'covering' operator based on time per month spent as a CR operator to ensure sufficient familiarity. Their training and development programmes incorporate this requirement.	It has been recognised that anyone covering the control room must be competent and their skills kept up to date.	
D	Each operator has a training and development plan to progress through structured, assessed skill steps combining work experience and paper based learning and training sessions. Training needs are identified and reviewed regularly and actions taken to fulfil needs.	The training and development needs are identified, provided and reviewed on an individual basis allowing operators to improve and extend their skills and understanding. It provides operators with a motivation to improve and continue to develop.	
W	All operators receive refresher training and assessment on major hazard scenario procedures on a regular, formal basis.	The need for formalised regular refresher training for major hazard scenarios has been recognised as essential when they are such infrequent events with severe consequences.	
X	New operators receive full, formal induction training followed by assessment on the process during normal operation and major hazard scenarios	Full training and assessment for new operators, it is formalised and covers normal operation plus major hazard scenarios.	
Y	There is an initial run through of major hazard scenario procedures by peers.	Only an informal briefing on major hazard procedures is provided to new operators.	
Z	There is no evidence of a structured training and development programme for operators. Initial training is informally by peers.	Poor practice, staffing arrangements do not fulfil any of the rungs above.	

Figure 3 - Assessment ladder 1 – Training and development (knowledge and skills)

The extract from a physical assessment summary in Figure 2 shows 'fail' ratings (as red boxes) against the eight physical 'tree' factors for current staffing arrangements and those after the reorganisation at the chlorine plant.

Physical Assessments - Summary		Current Staffing								Future Staffing							
No	Scenario Description	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
1	Guillotine failure of chlorine main in Cell Hall																
2	Anolyte Line Failure																
3	HCl Offloading - Line failure																
4	N2 Purge failure on Cell Hall shutdown																
5	SBT Regen Cycle malfunction																
6	Cell on Fire																
7	Hypo Plant trip during Cell hall start-up																
8	High H2 reading at LC																
9	Cl2 Leak during tanker loading - Loading p/w																
10	Cl2 Leak during tanker loading - ring main																
11	Super tank fails to trip in - Cl2 stack release																
12	Pre-absorber pump fails (only 1 op under CCR)																
13	Caustic Loading arm 'pops' out of tanker																
14	Brine slurry pump failure - shaft shears																
15	PCV18 closes when it should not																

Figure 2 - Extract from physical assessment summary showing current and future staffing

An example of a ladder rating summary is shown in Figure 4. The dotted line on any ladder indicates the minimal acceptable level. This is shown in the summary as a vertical red line with 'fail' ratings shown as red boxes.

Ladder Assessments - Summary		Future Staffing																	
No	Element	A	B	C	D	E	F	G	V	W	X	Y	Z						
1	Training & Development																		
2	Situational Awareness																		
3	Teamworking																		
4	Willingness to Act																		
5	Continuous Improvement of Safety																		
6	Management of Safety																		
7	Management of Operating Procedures																		
8	Management of Change																		
9	Roles & Responsibilities																		
10	Alertness & Fatigue - Work Pattern																		
11	Alertness & Fatigue - Health																		

Figure 4 - Ladder assessment rating summary showing future staffing

References and further information

HSE *Assessing the safety of staffing arrangements in the chemical and allied industries* CRR 348/2001, HSE Books (2001), ISBN 0 7176 2044 1. See HSE website:

http://www.hse.gov.uk/research/crr_hm/index.htm.

Shields, P. *Safe staffing arrangements – a case study*, IP Seminar *Human factors – Transferring expertise to you!*, London, 10–11 December 2002 (unpublished).

IP *Safe staffing arrangements – user guide for CRR348/2001 methodology: Practical application of Entec/HSE process operations staffing assessment methodology and its extension to automated plant and/or equipment*, Energy Institute (2004), ISBN 0 85293 411 4. See Staffing arrangements toolbox on Energy Institute website:

<http://www.energyinst.org.uk/humanfactors/staffing>.