Assessing the safety of process operation staffing arrangements

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Summary of method's life

- UK HSE research (CRR 348/2001), case studies plus trialed with HSE Inspectors
- Practical application at several sites; refineries, chemical manufacturers, waste incineration site
- Interest in method from Switzerland, France, Sweden, USA, Canada, Australia
- Using framework for wider problems with additional tools
- Elements useful for thinking about Human Factors requirements for COMAH (Control Of Major Accident Hazards:UK response to Seveso II Directive)

Introduction

- Study on behalf of Hazardous Installations Directorate (HID) of the UK Health & Safety Executive
- Concerns over reductions in staffing levels
  - *delayering, multiskilling, teamworking*
  - *control of abnormal & emergency conditions*
  - *negative effect on staff performance*

HSE requirements for the method

- Method should help to identify potential areas of unacceptable risk in process operations staffing arrangements
- Major concern was staffing arrangements on major hazard sites
- Initially the method concentrated on the staffing of central process control points (which often sit within a control room)
- Has developed to assess the process operation staffing arrangements
- Operators must be part of the assessment team to ensure the assessment output reflects reality and encourage workforce involvement

HSE concerns

- The ‘physical’ ability to be able to detect, diagnose and recover from scenarios in time
- Willingness to initiate major hazard scenario recovery actions
- Training, development, roles & responsibilities
- Teamworking and the role of outside support staff
- Management of organisational change
- Management of safety

Assessment methodology

- Method does not attempt to calculate a minimum or optimum number of staff
- There may be technological options to improve staffing arrangements as an alternative to an increase in operator numbers
- It assesses staffing numbers plus how the arrangements are managed
- Draws on socio-technical systems thinking, that technician performance is influenced by deeper organisational and management factors

Physical assessment

- Aims to identify potential areas of unacceptable risk due to the way identified scenarios are physically detected, diagnosed and recovered from
- Examples of 3 types of scenario are assessed:
  - *Worst case scenarios requiring implementation of the off-site emergency plan*
  - *Incidents which could escalate without intervention to contain the problem on site*
  - *Lesser incidents requiring action to prevent the process becoming unsafe*
- Each scenario must be defined in sufficient detail

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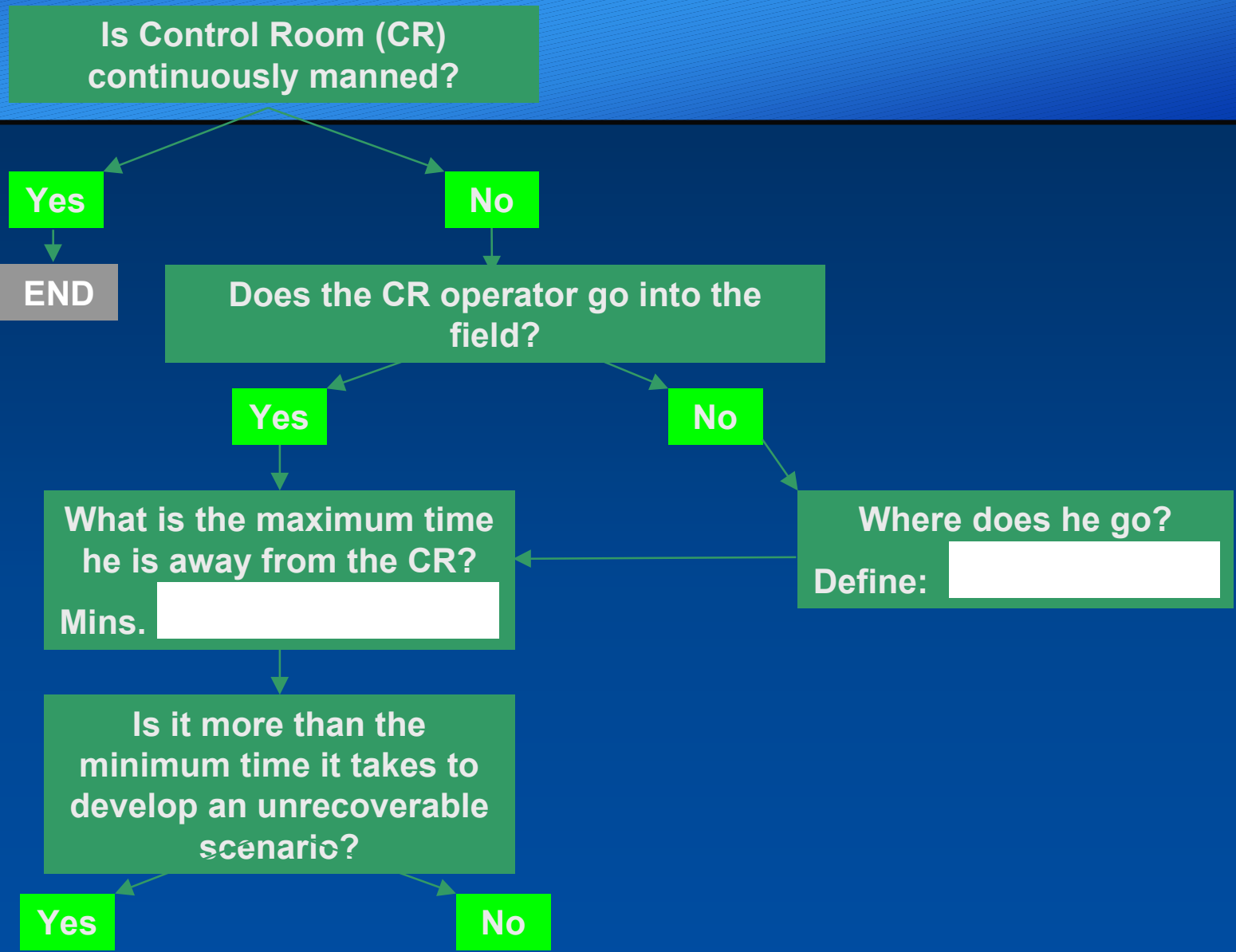
- Tests arrangements for each scenario against six principles of safe control room operation
  e.g. process should be continuously supervised by skilled operator(s)
- The physical assessment does not attempt to calculate the number of people required to cope with a particular scenario
- Instead it aims to hunt out potential problems associated with the staffing arrangements by questioning the reliability of detection, diagnosis and recovery from hazardous scenarios in time
- Justification of controls in place to ensure reliability of equipment and people is required where a principle of safe operation is found to be infringed

Physical assessment Tree 1



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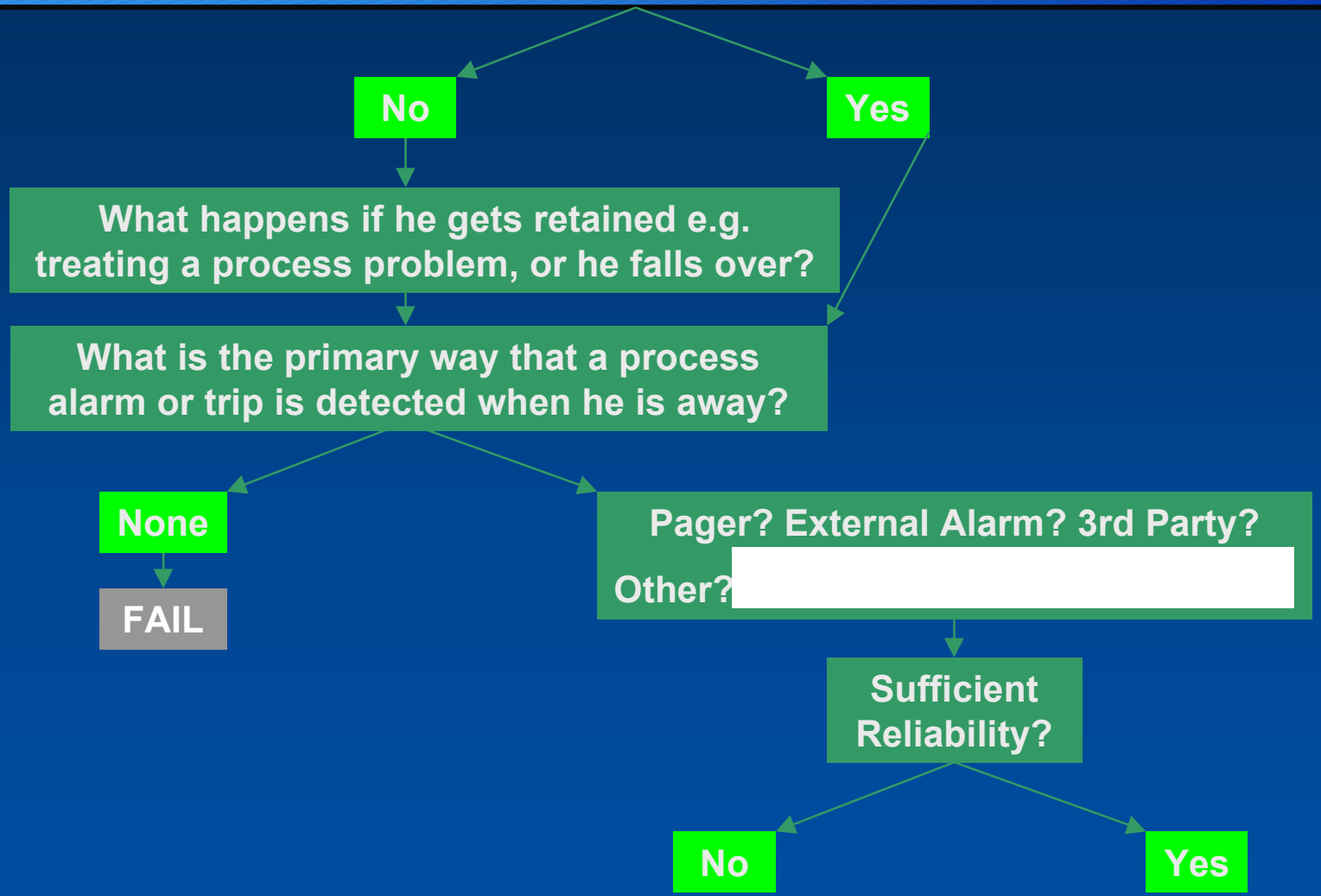

No
Yes
What happens if he gets retained e.g. treating a process problem, or he falls over?
What is the primary way that a process alarm or trip is detected when he is away?
None
FAIL
Pager? External Alarm? 3rd Party?
Other?
Sufficient Reliability?
No
Yes

.....Continued


No
Yes
Is there a back-up?
Sufficient and robust justification?
Yes
Define:
No
FAIL
Yes
END
No
FAIL
Sufficient Reliability?
No
FAIL
Yes
Sufficient and robust justification?
Yes
END
No
FAIL

Ladder assessment elements

- Willingness, training & development, roles & responsibilities, teamworking, management of organisational change & management of safety
- PLUS……
- Situational awareness
- Alertness & fatigue (work pattern)
- Alertness & fatigue (health)
- Management of operating procedures
- Continuous improvement of safety
- Each ladder is an anchored rating scale ranging from poor practice at the bottom to best practice at the top

Situational awareness ladder

GRADE	ANCHOR
A	There is a high level of continuity in the Operator(s) tasks during critical process events i.e. Operators are not required to perform tasks that significantly disrupt their concentration on the process, and they are able to delay/bring forward activities in order to minimise distractions.
B	During critical process activities that demand the Operator's attention, they are not disturbed unnecessarily by other activities such as mustering, site alarms, telephone/ radio communications, permit raising, issuing of interlock keys, visitors etc.
C	In upset and emergency conditions all relevant Operators and Supervisors can gauge accurately and reliably the condition and behaviour of the plant within the available time, without disturbing each other or blocking each other's access to information.
D	The presentation of information makes it straightforward for Operators to gauge accurately and reliably within the available time the condition and behaviour of the plant in normal and upset/emergency conditions, without reliance on support.
X	It is possible for operators to keep track of the process during upset/emergency conditions if they work hard to gather all relevant information from control room displays/log books. There can be times when they rely on other Operators/ Field Operators relaying information to them
Y	Information about the process and plant condition is adequate for Operators to be confident they can monitor 'smooth' running.
Z	Operators find it difficult to keep track of the process even in smooth conditions. This may be due to insufficient information, unreliability of sensors or displays, or they can't attend to the process because of other tasks they are required to perform, or distractions.

Example application

- Utilities supplying several petrochemical plants
- Several changes already implemented within previous 5 years:
  - *SMT implemented within last 2 yrs with removal of Supervisory role and changes to all operators' roles*
  - *Creation of Utilities Services in preparation for potential divestment, then,*
  - *Dismantlement of above Utilities Services*
  - *Voluntary Severance Initiative – significant numbers of highly experienced operators leaving within a relatively short timescale*

Additionally…

- Increased integration across site and introduction of common site policies and standards
- New Distributed Control System (DCS) within the past 2 years
- Move from 2 local control rooms (CR) (Electrical and Thermal) to one remote CR in the main Utilities building in the past 12 months
- New electronic Risk Assessed Permit system (RAP) in the past 12 months (permits prepared by Field Operators and approved by CRO)

Proposed changes assessed

- Plant - addition of CHP plant and new boiler
- The CHP to be operated by a 3rd party within same CR
- Control Room Layout - reallocation of DCS screens and introduction of the control of the Water Treatment Plant (WTP)
- Introduction of Utilities Shift Manager
- Control Room Operation - reduction from 3 Control Room Operators (CROs) to 2 CROs.
- Field Operation - reallocation of field duties for existing WTP operators

Study planning

- Physical assessment scenario selection
- Assessing current arrangements-baseline
- Assessing future arrangements
  - *Defining future arrangements*
  - *Which elements to reassess?*
- Team composition, CR operator, field operator, line manager, appropriate specialist(s) for each element
- Session planning; 2-3 hours long, 5-6 sessions per week
- Options to improve flexibility
  - *E.g. Session venue, start & finish times*

Sessions-Physical assessment

- Talk through scenario for 20-30 minutes for current arrangements
  - *who does what where, priority & sequence of tasks, how long it could take for detection, diagnosis & recovery & criticality of timing, historical incidents*
- Assess for current arrangements using decision trees
- Summarise future arrangements and talk through scenario
- Assess for future arrangements using decision trees
- Trees test the staffing arrangements for robustness and reliability of detection, diagnosis and recovery

Sessions-Ladder assessment

- Current arrangements
  - *Talk through preparation questions for ladder element being assessed exploring issues*
  - *Feed information into ladder working up 'rungs' until identify agreed position*
  - *Summarise rationale alongside each rung*
- Review ladder position for future arrangements
  - *Extent of further assessment depends on impact changes will have on element being assessed*
- Ladders position staffing arrangements between poor practice & best practice
- There is a nominal acceptable level on each ladder

Supporting evidence

- For both physical and ladder assessments supporting documents are required
- Consistent with demonstration principle
- May highlight problems with procedures when examined or…
- That there is a very good paper system but it is not being effectively implemented at operational level
- Supporting documents are identified during physical and ladder assessment sessions

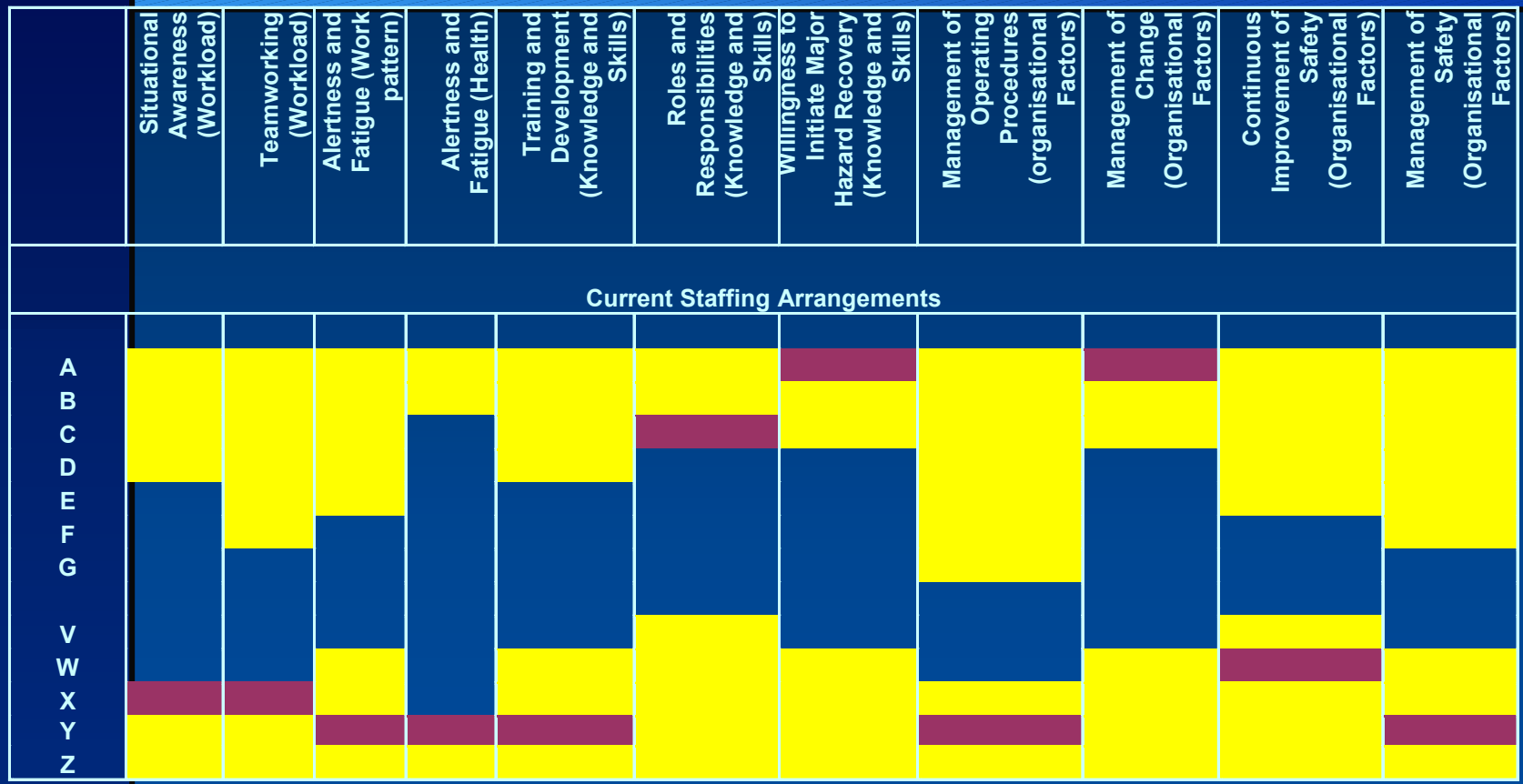
Findings-Current Physical

- Communication-between CR & field & within Utilities building
- Alarm management-scenarios leading to alarm floods
- Equipment response to demand-control scheme plus field equipment
- Presentation of information-overview, real time trends, PI on steam headers, consistent logic on similar plant items
- Procedure changes-suggested through desktop scenario talk through's
- Interface with CHP-emergency procedures, shared & duplicated alarms

Findings-Current Physical

- Evacuation procedure-need for local evacuation plus communicating alarm in noisy areas
- Fire-improved detection in field & diagnosis in CR
- Overrides-eliminate use for operational reasons
- Field-access, automated isolation valves, gas detection & wind indication in CR
- Testing-frequency & nature of performance test
- Critical tasks-minimise time critical tasks which impact on recovery

Findings-Current Ladders



Key

Assessment levels applicable to the particular Ladder

Assessment level achieved for that particular Ladder

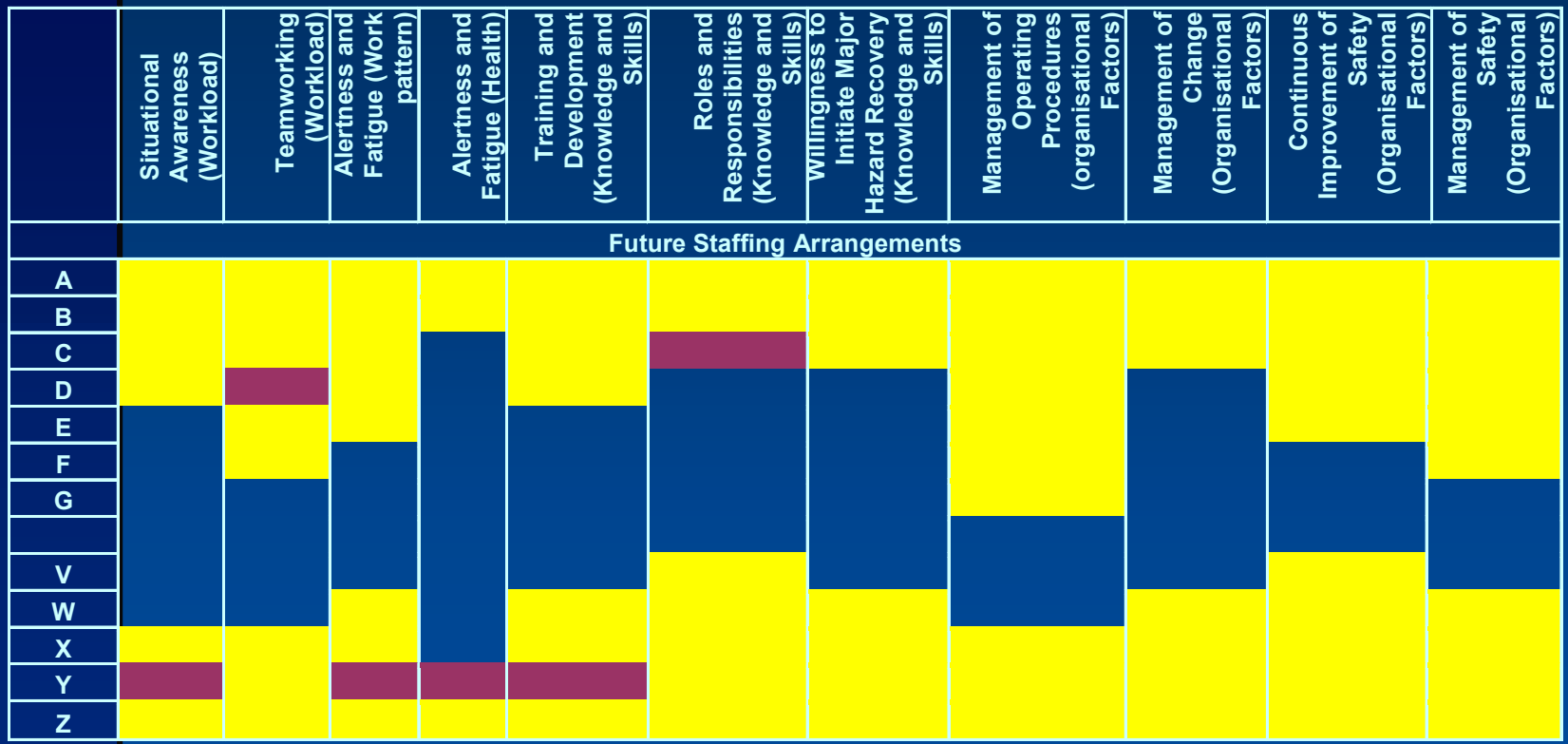
Findings-Future Physical

- All issues summarised for current arrangements
- Issues more critical for new organisation:
  - *Alarm management*
  - *Presentation of information*
  - *Minimisation of time critical tasks within CR which impact on recovery*
  - *Demonstration of control scheme & field equipment's ability to respond*

Findings-Future Physical

- CR & field operators understanding how control scheme responds to upsets & what their roles are:
  - *What & when to monitor, when & how to intervene*
  - *Would be aided by an overview with real time trend monitoring*
- Co-ordination of the multiple ongoing projects within field & DCS & communication of progress to shift teams

Findings- Future Ladders



Key

Assessment levels applicable to the particular Ladder

Assessment level achieved for that particular Ladder

Recommendations

Actions were prioritised as:

- 1 Do now (all physical assessment actions plus ladder assessment actions to achieve acceptable position)
- 2 Do prior to implementation of proposed changes
- 3 Needed to progress towards best practice position on ladders

Recommendations

And linked to proposed changes within the following groups:

- **Current 1 - groups of actions required which do not relate to a proposed change**
- **Current 2 - groups of actions related to a proposed change and required whether the change is introduced or not. These actions become more critical in the future arrangements**
- **Future - groups of actions related to a proposed change and linked to one or more of the following changes:**
  - Plant - new boiler
  - Plant - addition of CHP (the CHP will be operated by a 3rd party)
  - Control Room Layout - reallocation of DCS screens and introduction of the control of the Water Treatment Plant (WTP)
  - Control Room Operation - reduction from 3 Control Room Operators (CROs) to 2 CROs
  - Field Operation - reallocation of field duties for existing WTP operators

Feedback from sites

- ‘Has changed the way I think about introducing changes in staffing arrangements’.
- ‘The methodology has led me to think about issues I would otherwise not have considered relevant.’
- 'The methodology demonstrates the benefits which can be derived from using desk top exercises both in terms of developing understanding and highlighting areas of concern and weakness.'
- ‘We have now identified several action items from the assessment process and we think the process is very useful, as much in changing the way we look at human-factors related issues, as in other ways.’

Tool very flexible

- Assurance for existing and new staffing arrangements
- Defining changes, effects of combinations of changes, timing effects-tool aids decision making around these
- Can apply framework to wide range of situations and with modification, beyond the process industries e.g. rail