THE INSTITUTE OF PETROLEUM

HUMAN factors no2

briefing notes

For background information on this series of publications, please see Briefing Note 1 - Introduction

ALARM: *a signal to an operator (a sound - usually with a flashing light and a message) indicating a problem requiring the operator's attention.*

alarm handling

Case studies

1. On 25th September 1998, explosions at an Australian gas plant killed two people, injured eight others and cut the gas supply to Melbourne for two weeks. Investigations showed, among other things, that operators routinely ignored alarms in the plant control room. At a rate of 300-400 a day, and 8 500 during one incident (12 alarms every minute), the operators had little choice.

Source: Lessons from Longford, Andrew Hopkins CCH Australia Ltd. Sydney, (2000) ISBN 1 86468 422 4

2. In 1994 lightning caused a plant upset leading to fires and explosions at an oil refinery. Twenty-six people were injured. Damage amounted to £48 million. The company was prosecuted and fined £200 000.
   One reason plant operators could not control the event was because there were too many alarms to deal with. (275 in the 11 minutes before the accident). Also, the alarms were poorly presented.

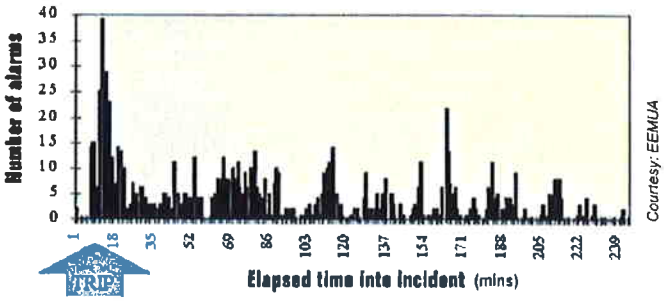
Source: www.hse.gov.uk/hid/land/comah/level3/a58dee.htm

3. In a petrochemical plant, 85% of all alarm activity came from nine alarms. In seven days, one alarm was activated 921 times. The average alarm rate was one a minute. There were 30 'standing' (permanently on) alarms. By reviewing the problem and making changes, the company removed 25% of alarms and changed another 15% of them. Average alarm rate was reduced by 26% and standing alarms to eight.

Source: reference 3

Why alarm handling?

Poorly-designed alarm systems may hinder rather than help the operator and may result in failure to identify a need to act, or failure to select an effective course of action, especially in emergency conditions. But systems can be redesigned by physically changing them or by training the operator to use the alarms. Companies should consider changes to improve responses to alarms and therefore improve safety.



Courtesy: EEMUA

Source: reference 2

Does your company have problems with alarms?

1. Are some alarms too quiet compared to background noise?
2. Are some alarms so loud that they startle operators and make it hard for them to think or to hear what anyone is saying?
3. Are too many alarms activated during a typical shift, even if there isn't a major problem?
4. When there is a problem, do hundreds of alarms activate and does one alarm seem to set off others until there are just too many to deal with?
5. Are a lot of them not really alarms; they're always there or come up because of maintenance or are some definitely false alarms?
6. Although alarms can be reset, do they just keep coming back?
7. Do alarm lists seem to be arranged in no obvious logical order or are they mixed with other information?
8. Do alarm messages go off computer screens before anyone has a chance to read them?
9. Is it hard for operators to decide which alarm to deal with first when a lot come in at once?
10. Is it often not clear what caused an alarm?
11. Do operators not always know what to do about a particular alarm?
12. Is the wording of some important alarm messages unclear?

If the answer to any of the above is 'yes', then you need to take action!

What can I do about it?

You can't control what you can't measure. Also, it's difficult to get management's attention without some data to illustrate the problem. So, the first thing to do is to 'measure' the problem:

i. Ask control room or workstation operators, either face to face, or by giving out a question sheet, to find out what experiences they have had with alarms in your company. You could base some questions on points 1 to 12 above, or there is a sample questionnaire in reference 2 Appendix 12.

ii. Find out how many alarms: go off in a typical shift; went off after the last fault on the plant; are 'standing' alarms (always on or repeatedly come up)
You might need printouts from alarm logs to get information for ii). The reference documents listed on the next page will give an idea of what is acceptable or not.

iii. Draw the information to the attention of company management. Advise them of the benefits of improving alarm systems in reduced plant upsets and down-time, better motivated personnel, etc.

A company policy/strategy/standard on alarm management should be adopted. Guidance in reference 2 can help.

What should my company do about it?

It is reasonable to expect that anyone who needs to take action in response to an alarm will:

- Be able to see and hear the alarm under all conditions
- Quickly understand what caused the alarm and how serious it is
- Know from training or instructions what to do next and in what order
- Have enough time to take action
- Realise when the situation has returned to normal.

But the operator should not:

- Be 'swamped' by lots of irrelevant alarms that come up quickly
- Have certain alarms activated permanently or coming up very frequently
- Be startled by the alarm or be unable to hear/concentrate because of it.

Your company should make sure that alarms are designed to modern guidelines such as that published by EEMUA (reference 2).

Courtesy: Colin Curwood

Api Energia gasification plant

Your findings might show that your alarm systems meet the above broad 'standard'. If not, then your company will need to consider the information provided and make changes to improve alarm handling. It is worth noting that operators facing as few as 10 alarms a minute in an emergency will quickly abandon the alarm list to reduce stress. They will then find a way to solve the problem without using the alarms. If alarms are ignored in this way, they might as well not be there and could result in incorrect actions that could compromise the safety of the plant. It may also be prudent to assess staffing levels to ensure that alarms can be managed during plant disturbances (see briefing note No.3, *Organisational change*).

As case study 3 showed, methods are available for improvement. Volume and brightness settings can be changed. Software systems can be re-designed, for example, to filter out those that are not required, show the correct priority for each alarm, etc. Even systems that are not based on VDUs/computers can be changed, for example, adjusting the sensitivity of some of the sensors, disabling alarms connected to out of service plant, ensuring that each alarm is justified, and so on.

Some changes will require long-term effort by the company to make a significant difference, with an initial step of establishing exactly what the problems are. However, some 'quick wins' - ways of making short-term enhancements - are possible as outlined above. Again, the EEMUA Guide (reference 2) can provide information on other possible ways of improving alarm handling.

The benefits should be obvious - improving alarm systems makes it easier for operators to interpret alarms and take correct and timely action and both reduce their stress and the likelihood of error. This allows better control of processes and helps avoid accidents. An editorial in Hydrocarbon Processing supports this:

> "3 - 15% in lost capacity can be attributed to lack of control during abnormal operating modes (i.e. plant incidents and transition events). A typical plant can save approximately $3,500,000 per year by providing good control during plant incidents and transition events such as startups, feed changes, etc."
> *Source*: Hydrocarbon processing, March 2002, 81 (3)

Useful reference information

1. *Better alarm handling*, Chemical Information Sheet 6 (2000) HSE Books (HSE Books website www.hsebooks.co.uk)
2. *Alarm systems, a guide to design, management and procurement*, Engineering Equipment & Materials Users Association publication No 191 (1999) ISBN 0 8593 1076 0.
3. *The management of alarm systems* Bransby, M. L. and Jenkinson, J., HSE Contract Research Report 166 HSE Books (1998) ISBN 0 7176 1515 4.
4. *The explosion and fires at the Texaco Refinery, Milford Haven, 24 July 1994: A report of the investigation by the Health and Safety Executive into the explosion and fires on the Pembroke Cracking Company Plant at the Texaco Refinery, Milford Haven on 24 July 1994*, HSE Books (1997) ISBN 0 7176 1413 1.

THE INSTITUTE OF PETROLEUM

HUMAN factors no4

briefing notes

For background information on this series of publications, please see Briefing Note 1 - Introduction

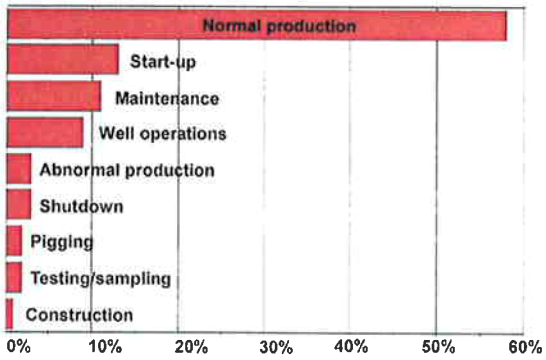
MAINTENANCE ERROR: *failing to perform a task or performing it incorrectly during routine testing/checking, servicing or breakdown repair. Result - the equipment malfunctions or the error causes damage to plant or personnel.*

maintenance error

Case studies

1. "Gas was released from a flange on a vent line which was overpressured when a compressor relief valve vented. A block valve in the vent line was found to be closed. **The valve had been left shut by mistake following maintenance two weeks previously.**"
   "….inspection/condition monitoring was identified in nearly a third of all incidents, suggesting that **checking and maintaining** the condition of the plant was one of the most important ways of preventing leaks."

2. Maintenance error is a significant contributor to hydrocarbon releases:

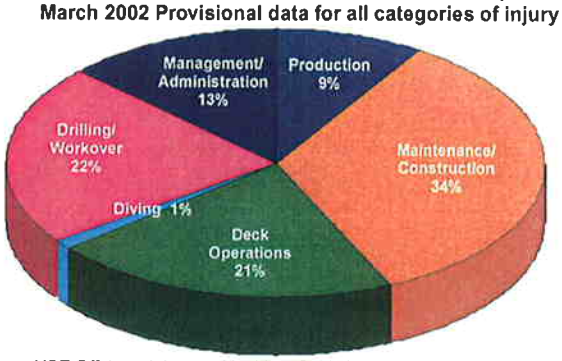


Source of 1 and 2: OSD Hydrocarbon release reduction campaign: Report on the hydrocarbon release incident investigation project 1/4/2000 to 31/3/2001 HSE Offshore Technology Report 2001/055

3. A gas compressor was being re-started after corrective maintenance. The train was slowly being pressurised when a leak was noticed around the recycle pipeline on the scrubber skid. The scrubber had been cooling down from normal operating temperatures. It is suspected that thermal expansion and contraction had loosened bolts on one of the flanges resulting in the release. A new maintenance routine has been created to check the torque settings after significant maintenance work.

Source: Step Change, SADIE record number 237: www.stepchangeinsafety.net

Severity of injury and work process environment, April 2001-March 2002 Provisional data for all categories of injury



Source: HSE Offshore Injury and Incident Statistics 2001/2002 (provisional data) www.hse.gov.uk/hid/osd/hsr1002/

Are you aware of any of the following problems with maintenance in your company?

1. Are lots of items of equipment difficult to maintain - hard to get at or strip down?
2. Do maintenance crews often have problems finding or using the right tools or spares?
3. Is there little or no checking of jobs in progress or when completed to make sure they're carried out properly?
4. Is there no priority rating of jobs - do maintenance crews just do the next one on the list?
5. Have fitters had problems where electricity or pressurised pipes haven't been isolated properly?
6. Are some maintenance procedures out of date or just poorly written so that they don't relate to the equipment in its current state?
7. Are conditions usually less than ideal for doing maintenance tasks - it's hot, noisy or cramped?
8. Is there any evidence that sometimes fitters take shortcuts on a job, especially when pushed for time?
9. Would it be easy to work on the wrong system - things look similar, labelling and P&IDs are poor?
10. Are lots of maintenance jobs badly planned?
11. Could protection of the fitter or anyone near the job be improved (guards, warnings, PPE, isolation methods, etc)?
12. Are contractor procedures and processes rarely monitored to ensure they meet company standards?

If the answer to any of the above is 'yes', then you need to take action.

What can I do about it?

If anyone to your knowledge is experiencing problems with maintenance work, you need to be clear what the problems are and inform management.

i. Ask people, either face to face, or by giving out a question sheet, to find out what experiences they have had with maintenance errors or near misses. You could base some questions on points 1 to 12 above, or the points raised on page 2. Also, reference 1 contains a useful 'workforce questionnaire'.

ii. Find out especially:
   - Which maintenance tasks are the most physically difficult to carry out
   - If systems for reporting problems are working properly
   - If procedures, permits or other safeguards are adequate and are being used.

iii. Draw the information to the attention of company management.