HUMAN FACTORS

BRIEFING NOTE No. 2

Alarm handling

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

Why alarm handling?

Alarm handling (also known as alarm management) refers to the automated treatment of alarms. Poorly-designed alarm systems may hinder 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. However, alarm systems can be redesigned, either by physically changing them, or by training the operator to use them better. Companies should consider changes to improve responses to alarms and therefore improve safety.

Does your company have problems with alarms?

If the answer to any of the following questions is 'Yes', then you should take action!	Yes	No
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 lots of alarms activate - 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 - 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 confusingly mixed in with other information?		
8. Do alarm messages scroll 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 unclear what caused an alarm?		
11. Are operators sometimes unclear about what to do in response to a particular alarm?		
12. Is the wording of some important alarm messages unclear?		
13. Is alarm overload a particular problem during start-up and shutdown (or other normal changes of process)?		
14. Do alarms seem to be there to make operators take action but that action should really have been automated?		

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.
- Know when the situation has returned to normal.

But the operator should not:

- Be over-burdened by lots of irrelevant alarms that come up quickly.
- Have to work at a panel where some of the alarms are displayed permanently or activate very frequently.
- Be startled by the alarm or be unable to hear/concentrate because of it.

The company should make sure that alarms are designed to modern guidelines such as the Engineering, Equipment and Materials Users Association (EEMUA) guide (Reference 1).

CASE STUDY 1

On 25 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.

Alarm recommendations from EEMUA

	EEMUA	Oil & Gas	PetroChem	Power	Other
Average alarms per day	144	1 200	1 500	2 000	900
Average standing alarms	9	50	100	65	35
Peak alarms per 10 mins	10	220	180	350	180
Average alarms per 10 mins	1	6	9	8	5
Distribution % (low/med/high)	80/15/5	25/40/35	25/40/35	25/40/35	25/40/35

(dark shading)	Recommended
(light shading)	Actual

Source: Matrikon

If findings show that the company is not meeting the EEMUA recommendations then it should make changes to improve alarm handling. Operators facing as few as 10 alarms a minute will quickly abandon the alarm list in an emergency to reduce stress - they will find a way to solve the problem without using the alarms. If alarms are ignored they might as well be inactive, and this could result in incorrect responses that could compromise the safety of the plant. Staffing levels should be assessed to ensure that alarms can be managed during plant disturbances (see Briefing note 3 *Organisational change*).

As Case Study 3 shows, methods are available for improvement. Software systems can be re-designed to filter out alarms that are not required or to show the correct priority for each alarm; volume and brightness settings can be changed. Even systems that are not based on visual display units (VDU)/ computers can be amended by adjusting the sensitivity of the sensors, disabling alarms connected to out-of-service plant, ensuring that each alarm is justified etc.

CASE STUDY 2

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 were reduced to eight.

Source: Reference 2.

Some changes will require long-term effort by the company to make a significant difference. However, some 'quick wins' - ways of making short-term enhancements - are possible. Again, the EEMUA guide (Reference 1) can provide information on other possible ways of improving alarm handling.

The benefits should be obvious - improving alarm systems makes it easier for the operator to interpret alarms and take correct and timely action - reducing 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, Vol. 81, No.3)

Measuring performance

The performance indicators in the table below can be used to monitor how effectively alarms are being managed. Leading indicators show that a problem may occur in the future, and lagging indicators show that there is currently a problem. These should be monitored regularly and trended over time to see how performance is improving. See Briefing note 17 *Performance indicators* for more information.

Leading indicators	**Lagging indicators**
Number of alarms that operators fail to acknowledge per shift. Evaluation of alarm follow-up actions (e.g. accepted/disabled) and standing alarm reviews, based on sampling. Compliance with EEMUA guidance on human/machine interfaces (Reference 3) and alarm handling, for example: counts of overall alarm frequency; number of standing alarms, alarms failing to initiate, false alarms etc.	Number of alarms failing to initiate on demand per shift. Number of standing alarms. Number of false alarms.

Courtesy of BP

"The alarm system [...] is frequently one of the least satisfactory features of the control system. The most common defect is that there are too many alarms and that they stay active for too long. As a result, the system tends to become discredited with the operator, who comes to disregard many of the alarm signals and may even disable the devices which signal the alarms."

Source: Lees' *Loss Prevention in the Process Industries*, Volumes 1-3 (3rd Edition) 2005.

CASE STUDY 3

Operators deal daily in a real-time, highly complex, dynamic environment. A good alarm system quickly provides appropriate information to operators - helping them identify its cause and to restore the plant to normal operations.

Research from Honeywell estimates that the inability to diagnose and control abnormal alarms costs manufacturers in the US petrochemical industry $10 billion a year. These losses are caused by accidents, equipment damage, unplanned plant or unit downtime, off-spec product, regulatory fines and intangible costs related to environmental and safety breaches.

Source: http://hpsweb.honeywell.com.

References

1. EEMUA (2007), *Alarm systems, a guide to design, management and procurement*, publication No 191, 2nd edition.
2. Bransby, M L and Jenkinson, J (1998), *The management of alarm systems* (Contract Research Report 166), HSE Books.
3. EEMUA (2010), *Process plant control desks utilising human-computer interfaces*, Publication No 201, 2nd edition.

Further reading

- HSE (2000), *Better alarm handling*, Chemical Information Sheet 6, HSE Books, http://www.hse.gov.uk/pubns/chis6.pdf.
- HSE (1997), *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.
- Stanton, NA (Ed) (1994), *Human factors in alarm design*, Taylor and Francis.

For background information on this resource pack, please see Briefing note 1 *Introduction*.