EIGA Human Safety Factors Information

Prepared by the Safety Advisory Group

Safety Info HF 08/09

Task

Alarm Handling

Alarm systems alert operators to abnormal plant conditions, such as deviation from normal operating limits and to abnormal events, which require timely action or assessment. Alarms are thus key sources of information to the operator in maintaining safety.

Alarm handling (or alarm management) is an issue for any site or process where there is reliance on human response to an alarm to control major accident hazards. This can range from sites with a small number of alarms (e.g. small storage sites) up to sites with a central control room and a fully distributed control system (DCS). The principle is the same, to assure the human response to alarms through:

- good interface and system design,
- monitoring and review,
- competency arrangements,
- procedures.

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. However, systems can be redesigned by physically changing them or by training the operator to use the alarms effectively or in different ways.

Companies should consider changes to improve responses to alarms and therefore improve safety.

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Learning more about alarm handling.

If the answer to any of the questions below is 'yes', then you need to take action

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 many alarms always there? Do they come up because of maintenance or are some false alarms?
6. Although alarms can be reset, do they just keep coming back?
7. Do alarm messages disappear from computer screens before anyone has a chance to read them?
8. Is it hard for operators to decide which alarm to deal with first when a lot come in at once?
9. Is it often not clear what caused an alarm?
10. Do operators not always know what to do about a particular alarm?
11. Is the wording of some important alarm messages unclear?

If the answer to any of the questions below is 'no', then you need to take action

12. Are alarm lists arranged in an obvious logical order or are they mixed with other information?
    - Are different alarm priorities distinguished on screen e.g. by colour/sound?
    - Is there a clear process overview (plant detail mimic) with adequate information including alarm details?
    - Is the alarm list clear? (Best is a page design- like a book, with a font and size that can be read standing back from normal screen sitting position e.g. to allow conferring with supervisor).
    - Can the alarm list be filtered e.g. by priority or plant area?
    - Can alarms be silenced before being studied or accepted? (an essential feature)
    - Is resetting of alarms only possible if they have **cleared** (i.e. have returned to normal) and have been **accepted** by the operator
13. Do you have a strategy or philosophy for alarm system design and handling?
14. Is there a process or a standard for alarm system review and modifications?
15. Does the alarm system recognise the difference in operational states and the different operator needs e.g. normal/upset/emergency & what has and hasn't occurred?
16. Are there competence requirements for of all those involved in design and use of alarm systems.
17. Are safety-critical alarms clearly distinguished and separately displayed (and hard-wired)? (In design the target maximum number for critical alarms is 20)
18. Are the alarms prioritised? Do operators find the prioritisation appropriate?
    (Recommended targets are high priority 5%, medium 15% and low 80%. Recommended target alarm occurrence rates: safety-critical - very infrequently; high priority – less than 5 per shift; medium priority – less than 2 per hour; low priority – less than 10 per hour)
19. Are key performance measures for the system (e.g. alarm rates) recorded and tracked?
20. Is there an adequate alarm log / history? (What information is recorded? How is the information used?)

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What should my company do about it?

What can managers do about it?

Understanding alarms:

Management should ensure 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.

Avoiding operator overload:

Management should ensure that operators are not:

- Overloaded by lots of irrelevant alarms that come up quickly.
    - It is worth noting that people facing as few as 10 alarms a minute in an emergency will quickly abandon the alarm list to reduce stress.
- Experiencing certain alarms activated permanently or coming up very frequently
- Startled by the alarm or be unable to hear/concentrate because of it.

If the operators are overloaded, they will 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

Alarm system design:

Alarm management is primarily a design issue, trying to correct problems or an issue later is much more difficult. Your company should make sure that alarms are designed to modern guidelines such as that published by EEMUA (reference 2). The aim of this guidance is to help engineers develop alarm systems that are more usable and which result in safer and more cost effective operation.

Improving alarm systems makes it easier for operators to interpret alarms and take correct and timely action and reduce both their stress and the likelihood of error. This allows better control of processes and helps avoid accidents.

Alarm system installation and training:

Alarm systems must be properly installed, commissioned and tested to ensure they will work under all required conditions. Employees must be fully trained in the meaning of alarms and actions to be taken. Special consideration should be given to communicating to visitors and ancillary employees the correct actions to be taken in the event of alarms.

Alarm system testing:

Alarms and alarm systems must be tested regularly to ensure that they operate correctly. Frequency of testing should be determined based on criticality of the alarms. E.g. where an atmosphere monitoring system is in place, (for asphyxiation risk, toxicity risk, etc) with visual and audible alarms, a test button should be pushed before entering the room.

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Guidance on solving alarm handling problems

Problems with alarm handling are of two types: problems with the design of the alarm system, and problems with the procedures for handling alarms. The table below is based on modern alarm guidance. It will help you to identify some of the main alarm handling problems you may have in your workplace and suggest what to do about them.

DESIGN	
PROBLEM	**POSSIBLE SOLUTIONS**
Masking – alarm sound is not heard above typical noise levels; alarm drowns out communications, lighting levels cannot be seen above typical lighting levels.	Raise alarm volume to 10dB(A) above other workplace noise; allow operators to lower the volume of alarms once they've sounded. Make alarm bright enough for all expected conditions; use colour to highlight the alarm; accompany visual alarm with a sound
Flooding – more alarms than the operators can deal with are presented at once	System should be designed to filter out or suppress unnecessary alarms and to present alarms in priority order; operators may need clear procedures and training on how to prioritise their actions
Difficult to tell one alarm apart from another – sounds or lights are very similar	Use 'coding' (e.g. different sounds; pulsing of sounds; different colours; flashing) to show importance of alarms and group by the safety function to which they relate
Nuisance alarms - false alarms, 'fleeting' or standing alarms	Change set points, hysteresis or dead bands to make the system less sensitive to short duration unimportant fluctuations. When alarms are expected (e.g. during testing and maintenance) and these cannot be overridden, use tags to indicate they are being tested

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ORGANISATION/PROCEDURES	
PROBLEM	**POSSIBLE SOLUTIONS**
Operators do not have enough time after the alarm commences to take the right action	Set the alarm levels to show the progress of an alarm situation e.g. a tank overfill alarm sounds at 'high' level then again at 'high high' level
Alarms are missed because the area where they appear is not constantly manned	Install 'repeater' alarms in several places; enforce manning of key operating areas
Operators experience other problems with alarms such as irrelevant and unimportant information being given or poor alarm names being used	Include operators in making suggestions about alarm problems and in suggesting solutions; check solutions against recommended guidance (see references)
Alarms are produced when a warning signal would do (alarm is attached to an event that is safety critical)	Alarms are designed against a risk assessment that identifies what plant conditions should produce an alarm
Alarms are in place because it's too difficult to automate the process – puts the responsibility on the operator to act	Design alarms according to good practice principles (see references) – beware not to overload the operator

Solving alarm problems will require persistence and patience. You will need to collect information on what the problem is – by asking people!
Then you will need to persuade management to make improvements. You can change some things easily – others may take a long time.

Useful Reference Information

1. Institute of Petroleum, Alarm Handling, Human Factors Briefing Notes No 2, 2003.
2. Health and Safety Executive, Alarm Handling, HSE Human Factors Briefing Note No 9.
3. Health and Safety Executive, HSE Human Factors Toolkit, June 2004.
4. Engineering Equipment & Materials Users Association (EEMUA), Alarm systems, a guide to design, management and procurement, EEMUA Publication No 191. ISBN 0 8593 1076 0.

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