

Scoping ergonomics information with User System Architectures to meet HSE's COMAH requirements

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Abstract. The Health and Safety Executive (UK) apply the COntrol of Major Accident Hazards (COMAH) regulations during inspections of designated sites. They pay attention to the ergonomics issues associated with the organisation, the jobs and individual characteristics including competency. The organisation needs to scope the ergonomic information, and integrate it appropriately prior to assessment. A User System Architecture (USA) was used to scope and contain all ergonomics information. This supported an integrated understanding of the ergonomics issues, and traceability.

Keywords. COMAH, User System Architecture, traceability

1. Introduction

1.1 The need for scoping the ergonomic issues

The Health and Safety Executive (HSE) visited a site where the COntrol of Major Accident Hazards (COMAH) Regulations 2015 applied (HSE, 2015). I was present as part of a management team and was given the responsibility of addressing the ergonomics/human factors requirements of the site's COMAH report.

The first task was to scope those characteristics of the site, its work and personnel, required by the HSE for inspection. This included the organisation, job/task, and individuals including competency issues (HSE, 2011), with the hazards, the hazard management system and assessments. The HSE requires topics to be addressed, but does not specify how they should be reported. A preliminary sketch of the site User System Architecture (USA) as used for computer-based systems (Tainsh, 2016) was presented to the HSE Inspection Team who replied that they believed that such a representation could help scope the set of issues under investigation. Hence the USA approach was developed as part of a full report to be delivered to the HSE Inspectorate. Only the general approach is presented here for confidentiality and security reasons.

1.2 Ergonomics assessments for COMAH

The HSE requires COMAH assessments to cover:

- The job: including areas such as the nature of the tasks, workload, the working environment, the design of displays and controls, and the design of procedures;
- The organisation: including roles and responsibilities, resources, communications, schedules, and the culture of the workplace;
- The individual: including his/her competence, knowledge and skills, personality, attitude, and risk perception.

The HSE approach requires the integration of site, work and personnel characteristics taken from an understanding of ergonomics and human resources, into a single framework to address hazards, risks and associated criteria. This includes reducing risks to levels that are As Low As Reasonably Practicable (ALARP). One of the features of the HSE approach is

that they ask to see documented evidence of practice prior to inspecting the work place. The HSE Inspectors stated that they would ask: “use documents to tell me, and then show me”.

2. Scoping the ergonomics information for integration and assessment

The approach started with the development of a USA: a framework for representing the structure and content of the system information from a User Point of View (PoV). It used Layers of Description and PoVs to structure the content. These techniques support integration of information and enable traceability of functional information whether expressed as documentation, tasks, competency or other. The USA was used to scope all the information under HSE investigation. In this case, because of the HSE inspection requirements, the starting point is ergonomics and safety documentation associated with COMAH requirements, including the hazard management system which contained the standards and risk mitigation details.

3. USA/Documentation

In this work, the content of the documentation portion of the USA covered five Layers (covering all management and employee levels) and five PoVs integrated as shown in Table 1:

- Documentation was mapped against the organisational layer to include:
 - Description of the legal, regulatory, standards and policy requirements (Layers 1 and 2);
 - Codes of Practice for roles and jobs including competency for all levels;
 - Work Instructions within all levels, including details for managing and handling hazards and failures.
- Description of the high level management organisation (Layer 2), with site and supervisory management (Layers 3 and 4). This includes communications within the organisation, focusing attention to those parts which are associated with the management of hazardous materials or processes, and the mitigating techniques and activities.
- Description of the sites, facilities and equipment (Layers 2, 3 and 4) mapped against organisation and roles to include:
 - Site, facilities and equipment covering design and maintenance, including possible failures, and the means of mitigating the consequences;
 - Hazard lists along with incident records;
 - Hazardous external events associated involving security, public emergencies or weather.

Table 1: User Systems Architecture for ergonomics, hazards and hazard management system documentation

Layer	Viewpoint - Documentation	Viewpoint – Organisation/ Group Responsibilities	Viewpoint – Individual Roles/ Competency	Viewpoint/Sites, Buildings and Facilities	Viewpoint - Equipment
Layer 1: Legal Requirements and	Legal documents, standards and	Organisational functional	Competency management	Deeds, maps of sites and facilities	Specification of major

Policy -	references	description with responsibilities	policy		installations and standards.
Layer 2: Senior Management levels	Codes of Practice and Work Instructions based on legal and policy requirements	Board responsibilities including setting of safety goals, jobs and tasks. This includes independent safety scrutiny.	Management of Competency Management Systems	Description of sites, building and major facilities, management consideration of hazards and mitigation	Description of major items of equipment with design standards
Layer 3: Site/Facility Management levels	Descriptions of sites, facilities and Safety Cases, taking account of physical and chemical hazards, and ALARP criteria	Management of safety policy and application to project plans, jobs and tasks	Handling of Competency Management System including roles, jobs and training	Safety/risk assessment of buildings and major facilities, detailed hazard descriptions and management	Safety/risk assessments of equipment and project tasks to be undertaken by users and maintainers.
Layer 4: Employee Work system levels	Detailed Work Instructions, including legal, safety or other compliance requirements,	Execution of project tasks by teams and individuals, with hazard mitigation according to plan and work instructions	Execution of learning/training programmes, and participation in learning and training	Execution of maintenance and upkeep tasks	Use of equipment in accordance with instructions and supervision
Layer 5: Assessment	BS OHSAS Standard 18001	Terms of Reference, management and project plans and statements of competence.	Competence accreditation and certification	Architectural and environmental assessments	Usability assessments including user and maintainer performance failures.

- Development of suitable job, role and task descriptions, supervisory arrangements, Codes of Practice and Work Instructions (Layers 2, 3 and 4). These included handling of hazards.
- Description of general professional and specific technical competencies against organisational level and project requirements (Layers 2, 3 and 4).
- Assessment information (Layer 5) to include :
 - Appropriate technical standards;
 - Appropriate competency standards;
 - Criteria associated with COMAH or other hazards
 - Information on potential severity of hazard and likelihood of occurrence;
 - Information on ALARP criteria (mainly at Layers 2, 3 and 4, but traceable back to Layer 1).

4. USA/Organisational Characteristics

The description of the organisation and processes was focused on the safety and hazard management system which was appropriate to the COMAH inspection. Layers 1 to 4 of Table 1 give a description of the organisation from five viewpoints. They support an understanding of the relationship of the highest levels of the organisation to the lowest. This

ensured that information within all Layers was traceable to others. The functional characteristics included:

- Roles and their competency requirements - information on current incumbents was included where appropriate;
- Tasks – including planning and management of projects, including allocation of financial and other resources, and allocation of manpower;
- Communication – ensuring the flow of information through the management structure for normal and COMAH emergencies;
- Handling of records and their analysis – ensuring the ability for evidence based review as part of the management process;
- Understanding indicators of safety culture including safety goals and responsibilities.

5. USA/Individual Task Description

Task descriptions were addressed in two ways:

- A generic description of all management and employee tasks, including those of sub-contractors who may be on site for a limited period of time;
- Detailed description of all tasks that are associated with the COMAH processes.

The task descriptions covered work characteristics including:

- Individual's task process and workload, with communication both within workgroups and to control points – this enabled risk performance assessments with consequences of failures and errors;
- Group processes, with an understanding of failures and errors;
- Equipment characteristics including design, training, instructions and supervision requirements;
- Environmental conditions, and their consequences;
- Hazardous materials and the associated handling processes, including potential severity and likelihood of failures - including an ALARP assessment.

6. USA/Individual and Organisational Competency

6.1 Individual Competency

The HSE (2011) describes how a Competency Management System (CMS) will be inspected. A competent person has been defined by Bassi and Russ-Eft (1997) to have the characteristics of those defined by criterion groups who perform specified tasks. Individual competency is specified with three components:

- General so that both internal and external agencies can have a reasonable expectation of what they can expect from any individual in the event of an accident or emergency. This will also enable the individual to function across a range of events and tasks within the organisation.
- Specific experience with facilities or equipment, with durations of experience and currency requirements appropriate to specific circumstances, and to ensure the control of hazards is ALARP.
- Specific to working practices such as fire equipment, manual handling or working at height where highly specific information is required.

Hence, part of the USA addresses CMS requirement with the Terms of Reference for roles, jobs and tasks and competency certification to reflect these three components. They appeared

as shown in Table 2. The Layers refer to Table 1 and the Levels to those advised by the National Careers Advisory Service.

Table 2: Summary of competency portion of User System Architecture

	Learning/Training /Qualifications	Facility/Equipment Experience	General Safety Training
Layer 1: Senior Manager	Graduate or equivalent (Level 7)	Substantial management experience	Appropriate to working environment.
Layer 2: Manager	Graduate or equivalent (Level 7)	Between 6 months to two years' experience on a facility and its associated equipment, or groups of equipment.	First aid, manual handling, working at height etc. as appropriate.
Layer 3: Supervisor	ONC, HNC or equivalent (Levels 5 or 6)	Between 6 months to two years' experience on an item of equipment. Capable of supervising others with advice of Manager.	First aid, manual handling, working at height etc. as appropriate.
Layer 4: General Worker /Technician	Little specific professional or academic training. (Levels 2 to 4)	Trained to operate specific items of equipment and carry out tasks as required.	First aid, manual handling, working at height etc. as appropriate.

6.2 Organisational Competency

It was also necessary to consider competence as a set of organisational characteristics. This means that the roles defining group membership were considered for their impact on the effectiveness of group operations, their impact on hazard management and the safety of personnel and equipment. Groups with specific relevance to hazard management and safety were examined at all levels as shown in Table 2. This was considered to be particularly important to ensure that every person on the COMAH site (permanent employees and subcontractors) had appropriate training, work instructions and supervision.

7. Assessment by Site Management and Stakeholders

7.1 The Documentation, Facilities, Equipment Tasks and Safety/Hazard Management

The USA structure was agreed with all stakeholders. The information required for the COMAH assessment was used to populate the USA. The assessment covered:

- Assessment of potential performance by the all management, employees and subcontractors (working individually and within groups) with a consideration of errors and failures, paying particular attention to competency;
- A description of the hazards being handled and those that may be encountered in the event of equipment or material failure, with an assessment of the severity and likelihood of the potential task/activity outcomes as a result of the error or failure;
- The adequacy of techniques used to mitigate any undesirable outcomes;

- An assessment of whether the work system has been designed to remove hazards or reduce them to levels that are ALARP;

This assessment information was used to generate a plan for future work on the site and other sites in due course.

7.2 Emergency Scenarios and Safety Process Charts

This task information was developed using Job Process Charts (Tainsh, 1985) as a starting point. For this purpose, they were adapted as Safety Process Charts (SPCs) to show both COMAH activities and hazard mitigation. They addressed the HSE requirement for a qualitative representation of failure outcomes, rather than detailed numerical estimates.

The organisation being inspected must be able to show how they can cope in the event of a COMAH failure, with particular emphasis on the involvement of the emergency services and impact on the public. Site and facility management and employees, and subcontractors, must be competent in handling or understand their role in emergency situations.

An example of an SPC from this project is given in Table 3. The actors (people, groups, hazards and physical objects) are given to the left of the table. Time periods are plotted on the horizontal axis but the scale is appropriate to understanding the event – it is nonlinear.

The Time Period 1 shows the management and planning prior to the event which may take a substantial period. Time Period 2 shows the event where as a result of objects coming into close proximity there is a COMAH incident. This may be a much shorter time period than Period 1. Time Period 3 shows the events following the incident over an extended period.

The time scale over the horizontal axis of Table 3 has been constructed for this presentation only, to emphasise the events when the hazardous materials are brought together with adverse consequences.

Table 2: Safety Process Chart for hazardous event at COMAH site

Actors	Time Period 1		Time Period 2		Time Period 3	
	Activity	Mitigation	Activity	Mitigation	Activity	Mitigation
Senior Manager	Set safety goals	Review of goals by independent experts				
Manager	Develop project plans including handling hazards	Review of plans by competent peers, and technical assurance				
Supervisor	Manage work systems	Briefing of plans, and technical assurance				
Technician	Carry out training and	Competency training and				

	work	supervision by competent manager				
Hazardous material	Be recorded on lists, associated with appropriate standards	To meet agreed standards.	Hazardous material and initiating agent brought together with severe outcome	Buildings, environments , shields, protective clothing etc in accordance with standards		
Initiating agent	Handled in accordance with standards	To meet agreed standards				
External groups					Take precautionary actions	Under COMAH control
Emergency services					Attend site with ambulances and/or other.	Under COMAH control
News media					Disseminate information.	Under COMAH control
Central Agencies					Record and assess so that policy may be influenced	Under own processes.

8. Conclusion

The USA approach is based on the use of layered functional descriptions and PoVs (Tainsh, 2016) with traceability between layers. The HSE reported that the USA helped them understand the scope of the ergonomics issues in all the areas that they investigated, and the SPC informed the understanding of the process description of COMAH scenarios.

The main advantages of the USA approach as discussed with the HSE, are:

- The USA representation indicates the structure and content of the site documentation in an easily comprehensible way for stakeholders;
- The functional descriptions can be easily related to standards and ALARP assessments;
- The functional approach to Layered Description enables PoVs to be integrated including roles, tasks and competency of both individuals and groups, sites and equipment hazards and risks, and their assessment information;
- The USA approach enables performance at individual levels to be understood in terms of resources, conditions, responsibilities and communications from higher levels of management (traceability);
- The USA is a low cost tool. It is based on well-understood techniques, and once developed supports additional project tasks such as the construction of SPCs.

There was a belief within the Project Team that this approach could be employed with benefit at any COMAH site.

9. References

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