Engineering Safety Management

Yellow Book 3

Application Note 3
Human Error:
Causes, Consequences and Mitigations

Issue 1.0

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Contents

1 Introduction

All systems have a human component. Even the most highly automated systems are designed, installed, and maintained by people. To err is human. Human error plays a part in most, if not all, accidents. If you have not considered human error during the design of the change, it will be difficult to show that you have reduced risk as far as reasonably practicable. Similarly, you should consider the impact of human intervention on the management of hazards. Understanding how people react in the event of a failure is important in understanding the overall system risk.

Human error has causes. We understand some of these and know how to prevent them. When changing the railway you can and should follow the Yellow Book guidance to "consider the people who the change will affect, and design it to help them avoid mistakes". You should also look for opportunities to design the change so that it can prevent human error from leading to an accident. People prevent accidents as well as contributing to them. Therefore you should try to design the change to help people prevent accidents.

This application note should be read in conjunction with Version 3 of the Yellow Book. It does not introduce additional fundamentals to those already set out in the Yellow Book. It is intended to raise the guidance on the human error aspects of the existing fundamentals towards the level already provided for technical aspects. This application note provides advice on how to integrate consideration of human error into the general process of safety engineering. This note does *not* seek to provide detailed descriptions of or advice on individual techniques.

This application note will refer to human factors, and ergonomics. Both are used to denote the entire field of study and practice concerned with the human element of any system, the manner in which human performance is affected, and the way that humans affect the performance of systems. They should be considered synonymous terms.

We have taken trouble to make this note accurate and useful, but it is only a guide. We do not give any form of guarantee that following the recommendations in this note will be enough to ensure safety.

We are continually working to improve the Yellow Book and we welcome comments. Please contact us at the address below, if you have a suggestion for improvement.

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2 Overview

This application note addresses human factors in the context of the Yellow Book fundamentals. It describes, for each fundamental, what you should be doing to address human factors, why it is important, and provides some suggestions about how you should be doing it.

Table 1 puts some of the activities that this note suggests into time order. It extends Table 11-2 in Yellow Book 4 (Chapter 11, Volume 2) under the "ESM From Start to Finish" fundamental. The table describes when in the system lifecycle different human factors work should be done, and indicates relevant sections of the application note.

Generic lifecycle phase	**Principal ESM Activities**	**Human Factors Activities**
Concept and Feasibility	Preliminary Hazard Identification	Identification of People affected (§0) Preliminary Human Error Identification (§10.2)
	Establish Hazard Log	Establish Human Factors Issues Database (§1)
	Preliminary Safety Plan	Assign Human Factors Task Responsibility (§1) Human Factors Strategy (§1)
Requirements Definition	Hazard Analysis (and revisiting Hazard Identification)	Human Error Identification (§10.2)
	Risk Assessment	Human Error Representation and Quantification (§10.3) Human Error Reduction (§10.4)
	Establish Safety Requirements	Human Factors Safety Requirements (§1)
	Full Safety Plan	Human Factors Plan (§1)
Design	Risk Assessment	See Risk Assessment above
	Safety Audit	Human Factors Review (§17) - should be done throughout the project
Implementation	Risk Assessment	See Risk Assessment above
	Safety Case	Provide Human Factors input to Safety Case (§1)
Installation and Handover	Safety Assessment	Independent safety assessment of human factors work (§17)
	Safety Endorsement	*Nothing specific*
	Transfer Safety Responsibilities	Handover of human factors records (§1)
Operations and Maintenance	Update Hazard Log and Safety Case	Update Human Factors Issues Database (§1)
Decommissioning and Disposal	Update Hazard Log and Safety Case	Update Human Factors Issues Database (§1)

Table 1: ESM and human factors activities by generic lifecycle phase

3 Safety responsibility

Your organisation must identify safety responsibilities and put them in writing. It must keep records of the transfer of safety responsibilities and must make sure that anyone taking on safety responsibilities understands and accepts these responsibilities. It must make sure that anyone who is transferring responsibility for safety passes on any known assumptions and conditions that safety depends on.

A person competent in managing human factors should be responsible for coordinating the ergonomics work within a project or programme.

This helps to prevent confusion over the human factors work within the project that may result in mistakes or missed work.

Some railway programmes are large, involving many organisations. The larger the programme, the more potential there is for confusion as to who is responsible for what.

The coordinator may be the project or programme manager, or someone appointed by them.

4 Safety culture

Your organisation must have safety as a primary goal.

You should treat human factors with the same importance as any other part of safety engineering.

The railways rely on people to ensure that they operate safely. People make mistakes. Therefore human error is likely to contribute to risk; it may even be the major source of risk. Any organisation that professes to have a safety culture should treat human behaviour as an important issue.

Your organisation should treat human error with as much seriousness as any other aspect of safety, such as component reliability, or systematic integrity. You should put checks in place to ensure that this is the case.

5 Competence and training

Your organisation must make sure that all staff who are responsible for ESM activities are competent to carry them out. Your organisation must give them enough resources and authority to carry out their responsibilities. Your organisation must monitor their performance.

Staff carrying out human factors work should be competent to do so.

Without competent staff, the results of human factors work may be unreliable.

The competence required will depend upon the project. It is not necessary that all work that involves human factors should be carried out by trained ergonomists; for example signal sighting is all about human factors but is quite adequately done by teams comprising signal engineers, drivers and specialists in signal sighting. The skills and competency level should be relevant to the work to be carried out.

You may find it useful to refer to some of the societies and organisations that are involved in ergonomics work, such as the Ergonomics Society of Great Britain, British

Psychological Society (BPS) and the Human Factors and Ergonomics Society (HFES), for assistance on assessing the competence of staff involved in human factors work through professional accreditation schemes.

If people are carrying out ergonomics works for you, you should ensure that they are competent.

You cannot give accountability for safety away, only devolve responsibility for conducting the work. If you do this, it is your responsibility to ensure that those carrying out human factors work are competent and have sufficient resources and authority to do so in a manner that maintains the safety of the railway.

Those carrying out human factors work should have sufficient resources and authority.

Without sufficient resources and authority, human factors considerations may be diluted or lost.

6 Working with suppliers

> Whenever your organisation contracts out the performance of ESM activities, it must make sure that the supplier is competent to do the work and can put these fundamentals (including this one) into practice. It must check that they do put them into practice.

You should agree who does what human factors work in a supply chain, and ensure that all the parties understand their responsibilities.

Failure to assign human factors work clearly may result in it being missed out. Confusion as to where responsibilities lie may result in something being omitted, as everyone assumes that someone else is responsible for it.

You should ensure that all agreements are clear and unambiguous about human factors work to be carried out.

Because human factors requirements are non-functional, they may not receive the necessary consideration unless all parties are aware of its importance and the effect that it can have on system safety.

With the large number of organisations involved in many rail projects, it is important to ensure that agreements between them are sufficiently rigorous, clear and complete to reduce the possibility of misunderstandings or mistakes.

You should ensure that contracts with suppliers are adequate, being clear about what human factors work is expected and what will be delivered. Both the Invitation to Tender, and bids from contractors should include details of what will be required and delivered in terms of human factors work.

7 Communicating safety-related information

> If your organisation has information that someone else needs to reduce risk, your organisation must pass it on.

You should communicate the broad range of information relating to human factors work.

It is common for a single individual on the railways to use a number of systems. When designing a system, the user's interaction with other systems should be taken into account. A failure to adequately communicate information between projects may result in decisions being taken that are detrimental to the safety of the system as a whole, for instance by introducing unnecessary and unwanted inconsistencies between systems used by one person.

Key information includes:

- *Characteristics of end users, their capabilities and limitations.*
  In order to understand how safely a system will be used, you need to understand those who will use it.
- *How the system is intended to be used.*
  The manner of use and context of the system will have a significant impact on the safety of a system.
- *Details of existing and/or similar systems.*
  In order to identify human factors safety requirements, you need to understand how existing or similar systems are used.

If you employ people who will be affected by a change, you should provide those performing the human factors work with access to them.

It is difficult to perform assessment of the ergonomics issues in a project without access to these people.

8 Co-ordination

Whenever your organisation is working with others on one change, they must co-ordinate their ESM activities.

You should coordinate human factors work with the other parts of the project.

Human factors influence many aspects of a system's design and implementation; it is important that they are taken into account at all stages and by all parts of the project.

You should have integrated documentation, such as risk registers and hazard logs.

You should identify, and coordinate with other projects and organisations that could affect or be affected by your project.

Where the same individuals use multiple systems it is important that work is coordinated to ensure that one system does not adversely affect their ability to use the other systems safely. For example: where two systems use the same noise to alert the driver to a problem, confusion is likely to result. See the Application Note for Railway-Level Issues for more information about coordinating projects.

Where multiple projects are part of a wider programme you should have a programme-wide human factors coordinator.

This will improve communication and visibility of human factors within a programme consisting of many projects.

Much of the work being conducted on the railways at present is part of large programmes of work integrating many systems.

The programme wide human factors coordinator will be responsible for making that projects coordinate their activities and to aid the discovery of conflicts (see §3).

9 Defining changes

Before starting work on a change, your organisation must define the aims, extent and context of the change.

You should identify and describe the people who are likely to influence safety at all stages of a project.

You cannot conduct assessment of human factors without considering the role of people within a system.

People play a very significant role in the operation of the railways, despite the increasing use of automated systems.

Below is a list of people that may be involved:

- The end users
- The people the end users of the system deal with, including their customers and suppliers
- Maintainers
- Regulators
- Management.

You should assess both the required and existing competency of end users.

The competence of those responsible for the operation and maintenance of the system will have a significant influence on the safety of a system.

You should assess the requirements of those who will be involved in all stages of the lifecycle of the systems affected. This will include operators, maintainers, installers, and those responsible for decommissioning.

You should assess abnormal or degraded modes of operation and mode transitions.

Users are often more likely to make mistakes in these modes because they are unfamiliar.

Such modes include the transition of the system during the implementation of the change and between modes of operation. It is important that the change should be well managed, and human factors will influence your ability to achieve this.

Be aware that small changes may have a significant effect when combined.

It is important that small changes are assessed to ensure that either that the combined effect is not significant, or that it is properly assessed in the context of the other changes taking place.

10 Identifying hazards, assessing and reducing risk

When your organisation considers change, it must make a systematic and vigorous attempt to identify any possible hazards. Your organisation must consider hazards which could contribute to an accident at any time, from introducing the change into the railway to removing it.

Your organisation must assess the effect of any proposed change on overall system risk.

Your organisation must carry out a thorough search for measures which reduce overall system risk, within its area of responsibility. It must decide whether each measure is reasonably practicable and, if so, must take it.

If your organisation finds that risk is still intolerable, it must not accept it.

10.1 Introduction

You should seek to identify, model and control human error.

It is possible to identify, model and control human error, and human reactions to failure. There are many useful human reliability techniques that allow a practitioner to identify human contribution to hazards, assess that risk, and devise methods to reduce that risk.

You should ensure that appropriate human reliability techniques are used and that they are used correctly.

Using inappropriate techniques or applying them incorrectly can produce unsound results.

Identifying, assessing and reducing the risk associated with human error should be a core part of any safety process.

Within this process you should address the human contribution to risk, and its mitigation (people can recover from problems as well as cause them), with the aim of reducing the system-wide risk as far as reasonably practicable.

The Yellow Book uses a seven stage process for identifying, assessing and reducing risk. For the purposes of this section we will combine some of these stages into three steps as follows.

1. Error identification (stage 1)
2. Error representation and quantification (stages 2 to 4)
3. Error reduction (stages 5 to 7).

For each step we will describe in general terms what human factors activities are necessary. We will not describe any specific human reliability techniques. The activities described here should be performed as a part of the overall safety engineering process.

10.2 Error identification

In order to identify sources of human error, you should first understand the tasks that are being carried out.

If you do not fully understand the tasks that people will perform, and the manner in which they are to be carried out, you cannot comprehensively identify where risks may originate.

There are a variety of task analysis techniques, all of which seek to decompose a task into its parts, and formally express the connections between them, such as task order, repetition, parallelism, and conditional execution of tasks.

The possible sources of error can be identified using methods that use the results of the task analysis. Generally a form of “human HAZOP” is used, with extensions to the normal

HAZOP process (failure conditions and keywords) for dealing with the classes of errors that arise in human action. Alternatively a variant of FMEA or FMECA can be used.

You should integrate the process of human error identification with the general process of hazard identification within the project.

Identification of error requires a multidisciplinary team who understand both the domain and the techniques.

10.3 Error representation and quantification

The representation of human error should be integrated with other aspects of safety analysis.

Many hazards will have both human and technical causes. In order to model the causes of hazards, it is necessary to consider both classes, and the manner in which they interact.

Standard notations for representing cause and effect, such as event and fault trees can be used to describe the sequences of events that lead to, and from, a hazard. Human error events can be integrated into these descriptions.

With human error represented within the overall model of errors for a system, it is possible to assess the likelihood of an error occurring, and of it leading to a hazard and an accident. In order to do this you will need to assess the likelihood of human actions being carried out incorrectly. Likelihood of human error can be expressed either qualitatively or quantitatively.

There are many methods for assigning human failure probabilities to human actions. Most use some mix of recorded probabilities of errors from a database, and expert assessment, to reason about and simulate human behaviour and the likelihood of an error. Experts and data sampling are subject to bias and techniques exist that attempt to minimise this bias.

You should understand dependencies between human actions.

One human error may make others more likely. A person may, knowing the correct value, mistakenly enter an incorrect value into a single system. Having committed this error, then they may enter the same incorrect value into multiple systems. Similarly, a mistake by an operator that results in a hazardous situation may cause them to be more stressed, impairing their thought processes and making further errors more likely. An inadequate understanding of dependencies between human actions can lead to a significant underestimation of risk.

See [7] for more information on dependencies between human actions.

10.4 Error reduction

You should seek to design systems to help the user avoid or recover from hazards.

As has been previously stated, human error is often a significant cause of hazards. However, people are also the most adaptable part of a system.

A simple change to a procedure may be more effective (and faster and cheaper) in reducing system risk than a complex technical solution. However you should demonstrate that the balance of risks does favour a procedural change; such an approach should not be used as a general excuse to not implement technical changes.

Broadly speaking there are three complementary strategies for reducing the probability of human error:

- Improve the design of the task and the equipment to avoid provoking the operator into error.
- Improve the working environment, e.g. by improving procedures, removing distractions, attending to factors which might cause fatigue.
- Improve the performance of the individual, e.g. by paying attention to training and competence, fitness, motivation, safety culture.

As well as reducing people's contribution to risk, you can improve their contribution to the mitigation of their own and other errors.

When human error is considered within the context of other system failures, it is possible to use standard methods of sensitivity analysis such as fault tree cut sets to identify those events that have the most impact on the likelihood of a hazard, identifying how the risk can be reduced most effectively.

As with other system failures, such as mechanical breakdown, the likelihood of human error is affected by environmental, physical and organisational factors. Human reliability techniques exist that allow you to model the effect that these factors have on the likelihood of human error. It is possible by improving an environmental or organisational factor, that the likelihood of error at several stages in a chain of events leading to a hazard can be reduced, leading to a significant reduction in risk. Human reliability tools exist to allow you to model these effects in order to identify those factors that have most impact on the likelihood of error.

When the factors that influence the likelihood of human error have been identified, it is possible to identify measures that will help to reduce those errors. Options analysis can be used to weigh the possible error reduction methods, taking into account the cost of the measure and the effect that it will have on error rates.

See [4] for more information.

When considering methods of risk reduction you should involve the system users.

A good safety process involves the system users throughout the project, investigating with them how the system may be improved, either to help them avoid error, or to mitigate other system errors.

11 Safety requirements

Your organisation must set safety requirements for any change, to reduce the risk associated with the change to an acceptable level.

You should set requirements for human factors.

Failure to set clear requirements for human factors may result in other system requirements or commercial concerns taking precedence, with human factors coming off worse.

Human factors requirements will come from several sources, including:

- Client requirements,
- Risk assessment,
- Legislation,

- Standards, and
- Good practice.

Some of these sources will be specific to the railways.

Some requirements will be safety-related, while some of them may not; it is likely that you will have to resolve conflicts between the requirements.

Integrate human factors requirements with the system requirements.

If human factors requirements are kept separated from the other requirements of the system they may receive less attention than other requirements. By integrating the requirements you make it more likely that they will be considered equally. Safety-related human factors requirements should be integrated with the general safety requirements. Many human factors requirements will exist in order to satisfy other system requirements especially safety-related ones.

Many aspects of ergonomics have safety connotations, however not all ergonomics issues are safety-related. Therefore some but not all ergonomics requirements will be safety-related. Similarly not all safety issues have an ergonomics component.

12 Evidence of safety and authorising change

Your organisation must convince itself that risk associated with a change has been reduced to an acceptable level. It must support its arguments with objective evidence, including evidence that it has met all safety requirements.

No change can be authorised until all necessary safety approvals have been given.

You should integrate human factors into the safety argument.

To demonstrate that that risk associated with a change has been reduced to an acceptable level, you must provide a safety argument. Because human factors affect the risk, the safety argument should consider human factors. Making human factors an integral part of the safety argument for a project will improve the argument.

You should have evidence to support the human factors parts of the safety argument.

Without evidence for its human factors parts, the safety argument is unsupportable.

You should collect this evidence throughout the project. You should work with the safety assessor throughout the project to decide what evidence will be required and what. This will help to reduce project risk.

The safety case should include an audit trail for human related design decisions (e.g. the rationale for why a procedure or control/display is designed in a certain way).

The evidence should demonstrate that you followed the human factors plan (see Section 2.14).

You will need evidence to show that you followed your human factors plan (see §14), and that the results of human factors work support your safety argument.

13 ESM from start to finish

> Your organisation must start ESM activities as soon as possible. It must review the results of these activities, and any assumptions made throughout the project. It must review and extend ESM activities whenever new information makes this necessary. It must monitor information on performance that relates to safety.

You should consider human factors from the outset of a project.

Many decisions concerning the requirements or design of a system or change may be taken at the beginning of a project. Failure to conduct proper human factors work at this stage may result in choices being made that are very difficult to change later on.

Railway projects can be very large, and may take many years to complete. Failure to do the right things at the beginning of such projects, could result in problems that prove complex and expensive to fix later on.

Human factors should be planned for and conducted from the beginning to the end of the project, both in relation to safety and for the project in general.

See §1 for an overview of what human factors activities should be carried out at different phases of the project.

14 Safety planning, systematic processes and good practice

> Your organisation must plan all ESM activities before carrying them out.

> Your organisation must carry out safety-related projects following systematic processes which use good engineering practices. It must write down the processes beforehand.

You should plan all human factors work.

If human factors work is not planned, and the necessary resources are not made available, there is a significant risk that the work will not be effective.

At the beginning of a project you should develop a high level strategy for the integration of human factors into the safety process. This will describe the general approach that will be taken throughout the project.

Once project safety requirements are known, you should produce a plan for the human factors work that describes in detail the techniques to be used, the skills needed and the points at which different activities will be carried out with details of their implementation. LUL Engineering Standard E1035 and its accompanying Manual of Good Practice [2] provide descriptions of the contents that would be expected in such a plan.

You should integrate human factors planning into the general project planning.

By making human factors planning an integral part of the overall project planning process, you reduce the risk of resource or time conflicts with other parts of the project, and make it more likely that human factors will be given sufficient attention.

You should produce a plan that described how the human factors process will integrate with the rest of the project.

You should also ensure that consideration of human factors is integrated into the overall design process.

15 Configuration management

Your organisation must have configuration management arrangements that cover everything which is important to achieve safety or to demonstrate safety.

Your configuration management procedures should cover any ergonomics related documents and data that relate to safety.

Human factors work often produces strategies and plans, reports and drawings, prototypes, mock-ups, and simulations. Configuration management arrangements should also cover these. Configuration management of human factors data and documents should be integrated with the configuration management arrangements for other project documents and data, such as the safety case. Where changes to non-project documents, such as the Rule Book, are required to implement the project, they should be tracked.

16 Records

Your organisation must keep full and auditable records of all project ESM activities.

You will need to hand over records to support through life management.

These records should cover human factors activities, at least as far as they relate to safety. You should maintain a database of human factors issues, which records the issues and the actions taken to resolve them.

17 Independent professional review

ESM activities you carry out must be reviewed by professionals who are not involved in the activities concerned.

The ISA for the project should have knowledge of ergonomics, both the manner in which it affects safety and the techniques used.

Without such knowledge, the ISA will not be able to make an informed judgement.

The review of human factors should be an integral part of the overall review.

If human factors work has been integrated with the other parts of the project, it will be desirable for its assessment to be integrated with the assessment of the other parts.

Human factors are integral to a project and it will be necessary to consider them within the project as a whole. It is not possible to consider the human factors work in isolation.

18 Summary of interaction between ESM and Human Factors Activities

Figure 2 presents a summary of the main interactions between ESM activities and human factors activities:

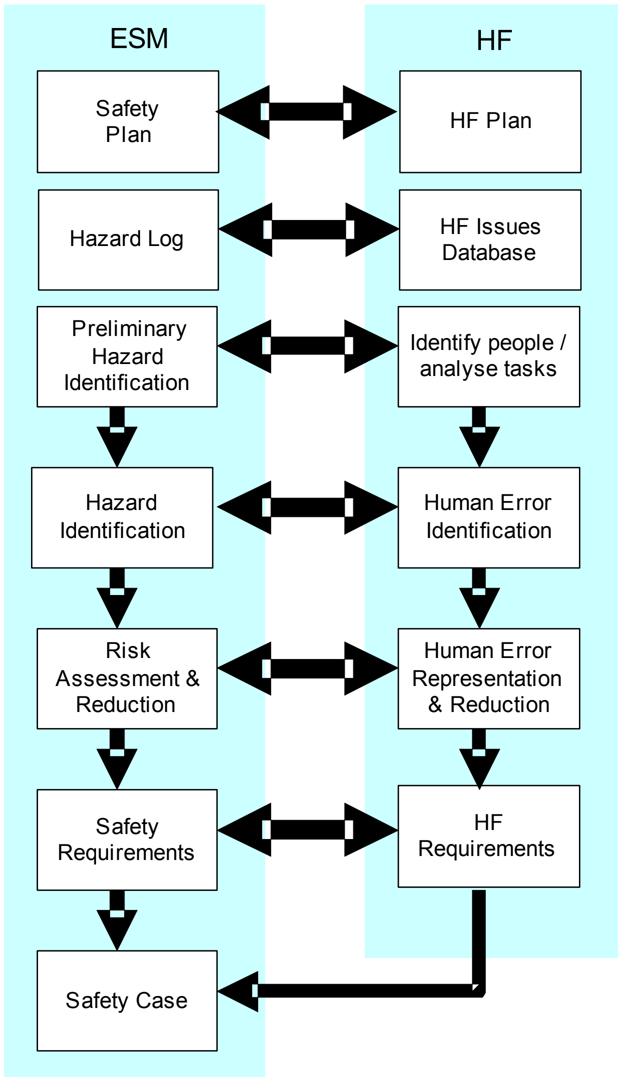

Figure 2: Summary of interaction between ESM and Human Factors Activities

19 Summary of points

The following is a resumé of this document in the form of a checklist of statements. Projects and assessors may find this checklist useful for ensuring good practice in human factors for a project.

1. A person competent in managing human factors is responsible for coordinating the ergonomics work within a project or programme.
2. Human factors is given the same importance as any other part of safety engineering.
3. Staff carrying out human factors work are competent to do so.
4. If people are carrying out ergonomics works for you, you should ensure that they are competent.
5. Those carrying out human factors work have sufficient resources and authority.
6. It is decided who does what human factors work in a supply chain, and all the parties understand their responsibilities.
7. All agreements are clear and unambiguous about human factors work to be carried out.
8. The broad range of information relating to human factors work is being communicated.
9. Access to those who will be affected by a change is being provided to those performing the human factors work.
10. Human factors work is being coordinated with the other parts of the project.
11. Other projects and organisations that could affect or be affected by the project are identified and human factors work is being coordinated.
12. There is a programme-wide human factors coordinator.
13. The people who are likely to influence safety at all stages of a project are identified and described.
14. Both the required and existing competency of end users is assessed.
15. Abnormal or degraded modes of operation and mode transitions are assessed.
16. The combination of small changes into a significant change is assessed.
17. Human error is identified, modelled and controlled.
18. Appropriate human reliability techniques are being used correctly.
19. The identification, assessment and reduction of risk from human error is being treated as a core part of any safety process.
20. The tasks that are being carried out are understood in order to identify sources of human error.
21. The process of human error identification is integrated with the general process of hazard identification within the project.
22. The representation of human error is integrated with other aspects of safety analysis.
23. Dependencies between human actions are understood.

24. The project seeks to design systems to help the user avoid or recover from hazards.
25. When considering methods of risk reduction system users are being involved.
26. Requirements are set for human factors.
27. Human factors requirements are integrated with the system requirements.
28. Human factors are integrated into the safety argument.
29. There is evidence to support the human factors parts of the safety argument.
30. The evidence demonstrates that the human factors plan is being followed.
31. Human factors is being considered from the outset of a project.
32. Human factors is planned and being conducted from the beginning to the end of the project, both in relation to safety and for the project in general.
33. There is a plan for all human factors work.
34. Human factors planning is integrated into the general project planning.
35. The Project configuration management procedures cover any ergonomics related documents and data that relate to safety.
36. Project records are being handed over to support through life management.
37. The ISA for the project has knowledge of ergonomics, both the manner in which it affects safety and the techniques used.
38. The review of human factors is an integral part of the overall review.

20 Document references and further reading

This section provides references for documents that are referred to in the application note, together with some that may be of interest for further reading.

Table 3 below gives an indication of the relevance of the documents listed in the list below, showing the reference number of the document along the top, with the section reference down the side. Relevance is shown with a shaded square.

	Document number													
Section	1	2	3	4	5	6	7	8	9	10	11	12	13	14
General										■		■	■	■
3		■	■							■	■		■	
4			■											
5			■											
6											■			
7		■									■			
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9			■											
10				■	■	■	■	■		■				■
11	■								■					
12										■				
13														■
14														
15														
16														
17														

Table 3: Further reading

1 *Human Factors Considerations for System Safety,* Dr. Carl Sandom, Praxis Critical Systems Ltd, 2002

2 LUL Standard E1035 A1 *Human Factors Integration in System Development* (London Underground Limited, Chief Engineer's Directorate , 2000) and LUL Manual of Good Practice M1035 A1 *Good Practice In Human Factors Integration* (London Underground Limited, Chief Engineer's Directorate, 2002)

3 *Reducing Error and Influencing Behaviour (HSG48)*, Health and Safety Executive, HSE Books, 2nd edition, ISBN 0717624528

4 *A Guide to Practical Human Reliability Assessment.* B. Kirwan. Taylor and Francis, London, 1994, ISBN 0748401113

5 *Evaluation of Human Work, J.R. Wilson and E.N. Corlett (eds.), Taylor and Francis, London, 1995, 2nd edition, ISBN 0748400842. Chapter 31: Human Reliability Analysis*, B. Kirwan; Chapter 31 of Evaluation of Human Work, Wilson, J.R. and Corlett, E.N (eds).

6 *Human Error*, J.T. Reason, Cambridge University Press, 1990, ISBN 0521314194. *Chapter 8: Assessing and Reducing the Human Error Risk*. Reason, J.T.

7 *Incorporating Human Dependent Failures in Risk Assessments to Improve Estimates of Actual Risk.* Hollywell, P.D. Safety Science, Vol.22, No. 1-3, pp.177-194, 1996

8 *A Guide to Task Analysis, B. Kirwan and K.L. Ainsworth (eds.), Taylor and Francis, London, 1992, ISBN 0748400583*

9 *Human Factors in Systems Engineering*, Alphonse Chapanis, John Wiley and Sons, 1996, ISBN 0471137820

10 "*Why, When and How Human Factors Integration*", DSTL HFI Symposium at the Institute of Civil Engineers, 2nd November 2001.

11 *Technical Committee Report No. 3 – The Influence of Human Factors on the Performance of Railway System,* IRSE, May 1996

12 *Proposed framework for addressing human factors in IEC 61508,* Prepared by Amey VECTRA Ltd for the Health & Safety Executive, 2001

13 *Managing the Risks of Organizational Accidents,* J.T. Reason, Ashgate Publishing Limited, 1997, ISBN 1840141050

14 *Friendly Fire – The Accidental Shootdown of U.S. Black Hawks Over Northern Iraq,* Scott A. Snook, Princeton University Press, 2000, ISBN: 0691005060

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