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Ref	NR/SP/ERG/24017
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Control Room Design Specification, Process and Guidance (formerly RT/E/S/24017)

This temporary front sheet facilitates change to the new Network Rail Standards referencing nomenclature.

The Ref above will be formally allocated to this standard when it is next changed in the meantime the contents, date and issue number of this Network Rail Standard are UNCHANGED and with immediate effect it should be referred to as “(new ref) formerly (old ref)”.

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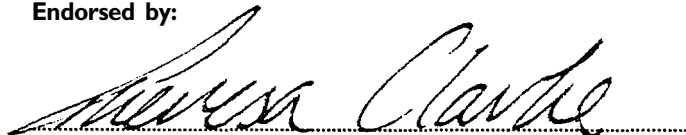
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Company Specification

Control Room Design: Specification, Process and Guidance

Endorsement & Authorisation

Endorsed by:



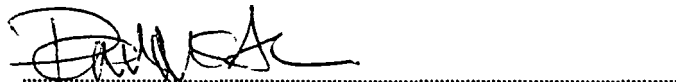
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Issue record

Issue	Date	Comments
1	April 2003	
2	April 2004	Document Updated to Reflect New Company Organisation

Implementation

The implementation date of this standard will be April 2004

Compliance

This standard must be complied with from May 25 2004 for all new schemes and refurbishment activities not yet to completed feasibility stage and thereafter to all new schemes and refurbishment activities. All Network Rail Staff, and its Contractors must be compliant to this standard.

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I Purpose

This standard presents ergonomics Requirements and Recommendations for the design, arrangement and organisation of Network Rail Control Rooms and closely associated areas. The standard covers all the main classes of Control Room including Signalling, Electrical, Zone, Station, Dispatch, Maintenance and Telecommunications activities making reference to the Operational Property Engineering Recommendations notes for Environmental Design Criteria. This standard is intended for control rooms where VDU's are used. However, many of the requirements are common to non –VDU environments such as those with NX Panels and lever frames.

The standard is intended to assist Network Rail Project Managers who have responsibilities for Control Room Design Programmes and/or their delivery. It would be anticipated that suitably qualified individuals would conduct any work undertaken in connection with the implementation of this standard. This standard shall also assist Project Managers in managing an ergonomics input.

2 Scope

The standard is applicable to new Control Rooms, Upgraded Control Rooms (Re-furbished sites, see definitions) and temporary Control Rooms (Stagework sites).

The requirements presented in the main body of the text cover both new sites and refurbishment sites – the additional constraints associated with refurbishment sites are addressed via checklists in Appendix A.

The standard deals only with those activities, which take place within the confines of the Control Suite – control room & associated rooms and spaces.

The standard is based on Requirements and Recommendations contained within the published Parts of ISO 11064 'The Ergonomic Design of Control Centres', ergonomics standards, Network Rail standards, relevant UK Health & Safety Regulations and best practice established within and outside of the rail industry.

The standard does not offer detailed Requirements or Recommendations for Control Room 'Workstations' or 'Control and Displays'. These are (and will be) provided in separate Network Rail standards.

Those involved in, or responsible for, the design, specification, delivery, management and audit of Network Rail Control Rooms shall use the standard. The standard has relevance to ergonomists and non-ergonomists, however it assumes an appropriate level of ergonomics competence is made available during the application and delivery of ergonomics techniques, processes and procedures.

3 Reference documentation

1. ISO 11064 Parts 1-7 (published and draft), Ergonomic Design of Control Centres
2. ISO 9241 Parts 1-17, Ergonomic requirements for office work with visual display terminals (VDTs)
3. ISO 9355 Parts 1 and 2, Ergonomic requirements for the design of display and control actuators
4. ISO 13407, Human centred design process for interactive systems
5. ISO 14738, Anthropometric requirements for the design of workstations and machinery
6. EN 547 Parts 1-3, Safety of machinery – Human body measurements
7. HSE, Workplace (Health, Safety and Welfare) Regulations
8. HSE, Health & Safety (Display Screen Equipment) Regulations
9. CIBSE, Code for Interior Lighting, 1994, ISBN 0900953640
10. Metric Handbook, Planning and design DATA, Architectural Press 1999.
11. The CIBSE Lighting guide LG3: The Visual Environment for Display screen use.
12. Stramler, James H. Jr, The Dictionary of Ergonomics. ISBN 0-8493-4293-4236.8.
13. Incorporating Ergonomics Within Engineering Design Projects: Requirements, [RT/E/P/24020](#), Network Rail, 2003.
14. Operational Property Engineering Recommendations Note for Environmental Design Criteria, Network Rail, Reference RT/ENGP/06/37
15. Lighting for Railway Premises, RSSB, [GI/RT/7010](#) (document comes into force 1 Feb 2003)
16. CIBSE Environmental Design, Guide A, 1999
17. Disability Discrimination Act, 1995
18. BS 5459-Part 2: 2000; Specification for Performance Requirements and Tests for Office Furniture – Part 2: Office pedestal seating for use by persons weighing up to 150kg and for use up to 24 hours a day including type-approval tests for individual components
19. ISO 13406-2, Ergonomics Requirements for work with visual displays based on flat panels – Part 2: Ergonomic requirements for flat panel displays
20. DIN EN 985:2002 Textile Floor Coverings: Castor Chair Test
21. BS ISO 2094: 1999; Textile floor coverings. Determination of thickness loss under dynamic loading

4 Definitions

Abnormal operating condition

State of continuing railway operations with specific, planned changes to its configuration or equipment (such as special events, engineering works in traffic hours or within station public areas).

Control Console

Structural framework which supports equipment, work surfaces and storage and which together comprise a control workstation. (Reference ISO 11064-3: 1999)

Control Panel

Discrete surface on which groups of displays and controls are mounted: control panels may be mounted on the control workstation or on walls. (Reference ISO 11064-3: 1999)

Control Centre

Combination of control rooms, control suites and local control stations which are functionally related and on the same site. (Reference ISO 11064-3: 1999) (Note – there may be multiple control suites and control rooms which together form a control centre)

Control Room

Core functional entity, and its associated physical structure, where operators are stationed to carry out centralized control, monitoring and administration. (Reference ISO 11064-3: 1999) (Note – the functions include also the provision of information)

Control Room Operator

Individual whose primary duties relate to the conduct of monitoring and control functions, usually at a control workstation, either on their own or in conjunction with other personnel both within the control room or outside. (Reference ISO 11064-3: 1999)

Control Workstation

Single or multiple working position, including all equipment such as computer and communication terminals and furniture at which control and monitoring functions are conducted. (Reference ISO 11064-3: 1999)

Control Suite

Group of functionally related rooms, co-located with and including the control room, which houses the functions supporting the control room. (Reference ISO 11064-3: 1999)

Degraded operating condition

State of continuing railway operations with significant equipment failures (such as track related failures and communications system failures).

Design Specification

Detailed description of features of the control suite, including control room arrangements, equipment, workstation displays and operator controls, which meet the control centre's

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overall requirements with regard to development, procurement and construction.
(Reference ISO 11064-1: 2001)

Direct Operator Supervision

Supervision of control room operators, and other staff, by direct observation and /or via direct speech links. (Reference ISO 11064-3: 1999)

Disability

Any reduction in normal capacity due to mental or physical factors which prevents an individual from experiencing or performing a full complement of activities [12].

Display

Device for presenting information that can change with the aim of making things visible, audible or discriminable by tactile or proprioceptive perception. (Reference ISO 11064-3: 1999)

Emergency operating condition

State of the railway in response to a major safety or security related event. Introduction of contingency plans at a moments notice.

Ergonomist (competent)

Qualified and experienced in the practice of ergonomics with a particular bias towards control room ergonomics. Further guidance can be obtained from the Network Rail Professional Head of Ergonomics.

Ergonomics Specification (HFS)

A document including job descriptions, operational links, equipment provision, job aids and staffing levels for the control suite.

‘Fixities’

Elements of a project that are not amenable to change and need to be accepted as fixed for a given control room design programme.

Function Allocation

Distribution of functions between man and machine. (Reference ISO 11064-1: 2001)

Functional Analysis

Analysis identifying those requirements which need to be met by men or machines in order to achieve the operational goal. (Reference ISO 11064-1: 2001)

Functional Groups

Grouping of control workstations where the operational duties are such that close, direct liaison is required and therefore benefit from proximity to one another. (Reference ISO 11064-3: 1999)

Functional Layout

Layout in which the general location of differing control functions in a control room are indicated. (Reference ISO 11064-3: 1999)

Functional Specification

A record, based on a functional analysis, of what the control centre is to provide for in terms of such features as functions, support of users and machines, relationships with external systems, and physical and environmental attributes. (Based on ISO 11064-1: 2001)

Gross area

Overall number of square metres designated for a control room. (Reference ISO 11064-3: 1999) (Note – this is based on the floor area)

Human-Centred Design Approach

Approach to interactive/iterative system development, focusing specifically on making systems usable, and emphasizing the role of human operators as control agents who maintain authority within a working system. (Ref ISO 11064-1: 2001)

Job Design

Process of determining what the job content should be for a set of work tasks and how the tasks should be organized and interlinked.

L_{Aeq}

Equivalent continuous A-weighted sound pressure level L_{AeqT} the level in decibels given by the equation:

$$L_{Aeq,T} = 10 \lg \left[\frac{1}{t_2 - t_1} \int_{t_1}^{t_2} \frac{R_A^2(t)}{R_0^2} dt \right]$$

where $t_2 - t_1$ is the period T over which the average is taken started at t_1 and ending at t_2 . (ISO 77779:1999 Definition 3-5)

LINK Analysis

A process whereby necessary operational links between operators and/or systems - such as visual, reach and team links - is documented and analysed.

Normal operating condition

State of normal running of the railway incorporating minor disturbance and delays to the service in traffic hours and operations during non-traffic hours.

Off-Workstation Display

Displays which are not mounted on the control workstation: such displays, often visual, may be display panels, mimic diagrams and observation windows. (Reference ISO 11064-3: 1999)

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Primary Information

Information which is essential for the satisfactory exercise of control functions. (Reference ISO 11064-3: 1999)

Primary User

Person engaged in those job functions normally associated with control centre activities. (Reference ISO 11064-1: 2001)

Primary Workstation

Control workstation that is usually staffed and is in the main control area. (Reference ISO 11064-3: 1999)

Refurbishment

A programme of work or works to change or improve the control facility. Routine maintenance, painting etc. is not encompassed within the definition of refurbishment. Guidance can be obtained from the Network Rail Ergonomics Group.

Secondary Information

Information which is either of secondary importance to the control function or which does not need to be immediately available to the control room operator. (Reference ISO 11064-3: 1999)

Secondary Workstation

Workstation on which supportive tasks are undertaken or on which an overload of tasks can be carried out during periods of peak workloads. (Reference ISO 11064-3: 1999)

Shared Visual Display Device

On-workstation visual display, which needs to be used by more than one control room operator while they are at their control workstations. (Reference ISO 11064-3: 1999) (Note – off workstation displays may also be shared)]

Slab to Slab

The distance between the concrete floor and ceiling before any finishes (e.g. suspended ceiling) are applied.

Situational Analysis

A task analysis in an existing situation to analyse all the behavioural aspects of the work system (i.e. such as revealing practical experiences, informal communication, expectations and complaints of current users and any other facts that might be useful for redesign purposes). (Based on ISO 11064-1: 2001)

Supervisor

Individual whose primary responsibilities relate to the satisfactory conduct of control functions by the control room, the supervision of staff and equipment and, when necessary, the conduct of control tasks. (Reference ISO 11064-3: 1999)

Task Analysis

Analytical process employed to determine the specific behaviour required of people when operating equipment or doing work. (Reference: ISO 9241-5:1998)

Task Allocation

Distribution of work tasks or work task elements between operators and systems. (Reference ISO 11064-2: 2000)

Usable Area

Gross area less deduction for unusable spaces, such as around pillars, awkward corners and nearby entrances/exits. (Reference ISO 11064-3: 1999)

Work Environment

Physical, chemical, biological, organisational, social and cultural factors surrounding a person in his or her work space. (Reference EN 614-1)

Work Space

Volume allocated to one or more persons in the work system to complete a work task. (Reference ISO 6385)

Work Task

Activity required to achieve an intended outcome of the work system (Reference ISO 11064-2:2000)

Workstation

Combination of work equipment for a particular person in a work space. (Reference ISO 11064-3: 1999)

Work System

One or more person and work equipment acting together to perform the system task, in the work space, in the work environment, under conditions imposed by the work tasks. (Reference EN 614.1)

Working Assumptions

Assumptions concerning key aspects of the control centre project, which allows the design to progress. (Note - these are arrived at and agreed with the project team and appropriate SME's)

Validation

Confirmation by a systematic examination and provision of evidence that the particular requirements for a specific intended use are fulfilled, (based on ISO 8402)

Verification

Confirmation by examination and provision of objective evidence that specified requirements have been fulfilled, (see ISO 8402)

Abbreviations

AF	Allocation of functions
BSRIA	Building Services, Research and Information Association
CCTV	Closed Circuit Television
CIBSE	Chartered Institute for Buildings Services Engineers
COTS	Commercial Off The Shelf
DB	Decibel
ECO	Electrical Control Operator
F Ergs.	Fellow of The Ergonomics Society
FMEA	Failure Mode and Effect Analysis
GUI	Graphical User Interface
HAZOP	Hazard and Operability Study
HCI	Human Computer Interaction
HEART	Human Error and Assessment and Reduction Technique
HF	Human Factors
EIP	Ergonomics Integration Plan
HFTES	Human Factors Test and Evaluation Strategy
HMI	Human Machine Interface
HMRI	Her Majesty's Railway Inspectorate
HR	Human Resources
HRA	Human Reliability Analysis
HSC	Health and Safety Commission
HSE	Health and Safety Executive
HVAC	Heating, Ventilating and Air conditioning

IMD	Instructional Module Design
ISD	Instructional Systems Design
ISO	The International Organisation For Standardisation
M ErgS.	Member of The Ergonomics Society
PPE	Personal Protective Equipment
SME	Subject Matter Expert
TA	Task Analysis
TAD	Target Audience Description
TCS	Train Control System
THERP	Technique for Human Error Rate Prediction
TNA	Training Needs Analysis
UGR	Universal Glare Rating
UPS	Uninterrupted Power Supply
VDU	Visual Display Unit
VOCs	Volatile Organic Compounds
WBS	Work Breakdown Schedule.

5 Control Room: Ergonomics Design Process

5.1 Requirements

I(1) Ergonomics input within the Control Room Design Process shall follow the phases presented in Figure 2.

I(2) An Interdisciplinary Team, including suitable ergonomics competence (see definition), shall be assembled to ensure an appropriate balance and representation of skills.

I(3) Ergonomics input shall encourage a User Centred approach within the Control Room Design Process.

I(4) Suitable time and resource shall be made available for iterative ergonomics input throughout the Control Room Design Process lifecycle.

I(5) Task Analysis of existing or comparable operations shall be conducted by competent personnel at an early stage of the design programme.

I(6) Functional Analysis covering User and systems shall be conducted by competent personnel during the early stages of the design programme.

I(7) Appropriate consideration shall be given to accommodating the needs of employees with disabilities.

I(8) A system for documentation of ergonomics input shall be developed and maintained throughout the Control Room Design Process lifecycle.

I(9) The criteria and methods used in the ergonomics verification and validation process shall be recorded.

I(10) New site projects shall meet all Requirements presented in this standard.

I(11) Re-furbishment projects shall meet Requirements here unless 'fixities' preclude compliance. In this case, an ergonomics risk assessment shall be undertaken and, if shown to be appropriate, derogation from this standard shall be agreed with responsible stakeholders. Agreed ergonomic derogations shall be documented.

I(12) Stagework projects may not be required to meet all the Requirements presented in this standard. An ergonomics risk assessment shall be undertaken for all Stagework projects to identify suitable ergonomics solutions. A 'Temporary Use License' shall be assigned by the Network Rail Professional Head of Ergonomics before operation of any temporary Control Room, or parts of a control room set up for interim operation.

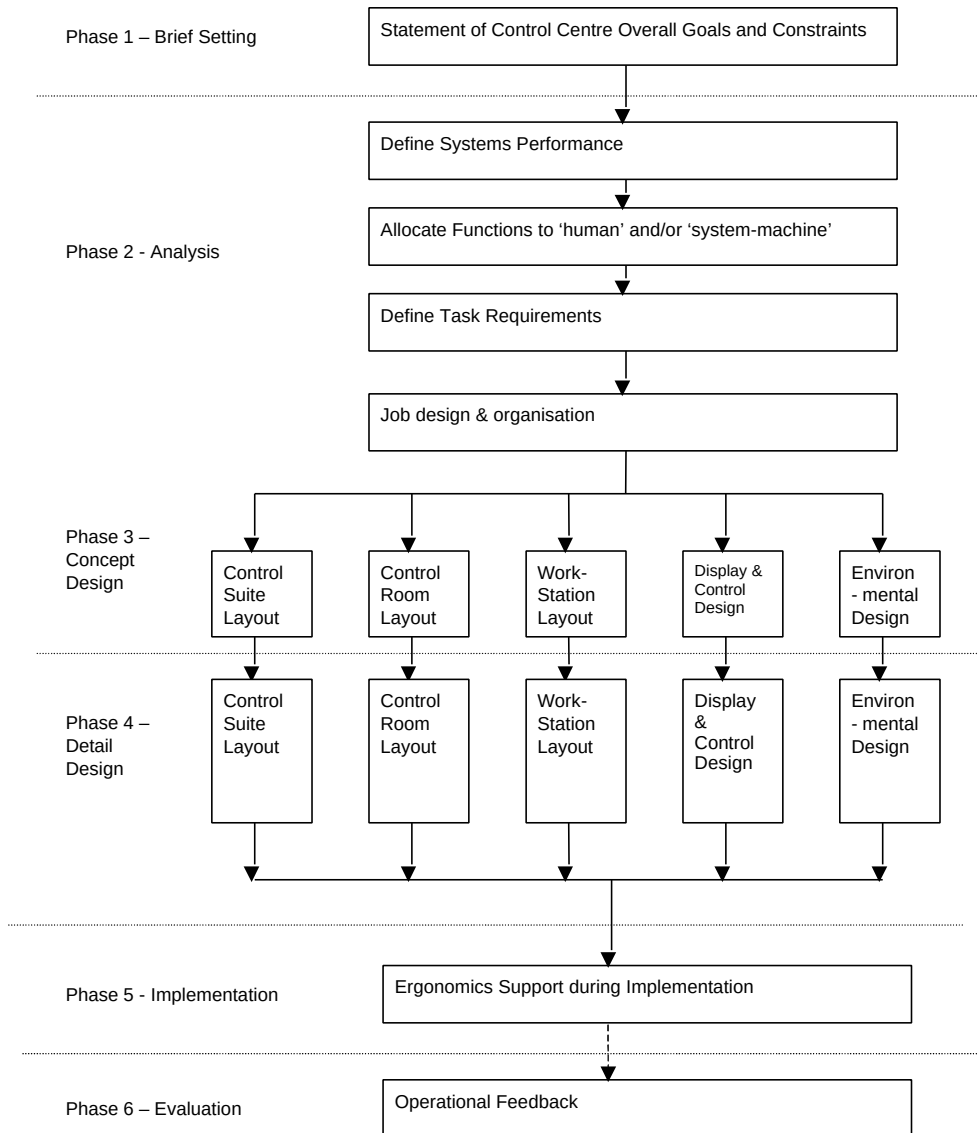


Figure 2: Control Centre Ergonomics Design Process
(based on ISO 11064-1: 2000 reference 1)

5.2 Recommendations

Brief Setting Phase: Ergonomics input should establish context, resources and constraints. It may not be possible, or even feasible, to meet ergonomics Requirements within the design brief and such constraints should be identified as early as possible. Ergonomics methods should include:

- Documentation review
- Interviews
- Audits of comparable Control Rooms
- Technology reviews
- Requirements preparation & review

- Ergonomic Cost Benefit Reviews

Analysis Phase: Ergonomics input should establish User and systems functionality and performance requirements to determine job roles & responsibilities, work organisational plans, systems functionality & usability and overall Control Room operating goals. Ergonomics methods should include:

- Task Analysis
- Functional Analysis (normal, degraded and maintenance)
- Operational simulations
- Hazard and risk analysis
- Systems interface analysis
- Workload analysis
- Human error analysis
- Preparation of Ergonomics Specification
- Operational competency requirements

Concept Design Phase: Ergonomics input should support the development of an integrated design project that satisfies the functional, organisational, task and systems requirements identified in the Analysis Phase. Ergonomics input should not be restricted to physical issues (Control Room, Control Suite, Workstation, Display & Control and Environment) but should also consider relevant aspects of human resourcing, organisation, welfare, training and team working. Ergonomics methods should include:

- Layout and mock-up trials (workstations and control room layout)
- LINK analysis
- Prototyping
- Scenario analysis (such degraded, normal and emergency operations)
- Simulation
- Product assessments
- Style Guide development
- Standards compliance audit
- Environmental assessments
- Virtual Reality visualisation
- Preliminary designs

Detailed Design Phase. Ergonomics input should support the development of detailed design specifications. Ergonomics methods should include:

- User trials
- Ergonomic specifications
- Procurement ergonomics