Eskom	Standard	Technology

Title: **Human Machine Interface Design Requirements Standard**

Unique Identifier:	**240-56355728**
Alternative Reference Number:	**N/A**
Area of Applicability:	**Engineering**
Documentation Type:	**Standard**
Revision:	**2**
Total Pages:	**11**
Next Review Date:	**March 2023**
Disclosure Classification:	**CONTROLLED DISCLOSURE**

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PCM Reference : **240-56355828**

SCOT Study Committee Number/Name : **Power Plant C&I Study Committee, PP C&I SC08-03**

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1. INTRODUCTION

The Human Machine Interface (HMI) is an essential interface between plant Operating personnel and the plant's systems and components. The Operator depends on the HMI to provide feedback on plant processes. The HMI governs the flow of information from the plant to the Operator (in terms of displays, warning sounds, etc.) and from the Operator to the plant (in terms of control devices such as keyboards, switches, levers, etc.). An optimally designed HMI is easy to navigate, increases operator productivity, and reduces operator stress.

This document aims to standardise the physical and functional characteristics of the HMI's across Eskom Power Generating Stations. It provides a standard for the design and development of the HMI that is to be implemented on all Eskom Power Generating Stations.

2. SUPPORTING CLAUSES

2.1 SCOPE

This document specifies minimum requirements of the HMI that shall be implemented in an Eskom Power Station. It is primarily intended to be used in the design of the HMI. These design requirements are applicable to the Power Islands and the Common plant.

The scope of this document excludes the following:

- The ergonomic design considerations of the control suite which is subject to a separate document namely, 240- 56355808: Ergonomic Design of Power Station Control Suites Guideline.
- Alarm management issues such as alarm rationalisation and prioritization.
- All software applications and licensing, network architectures and connectivity, Plant Information Systems (PIS) design requirements, hardwired mimic panels and operating and maintenance practices.
- Touch screen operator panels that are used for local operations (Local Control Panels).

2.1.1 Purpose

The purpose of this standard is to specify the minimum requirements that need to be met for the design and implementation of the Human Machine Interfaces (HMI) for Eskom Power Stations.

2.1.2 Applicability

This document shall apply to HMI applications at Eskom Power Stations, including Nuclear Power Stations. This document shall be used for new build, refurbishment projects as well as modifications to existing HMIs.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] IEC 60027, Letter symbols to be used in Electrical Technology

[2] IEEE Standard 1289-1998, "IEEE Guide for the Application of Human Factors Engineering in the Design of Computer-Based Monitoring and Control Displays for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers, Inc., 1998.

2.2.2 Informative

[3] 1001066 - Human Factors Guidance for Digital I&C Systems and Hybrid Control Rooms: Scoping and Planning Study, 27 November 2000.

[4] Hexatec, Operator Screen (HMI) Design Guidelines, 2002.

[5] 240-56355731 - Environmental Conditions For Process Control Electronic Equipment used at Power Stations

[6] European Agency for Safety and Health at Work; *The Human Machine Interface As An Emerging Risk*, 2006

[7] 240- 56355808 - Ergonomic Design of Power Station Control Suites Guideline.

2.3 DEFINITIONS

Definition	Description
Alphanumeric Characters	Alphanumeric characters are symbols consisting of letters, digits, and usually other symbols, such as punctuation marks.
Arbitrary Code	Arbitrary codes are alphanumeric characters without natural organization.
Cursor	A cursor is an on-screen graphic element that is driven by the user (using a mouse or other control device) to move and manipulate on-screen objects.
Display Navigation	Display navigation refers to the operation of searching for information, such as finding a desired display in a display network, or finding an item of information within a large display.
Display Page	Display pages are defined sets of information intended to be presented as a single unit.
Display Selection	Display selection refers to the process of retrieving a desired display or item of information.
Dynamic Sequence Displays	Dynamic Sequence Displays refers to the step-by-step monitoring of power plant automation sequence logic consisting of pre-conditions, step conditions and completed conditions that are available as a display on the HMI.
Ergonomics	Ergonomics is the science of humans' relationship with the working environment. It considers all aspects of human interaction with systems and machines and its application takes many forms, which include the working environment, the social environment, physical aspects of equipment design, information engineering and psychological aspects of information transfer.
Faceplate	The interface or window of a particular component in an HMI graphic page through which the said component is operated and monitored in detail.
Graphic Page	A software mimic representing a specific plant area using dynamic and static elements (graphical symbols).
Highlighting	Highlighting is a means of directing the user's attention to a feature of the display.
HMI	The human machine interface is the software package on the operator workstations via which the plant operator interacts (operates & monitors) the process plant. The HMI is inclusive of all HMI graphics, alarm pages, event pages, trends, plots, and other elements that form part of the software package used to operate and monitor the plant.
HMI Graphic	Refers to all faceplates and graphic pages of an HMI.
Icon	An icon is a pictorial, pictographic, or other nonverbal representation of objects or actions.
Label	A label is a descriptor containing one or more character strings that is intended to

Definition	Description
	support users in identifying structures or components.
Menu	A menu is a displayed listing of possible options from which a user can choose.
Numeric Data	Data that is represented in numerical form, as opposed to text form.
Plant Information Systems	The Plant Information System allows near real-time and historical plant information to be available to users and other software applications. It performs short term, long term storage and archiving of process information as well as Sequence of Event recording, process trending and operator event logging.
Sans-Serif Font	Sans-serif fonts are those without serifs
Serif Font	Serifs are the structural details on the end of strokes that make up letters and symbols in serif fonts.
Symbol	A symbol is a representation of something by reason of relationship, association or convention. Symbols used in information displays may be alphanumeric characters or abstract shapes.
Window	A window is a dedicated geometric area on a display screen within which the system presents information or receives input from the user.

2.3.1 Disclosure Classification

Controlled Disclosure: Controlled Disclosure to External Parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
HMI	Human-Machine Interface
P&ID	Piping and Instrumentation Drawings
PLCM	Project Life-Cycle Model
PIS	Plant Information System

2.5 ROLES AND RESPONSIBILITIES

The design of the HMI shall meet the requirements outlined in this document.

- The Lead Design Engineer shall be responsible to ensure that this standard is implemented on new projects.
- The Design Review Team checks compliance to this standard during the various stages of review as part of the project lifecycle model (PLCM)

2.6 PROCESS FOR MONITORING

The document shall be updated in accordance with the Eskom document review process or as business needs change.

2.7 RELATED/SUPPORTING DOCUMENTS

This document supersedes EED_GTD_C&I_002

3. HUMAN MACHINE INTERFACE DESIGN REQUIREMENTS STANDARD

3.1 GENERAL REQUIREMENTS

3.1.1 Alphanumeric Characters

- Text, with the exception of labels, shall be presented using upper and lower case characters.
- Capitalization shall be used to start sentences, and to indicate proper nouns and acronyms.
- Labels shall be displayed in upper case.
- A sans-serif font shall be used. An example of a sans-serif font is Arial. Sans-serif fonts are more legible on electronic displays than serif fonts.
- For the selected font, it must be possible to clearly distinguish between X and K, T and Y, I and L, I and 1, O and Q, O and 0, S and 5, and U and V.
- Text, numbers and symbols shall be readable from the normal operating position be it seated or standing at the control desk.

3.1.2 Numeric Data

- Numeric values shall be displayed using the decimal number system.
- Leading zeros for whole numbers shall not be displayed. For example, the number fifty two must be displayed as 52, rather than 0052. A leading zero shall only be provided if the number is a decimal with no preceding integer. For example, the decimal number of a half should be displayed as 0.5, rather than .5.
- Numbers shall be displayed at the number of significant digits required by the users to perform their tasks. The number of significant digits must be supported by the accuracy of the underlying instruments and control system hardware.
- Each numeric display must be able to accommodate all the values in the range of its variable.
- All numeric data shall be oriented horizontally.

3.1.3 Abbreviations and Acronyms

- Abbreviations shall be avoided, except when terms are commonly referred to by their initials.
- When an abbreviation is necessary due to space constraints, they shall be used in accordance with the Eskom Plant Labelling Abbreviation Standard, 240-109607332. The words chosen for abbreviation shall be commonly known in their abbreviated form as per standard, and be unambiguously interpreted.
- Abbreviations shall be distinctive so that the abbreviations for different words are distinguishable.
- Abbreviations and acronyms shall not include punctuations. For example, BFPT is preferred over B.F.P.T.
- Abbreviations shall be used consistently, i.e., a word shall not be abbreviated in one label and spelt out in full in another i.e. the description for a particular component is always consistent and contains the same words, sequence of words and/or abbreviations
- The use of the letters ‘O’ and ‘I’ in arbitrary codes shall be avoided, since they are easily confused with the numbers ‘0’ (zero) and ‘1’ (one), respectively.
- When arbitrary codes use both letters and numbers, the letters shall be grouped together and numbers grouped together rather than interspersing letters with numbers.

3.1.4 Labels

- Label formats shall be consistent across and within displays.
- Labels shall be worded consistently, so that the same item is given the same label wherever it appears.
- Labels shall be uniquely emphasized to differentiate them from other screen structures and data.
- Labels shall be separated from one another by at least two standard character spaces.
- Labels shall be oriented horizontally.

3.1.5 Icons and Symbols

- Icons in graphic displays shall primarily be used to represent actual objects or actions.
- Icons and symbols shall be used consistently throughout the displays. Icons shall be designed to look like the objects, processes, or operations they represent, by use of literal, functional, or operational representations.
- Icons must be closed i.e. they must have a continuous outside border.
- The symbols used on displays shall be consistent with those of other information sources used in the work area, such as P&IDs and logic diagrams, or based on the outline or physical structure of the plant device if ergonomically appropriate.
- Each icon and symbol shall represent a single object or action, and shall be easily distinguished by their external geometric configuration from all other icons and symbols.
- Icons and symbols shall be large enough for the user to perceive the representation and discriminate it from other icons and symbols.
- Icons shall be accompanied by a text label, except when the icon has an unambiguous meaning to the user, e.g., standard P&ID symbology as per Piping and Instrumentation Diagram Standard, 240-61227631. The text label shall be incorporated into the icon itself, provided it does not clutter or cause distortion of the icon.

3.1.6 Colours for HMI Graphics

- The colours used for coding shall be readily distinguishable from each other.
- The number of colours used for coding shall be kept to the minimum needed for providing sufficient information. Once colours are assigned a specific use or meaning, no other colour shall be used for the same purpose.
- The colours used for emphasizing critical items shall be confined to a single use or meaning.
- Colours of text shall be consistent throughout.

3.1.7 Cursors

Cursors shall have distinctive visual features.

3.1.7.1 Pointing Cursors

- The pointing cursor shall be visible to the user at all times.
- The pointing cursor shall not blink.
- The position of the pointing cursor shall be clearly visible during movement from one screen position to another.

- The pointing cursors shall be completely graphical and shall not contain a label.
- The pointing cursor shall maintain its size across all screen and display locations.
- The pointing cursor shall not move in the absence of any input from the user.

3.1.7.2 Text Entry Cursors

- The text entry cursor shall only be visible when text entry is possible or required.
- The text entry cursor shall blink at a at a rate that can be easily located by the operator.
- The text entry cursor shall not obscure any displayed characters.
- There shall be only one text entry cursor, at a time, per window.
- The text entry cursor shall assume the height and/or width of the text characters adjacent to it.

3.1.8 HMI Graphics

- HMI displays should have high contrast between objects in the foreground and background. The effects of alternate light source reflection shall be considered.
- Displays shall be configured in a clear and unambiguous manner to provide the operator with information relevant to the task.
- Every display shall have a title positioned suitably at the top, which briefly describes the contents or purpose of the display.
- Every display page shall have a unique identification to provide a reference for use in requesting the display of that page.
- Displayed information, which temporarily overlays and obscures other display data, must not erase the overlaid data.
- In a multi-page display, each page must be labelled to show its relation to the others.
- Dynamic sequence displays shall be used to initiate groups, subgroups or final control elements, such as actuators, in a distinct sequence, determined by the actions of previous events. The display shall as a minimum include the following:
    - The description of the entire sequence and associated steps using appropriate colours for the visualisation
    - The state of the sequence and corresponding codification
    - The mode of the sequence
    - The “total time” against “remaining time” of the sequence and active step

3.1.9 Menus

- Navigation shall be clear, simple and unambiguous.
- Navigation between pages must be consistent from.
- All menu items shall be visible to the user without scrolling.
- Menu options shall be ordered and grouped logically. If no logical structure is apparent, the menu options must be ordered alphabetically.
- The order of the menu options shall be fixed.
- Menus shall clearly indicate which options are selectable.

- When the same options appear on several different menus, consistency of wording and ordering on all of the menus shall be maintained.
- When menu selection is to be made from a long list, and not all options can be displayed at once, a hierarchical sequence of menu selections shall be provided rather than one long multi-page menu.
- When hierarchical menus are used, the user must have some indication of current position in the menu structure.
- Users shall be able to return to the highest level menu in the hierarchical menu structure by a single key action.

3.1.10 Windows

- Windows shall be identified by a label consistently located at the top of the window's border.
- Windows shall be visually separated from each other and from their background, preferably by borders or similar demarcation.
- Users shall be able to select separate windows that will share a single display screen.
- When multiple windows are opened simultaneously, the user shall have the capability to layer, or sequentially view the windows. Layering refers to moving one window so it appears to be positioned on top of another one.
- The viewable area of a window shall not be larger than the display screen.
- Window types shall be perceptually distinct. For example, active windows in both the tiled and layered window environments shall be perceptually distinct from inactive window types.
- Under normal operating conditions, active windows shall be front most on the display.
- Caution and warning windows shall be front-most on the display.
- User control of windows shall operate consistently from one display to another for each type of window.
- Users must be able to close windows with a single action.
- The users must be able to move windows to different areas of the display.
- The action that opens a window shall automatically make that window active.
- Windows shall have a default location on the display screen.
- Windows shall not be larger than the display screen.
- Display data that is temporarily obscured by a window object shall reappear when the object is removed.
- There shall be an upper limit to the number of windows allowed to be open at one time.

3.1.11 Errors

- The HMI shall be fault tolerant to the extent that no set or sequence of key strokes shall cause the HMI to fail or freeze.
- Any incorrect operation shall be indicated to the operator by audible signal or suitable text message.
- In all cases a standardised back track facility shall be available so that the operator can escape from a display. True system errors shall be fully indicated as to type, cause and remedial action.

4. AUTHORISATION

This document has been seen and accepted by:

Name & Surname	Designation
	C&I Engineering Manager – Matimba Power Station
	C&I Engineering Manager – Camden Power Station
	C&I Engineering Manager – Tutuka Power Station
	C&I Engineering Manager – Arnot Power Station
	C&I Engineering Manager – Lethabo Power Station
	C&I Engineering Manager – Kriel Power Station
	C&I Engineering Manager – Kendal Power Station
	C&I Engineering Manager – Grootvlei Power Station
	C&I Engineering Manager – Komati Power Station
	C&I Engineering Manager – Matla Power Station
	C&I Engineering Manager – Hendrina Power Station
	C&I Engineering Manager – Majuba Power Station
	C&I Engineering Manager – Duvha Power Station
	C&I Engineering Manager – Medupi Power Station
	C&I Engineering Manager – Kusile Power Station
	C&I Chief Technologist - PEIC
	Chief Technologist – Electrical CoE
	Senior Technologist – C&I Engineering Koeberg Power Station
	Senior Advisor –Nuclear Engineering Koeberg Power Station
	Senior Advisor - Engineering
	Technical Officer – Operator Training
	Chief Engineer - Peaking
	C&I Senior Engineer – C&I CoE
	Chief Technologist – Electrical CoE
	Engineer – C&I CoE

5. REVISIONS

Date	Rev.	Compiler	Remarks
November 2012	0		Draft document for Review created from EED_GTD_C&I_002
January 2015	0.2		Draft Document
January 2015	0.3		Draft Document for Comments Review
February 2015	0.4		Draft Document for Comments Review
May 2015	0.5		Draft Document for SCOT Comments Review
June 2015	1		Final Document for Authorisation and Publication
February 2018	1.1		Document reviewed as per review cycle.
March 2018	2		Final Rev 2 Document for Authorisation and Publication

6. DEVELOPMENT TEAM

The following people were involved in the development of this document:

- Dr. C.D. Boesack
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- P. Govender

7. ACKNOWLEDGEMENTS

- None.