

ISA–TR77.60.04 (R2008)

**Fossil Fuel Power Plant
Human-Machine Interface —
Electronic Screen Displays**

Reaffirmed 14 November 2008

.....



Documents
Document Sharing Hub

ISA-TR77.60.04 (R2008)
Fossil Fuel Power Plant Human-Machine Interface – Electronic Screen Displays

ISBN: 978-1-934394-86-1

Copyright © 2008 by ISA. All rights reserved. Not for resale. Printed in the United States of America. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means (electronic, mechanical, photocopying, recording, or otherwise), without the prior written permission of the Publisher.

ISA
67 Alexander Drive
P.O. Box 12277
Research Triangle Park, NC 27709
www.isa.org

Copyright 2008 ISA. All rights reserved.



Documents
Document Sharing Hub

Preface

This preface, as well as all footnotes and annexes, is included for informational purposes only and is not part of ISA-TR77.60.04 (R2008). The purpose of this Technical Report is to provide advice and guidance in the development of Electronic Screen Displays for use in conjunction with real-time Distributed Control Systems used in utility fossil-fired power plants with boilers of 200,000 lb/hr or greater capacity.

This document has been prepared as part of the service of ISA—The Instrumentation, Systems, and Automation Society—toward a goal of uniformity in the field of instrumentation. To be of real value, this document should not be static but should be subject to periodic review. Toward this end, the Society welcomes all comments and criticisms and asks that they be addressed to the Secretary, Standards and Practices Board; ISA; 67 Alexander Drive; P. O. Box 12277; Research Triangle Park, NC 27709; Telephone (919) 549-8411; Fax (919) 549-8288; Email: standards@isa.org.

The ISA Standards and Practices Department is aware of the growing need for attention to the metric system of units in general, and the International System of Units (SI) in particular, in the preparation of instrumentation standards. The Department is further aware of the benefits to USA users of ISA standards of incorporating suitable references to the SI (and the metric system) in their business and professional dealings with other countries. Toward this end, this Department will endeavor to introduce SI-acceptable metric units in all new and revised standards, recommended practices, and technical reports to the greatest extent possible. *Standard for Use of the International System of Units (SI): The Modern Metric System*, published by the American Society for Testing & Materials as IEEE/ASTM SI 10-97, and future revisions, will be the reference guide for definitions, symbols, abbreviations, and conversion factors.

It is the policy of ISA to encourage and welcome the participation of all concerned individuals and interests in the development of ISA standards, recommended practices, and technical reports. Participation in the ISA standards-making process by an individual in no way constitutes endorsement by the employer of that individual, of ISA, or of any of the standards, recommended practices, and technical reports that ISA develops.

CAUTION — ISA adheres to the policy of the American National Standards Institute with regard to patents. If ISA is informed of an existing patent that is required for use of the standard, it will require the owner of the patent to either grant a royalty-free license for use of the patent by users complying with the document or a license on reasonable terms and conditions that are free from unfair discrimination.

Even if ISA is unaware of any patent covering this document, the user is cautioned that implementation of the document may require use of techniques, processes, or materials covered by patent rights. ISA takes no position on the existence or validity of any patent rights that may be involved in implementing the document. ISA is not responsible for identifying all patents that may require a license before implementation of the document or for investigating the validity or scope of any patents brought to its attention. The user should carefully investigate relevant patents before using the document for the user's intended application.

However, ISA asks that anyone reviewing this document who is aware of any patents that may impact implementation of the document notify the ISA Standards and Practices Department of the patent and its owner.

Additionally, the use of this document may involve hazardous materials, operations or equipment. The document cannot anticipate all possible applications or address all possible safety issues associated with use in hazardous conditions. The user of this document must exercise sound professional judgment concerning its use and applicability under the user's particular circumstances. The user must also consider the applicability of any governmental regulatory limitations and established safety and health practices before implementing this document.

The following people served as voting members of ISA77 and reaffirmed the document on 7 December 2007:

NAME	COMPANY
D. Roney, Chair	URS - Washington Division
L. Altcheh	Israel Electric Corp.
J. Batug	PPL Generation LLC
D. Christopher	Consultant
G. Cohee	Applied Control Systems
D. Crow	Invensys Foxboro
R. Eng	Hitachi Power Systems America
A. Gavrilos	ABB Inc.
J. Gilman	JFG Technology Transfer LLC
W. Hocking	Consultant
W. Holland	CH2M Hill
R. Hubby	Consultant
R. Johnson	Retired
D. Lee	ABB Inc.
G. McFarland, Managing Director	Emerson Process Management
G. Mookerjee	Detroit Edison Co.
J. Olson	Tennessee Valley Authority
P. Reeves	Luminant Power
M. Skoncey	First Energy Generation Corp.
T. Stevenson	Constellation Energy
C. Taft	Consultant
A. Zadiraka	Babcock & Wilcox

The reaffirmed technical report was approved for publication by the ISA Standards and Practices Board on 14 November 2008.

NAME	COMPANY
T. McAvinew, Chair	I&C Engineering, LLC
M. Coppler	Ametek, Inc.
E. Cosman	The Dow Chemical Co.
B. Dumortier	Schneider Electric
D. Dunn	Aramco Services Co.
J. Gilsinn	NIST/MEL
E. Icahan	ACES, Inc.
J. Jamison	Husky Energy, Inc.
K. Lindner	Endress+Hauser Process Solutions AG
V. Maggioli	Feltronics Corp.
A. McCauley, Jr.	Chagrin Valley Controls, Inc.
G. McFarland	Emerson Process Management
R. Reimer	Rockwell Automation
N. Sands	E I Du Pont
H. Sasajima	Yamatake Corp.
T. Schnaare	Rosemount, Inc.
J. Tatera	Tatera & Associates, Inc.
I. Verhappen	Syncrude Canada Ltd.
R. Webb	Consultant
W. Weidman	Parsons Energy & Chemicals Group
J. Weiss	KEMA, Inc.
M. Widmeyer	Stanford Linear Accelerator Center
M. Zielinski	Emerson Process Management

Table of Contents

Preface.....	3
Table of Contents.....	5
Abstract.....	6
Key words	6
1 Scope.....	7
2 Purpose.....	8
3 Display structure	8
4 Display access	9
5 Display types.....	10
6 Format standards.....	10
7 Display organization.....	11
8 Coding conventions.....	13
9 Display elements.....	17
10 Operator entry techniques.....	19
11 Control applications.....	21
12 Alarm management.....	23
13 Work station ergonomics.....	23
14 Electronic Screen Display replacement guidelines	24
15 Security Safeguards for HMI	24
Annex A — References.....	25
Annex B — Typical color conventions for grey background.....	27

Abstract

This report recognizes the substantial volumes of technical information already in existence on the topic of Electronic Screen Display development. The intention of this Report is to provide a practical summary overview of the important considerations that apply to the development of effective Electronic Screen Displays. It is hoped to be a handy reference to those design engineers and power-plant operators who are directly involved in display development.

Key words

Electronic Screen Displays, coding conventions, color coding, Electronic Screen Display alarm management, Electronic Screen Display control applications, Electronic Screen Display development, Electronic Screen Display elements, Electronic Screen Display organization, Electronic Screen Display status, Electronic Screen Display structure, Electronic Screen Display types, Electronic Screen Display replacement guidelines, display access, Distributed Control Systems (DCS)*, format standards, fossil fuel power plant, human-machine interface, navigation designs (standard), operator entry techniques, real-time DCS, shape coding, size coding, typical color conventions for black background, work station ergonomics.

NOTE - Distributed Control Systems are also referred to as Digital Control Systems.

Copyright 2008 ISA. All rights reserved.

1 Scope

This technical report is provided for the benefit of design engineers and ultimately fossil-power plant operators. By following this technical report, the developer of Electronic Screen Displays will

- a) provide clear and efficient communication between the user and the distributed control system, SCADA and/or PLC based system with HMI;
- b) accomplish display design based on the user's needs that are based on an assessment of planned control-operator functions to be performed; and
- c) provide a display design to obtain timely access to required information and controls in a logical structure convenient to the user.

The display structure and organization, including access time to make appropriate control adjustments, should provide for operator response comparable to that of non-display-based, human-machine interface systems. To meet this requirement, the display structure must be developed using

- a) clearly designed display accessing techniques;
- b) a set of well-structured display relationships, predictable and familiar to the user;
- c) standard display formats to increase speed of access to items within a display;
- d) logical grouping of functions and tasks that minimize memorization of elements or results from previous displays;
- e) separation of overview graphics to simplify control graphics, preventing a "cluttering" of information and facilitating quicker display updates;
- f) as few levels as possible going from the overview display to the detail displays; and
- g) consistent use of colors, patterns, symbols, shapes, etc. throughout the entire set of graphics.

Input from plant operating personnel in all phases of Electronic Screen Display development is critical to the development of effective displays. It is even recommended to have plant operating personnel build many of the graphics to ensure a sense of ownership by operations personnel.

This technical report will address the following issues relating to Electronic Screen Display development: Display structure Display elements Display access Operator entry techniques Display types Control applications Format standards Alarm management Display organization Work station ergonomics Coding conventions

Recognizing the substantial volumes of technical reports on the topic of Electronic Screen Display development, the intent of this report is to provide a summary/overview of the important considerations that apply in the development of effective Electronic Screen Displays. For additional detailed guidance, please refer to Annex A — References.

2 Purpose

The purpose of this technical report is to provide advice and guidance in the development of Electronic Screen Displays for use in conjunction with real-time Distributed Control Systems (DCS) used in utility fossil-fired power plants with boilers of 200,000 lb/hr or greater capacity.

NOTE - Distributed Control Systems are also referred to as Digital Control Systems.

3 Display structure

Display structure establishes the relationship among displays and should reflect the relationships between functions and tasks to be performed through the Electronic Screen Displays. A function/ task analysis and goal assessment based on plant operating procedures is recommended to determine the goals and tasks to be accomplished.

Display structure provided with real-time distributed control systems is most commonly organized in a hierarchical structure. Displays are grouped according to levels of detail where each display serves as a menu to information above or below its level.

Using windowing techniques superimposes a sequential structure within the hierarchical structure, enabling the operator to access the requisite level of detail necessary to perform the required control functions (e.g., survey equipment status, get control help, select a transmitter, or call up a control face plate).

Three levels are typical of many fossil-plant Electronic Screen Display structures as applied to the boiler/turbine and result in the following hierarchy:

Unit Display:	Unit overview. Unit master control provides the highest level monitoring and control of major process-control functions.
System Overview/	
Summaries:	Overview graphics will be needed to help spot abnormal conditions, control mode summaries, plant status, and plant-process variable summaries.
Subsystem Control:	Fuel, air, feedwater, condensate, etc. — the main controls for each supporting process
Equipment Control:	Mills, induced draft and forced draft fans, boiler feed, or condensate pumps, and associated control valves — the lowest level of control on specific equipment

Two additional Electronic Screen Display structure organizing approaches are

- a) **sequential structure**, where movement from one display to the next is governed by a sequence. This technique is useful for procedural management of a plant such as a startup/shutdown sequence and is well applied when using pop-ups in a windowing environment; and
- b) **spatial structure**, where the Electronic Screen Display structure matches a mental map of the physical layout of the system/plant that the user has.

These techniques may be embedded as appropriate into a hierarchical display structure for the plant tasks to be managed.

4 Display access

Display access provides the means by which the user navigates through the display structure. Ease of navigation is critical to the effectiveness of Electronic Screen Display structure. Electronic Screen Display planning and design must take full advantage of operating system features for linking displays, including application software that enhances those features to provide a complete system of links and intelligent selection of targets. Some principle requirements for display access design are as follows:

- a) Information provided must include selections based on goal/function/task analysis data with few user decisions. Critical information must be obtained within one or two selections. The system's response to the user must appear to be immediate or at least must provide some indication that processing is underway.
- b) Information called up for each selection must be obvious to the user based on clear and consistent labeling and/or coding. Care must be taken to prevent labeling or graphics from overshadowing the pertinent process data.
- c) Display access must be governed by consistent user actions to call-up windows/ displays (e.g., touch screen, mouse, keyboard, or any combination of these).
- d) Using access devices, such as a touch screen, mouse, trackball, or equivalent, that keep the user's eyes focused on data/action areas is preferred to using a keyboard, which only interfaces (see operator entry techniques). Touch screen targets should be adequately sized to ensure selection on the first attempt to select on touch applications. Touch screen set up to select on release is recommended since it mimics the mouse and allows for the user to touch the screen and move the cursor before taking action (on the release of the finger). It also allows the user to change his or her mind and release the finger in a safe area where no action will be performed. Tab-key cursor control is not recommended.

4.1 Standard navigation designs

Various standard navigation designs for display access are available for displaying user options and defining user actions for display call-up. These methods are discussed as follows in accordance with their suitability for real-time system operation:

- a) **Display targets** (hot spots) provide immediate access to any form of pop-up that, in turn, can include menu selections or appropriate control face plates for operator actions. Because of its fast response system, this approach is very suitable for the real-time user.
- b) **Maps/Menus** are a special form of display/pop-up by which a selected display can be called up by the user. These may include structured menu tables or menus coded by display elements (hot spots), which, in turn, can be used to make further selections. Consistency of symbolic representation and selection response is critical in using coded display elements.
- c) **Context sensitive help** allows help and associated displays to be called up based on the current display or control face plate selected. These associated displays or pop-up windows can provide interlock, override, and/or permissive information for the associated device.

Prior to the widespread use and acceptance of touch screen and/or mouse-selected targets, command language, paging keys, and dedicated and variable function keys (in hardware) were commonly used as display access navigation aids. These approaches are less desirable today because they require the user to focus attention away from the Electronic Screen Display.