

AMERICAN NATIONAL STANDARD

ANSI/ISA-101.01-2015

**Human Machine Interfaces for
Process Automation Systems**

Approved 9 July 2015

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ANSI/ISA-101.01-2015, Human Machine Interfaces for Process Automation Systems

ISBN: 978-1-941546-46-8

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Introduction

Purpose

The purpose of this standard is to address the philosophy, design, implementation, operation, and maintenance of Human Machine Interfaces (HMIs) for process automation systems, including multiple work processes throughout the HMI lifecycle. It is also intended to help users to understand the basic concepts as a way to better and more readily accept the style of HMI that the standard is recommending.

The standard defines the terminology and models to develop an HMI and the work processes recommended to effectively maintain the HMI throughout the lifecycle. Use of this standard should:

- a) provide guidance to design, build, operate and maintain HMIs to achieve a safer, more effective, and more efficient process control system under all operating conditions.
- b) improve the user's abilities to detect, diagnose, and properly respond to abnormal situations.

The HMI is the collection of hardware and software used to monitor and interact with the control system and ultimately with the process.

The target audiences are end users, designers, developers, and implementers of HMI systems.

Organization

This standard is organized into nine clauses. The first three clauses are introductory in nature. Clause 4 presents the lifecycle model for the HMI. Clauses 5 through 9 provide additional details to support the lifecycle. The main body of the standard (Clauses 4-9) presents mandatory requirements and non-mandatory recommendations as noted. If a clause contains mandatory requirements, it is noted at the beginning of the clause.

1 Scope

1.1 General applicability

This standard addresses Human Machine Interfaces for equipment and automated processes. If the standard, recommended practices and methodology are followed, the result should enable the users to be more effective yielding improved safety, quality, productivity and reliability.

The recommendations in this document are applicable to any process using an HMI to interface to a control system, including but not limited to continuous, batch, and discrete processes. There may be differences in implementation to meet the specific needs based on process type.

1.2 Exclusions

1.2.1 Change management

Some requirements and recommendations to be included in a change management procedure are included in this document. However, a specific change management procedure has not been included in this document.

1.2.2 Jurisdictions

In jurisdictions where the governing authorities (e.g., national, federal, state, province, county, city) have established process safety design, process safety management, or other requirements; those requirements take precedence over any requirements defined in this document.

1.2.3 Purchase specification

This document is not intended to be used as a Human Machine Interface system selection or procurement specification, although at the discretion of the person specifying or requiring it, suppliers could be requested to provide an HMI system including the features mentioned herein. This document does not eliminate the need for sound engineering judgment. No particular platform or technology is mandated nor implied.

1.3 Intended audience

This document's target audiences are end users, designers, developers, and implementers of HMI systems. However, the designs developed by using this standard should include the inputs and needs of all the intended users. These users are the personnel in contact with the HMI systems, such as those from the process, operations, engineering, maintenance, risk assessment (including safety), and quality control user groups.

2 Normative references

2.1 References

The following referenced documents should be considered for the application of this document. For dated references, only the edition cited applies. For references without a date, the latest edition of the referenced document applies.

ANSI/HFES 100-2007, *Human Factors Engineering of Computer Workstations*

ANSI/ISA-5.06.01-2007, *Functional Requirements Documentation for Control Software Applications*

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Documents
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ANSI/ISA-18.2-2009, *Management of Alarm Systems for the Process Industries*

ANSI/ISA-88.00.01-2010 - *Batch Control Part 1: Models and Terminology*

ANSI/ISA-95.00.01-2010 (IEC 62264-1 Mod) - *Enterprise-Control System Integration – Part 1: Models and Terminology*

ANSI/ISA-100.11a-2011, *Wireless systems for industrial automation: Process control and related applications*

ANSI/ISA-62381-2011 (IEC-62381 Modified), *Automation Systems in the Process Industry – Factory Acceptance Test (FAT), Site Acceptance Test (SAT), and Site Integration Test (SIT)*

ANSI/ISA-62443-1-1 (99.01.01)-2007, *Security for industrial automation and control systems Part 1: Terminology, concepts, and models*

ANSI/ISA-62443-2-1 (99.02.01)-2009, *Security for industrial automation and control systems: Establishing an industrial automation and control systems security program*

ANSI/ISA-62443-3-3 (99.03.03)-2013, *Security for industrial automation and control systems Part 3-3: System security requirements and security levels*

ISO 11064-1:2000, *Ergonomic design of control centres – Part 1: Principles for the design of control centres*

ISO 11064-4:2004, *Ergonomic design of control centres – Part 4: Layout and dimensions of workstations*

ISO 11064-5:2008, *Ergonomic design of control centres – Part 5: Displays and controls*

3 Definition of terms and acronyms

Defined terms are used in this standard. Synonymous terms, which are not used in this standard, are listed in parentheses.

3.1 Definitions

For the purposes of this document, the following definitions apply.

3.1.1 Alarm

An audible and/or visible means of indicating to the operator an equipment malfunction, process deviation, or abnormal condition requiring a response. [ANSI/ISA-18.2-2009]

3.1.2 Alert

An audible and/or visible means of indicating to the operator an equipment or process condition that requires awareness, that is indicated separately from alarm indications, and which does not meet the criteria for an alarm. [ANSI/ISA-18.2-2009]

3.1.3 Aspect ratio

The ratio between the total horizontal and total vertical pixels on a screen (e.g., 4:3 or 16:9).

NOTE Displays designed for one aspect ratio screen (e.g., 4:3) may appear distorted when shown on a screen with a different aspect ratio (e.g. 16:9).

3.1.4 Auditory coding

The use of auditory signals to convey information to operators.

3.1.5 Auditory signal

A particular, unique, recognizable sound used to convey a particular, unique meaning.

3.1.6 Call up time

The lapsed time for all display elements to be refreshed after a display change has been requested.

3.1.7 Chromatic distortion

Color fringing or smearing caused by unequal focusing of different colors.

3.1.8 Commissioning

Procedures prior, or related, to handing over a system for placing into service. These procedures often include acceptance testing (FAT, SAT and SIT); handing over of drawings and documentation; delivering instructions for operation, maintenance, and repair; and providing training to personnel.

3.1.9 Console

The hardware, software, and furniture or enclosure at which users monitor and/or control the process, which may include multiple stations, communication devices, and other devices (e.g., cameras, barcode devices, pushbutton stations). See Figure 1.

3.1.10 Control room

A room with at least one HMI console from which a process is monitored and/or controlled and possibly containing other control system equipment and/or other facilities for operators.

3.1.11 Control system

A system that responds to input signals from the equipment under control and/or from an operator and generates output signals that cause the equipment under control to operate in the desired manner. [ANSI/ISA-18.2-2009]

3.1.12 Controller

The hardware which executes functions for monitoring and control of one or more process variables.

NOTE In some industries, the primary user of the HMI is called the controller. Within this standard, the term controller is used as defined in Clause 3.1.12.

3.1.13 Dashboard

A graphical summary showing various pieces of important information typically used to give an overview of a process or part of a process.

3.1.14 Display (Graphic, window)

A visual representation of the process and related information used by the operator for monitoring and control. See Figure 1.

3.1.15 Display style (Display format, graphic layout)

A description of the generic layout of a display and its presentation of information, not referring to any particular content.

3.1.16 Drill-down

A method of navigation in which successive displays show increasing detail for smaller subsets of the system scope.

3.1.17 Faceplate

A display, part of a display, or popup used for monitoring and/or direct operation of a single control loop, device, sequence, or other entity.

3.1.18 Graphic element

A component part of a graphic symbol, such as a line or circle. See Figure 1.

3.1.19 Graphic symbol

A visual representation of a process component, instrument, or condition in a display composed of a combination of simple graphic elements. See Figure 1.

3.1.20 Human factors engineering (HFE, ergonomics)

A scientific discipline concerned with the understanding of interactions between human and other elements of a system that applies theory, principles, data, and methods to design in order to optimize human well-being and overall system performance.

3.1.21 Human machine interface (HMI, HMI system)

The collection of hardware and software used by the operator and other users to monitor and interact with the control system and with the process via the control system.

3.1.22 Keyboard

An input device that allows the user to type characters, values or commands to affect the control system. See Figure 1.

3.1.23 Monitor (Video display unit, VDU, computer screen, LCD display) - noun

An electronic device for the display of visual information in the form of text and/or graphics. See Figure 1.

3.1.24 Monitor - verb

To maintain awareness of the state of a process, by observing variables or the change of variables against limits or other variables, to keep track of operations and enable timely and appropriate response to abnormal conditions.

3.1.25 Navigation

A function which supports users in locating desired information in an HMI-based information system, and also in guiding the selection of displays, or the act of selecting a display.

3.1.26 Operator

The primary user of the HMI, the person who monitors and makes changes to the process.

NOTE In some industries, the primary user of the HMI is called the controller. Within this standard, the term controller is used as defined in Clause 3.1.12.

3.1.27 Platform

A particular family of HMI products capable of using a common toolkit.

3.1.28 Pointing device

An input device which translates physical movements to movements of a pointer, cursor or other indicator across the screen (e.g., a mouse, trackball, or touchscreen). See Figure 1.

3.1.29 Popup (Popup display, overlay)

A display that appears (pops up) in the foreground of the screen, possibly obscuring part or all of other displays. See Figure 1.

3.1.30 Resolution (Screen resolution)

The size and pixel density of the screen, usually specified by the number of vertical and horizontal pixels (e.g., 1024 horizontal x 768 vertical) and the diagonal dimension. The resolution determines the fineness of detail that can be distinguished in an image on a screen. Alternately, this fineness of detail can be specified in pixels per linear dimension (e.g., 96 DPI – dots per inch).

3.1.31 Remote terminal unit (RTU)

One or more monitoring and/or control devices at a location geographically separate from, but communicating with the control center (e.g., in a Supervisory Control and Data Acquisition (SCADA) system).

3.1.32 Salience

Distinctiveness, prominence, obviousness, or conspicuousness of a graphic symbol or other part of a display, for the purpose of quickly drawing operator attention.

3.1.33 Screen

The part of the monitor that shows an image. See Figure 1.

NOTE See Resolution, Clause 3.1.30, for more information.

NOTE Some computer operating systems support a software "screen" (desktop) spanning multiple monitors, but for the purposes of this standard, a screen is the part of a single monitor on which displays are shown.

3.1.34 Script

A code module which performs tasks executed on the HMI platform and usually invoked by some operator action or other control system event.

3.1.35 Scripting

A feature provided by some HMI platforms to allow execution of scripts.

3.1.36 Situation awareness

The relationship between the operator's perception of the plant's condition and its actual condition at any given time.

3.1.37 Station (Workstation)

The primary user interface which includes one or more monitors and supporting software, user input devices (e.g., keyboard, pointing device), and output devices (e.g., speaker, printer). See Figure 1.

3.1.38 Supervisory control and data acquisition (SCADA)

A system for monitoring and control of processes which are geographically widespread. This includes all equipment and functions for acquiring, processing, transmitting, and displaying the necessary process information.

3.1.39 Tag (Point)

The unique identifier assigned to a process measurement, state, calculation, device, or other entity within the HMI or controller.

3.1.40 Task analysis

A method of extracting a user's requirements based on a review of tasks performed by the user.

3.1.41 Toolkit

A collection of custom or pre-defined HMI configuration items that reduce time and effort to produce a control system.

3.1.42 Trending

A feature for displaying real-time and/or historical data in various chart formats, usually with respect to time.

3.1.43 Usability

The extent to which a system can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.

3.1.44 Validation (Qualification)

Process of demonstrating by examination, testing, or other objective evidence that the HMI, as installed, meets applicable requirements and specifications.

NOTE Requirements and specifications include HMI Philosophy, HMI Style Guide, and User, Task and Functional Requirements.

3.1.45 Verification

Process of demonstrating by examination, review, testing or other objective evidence that the outputs of an HMI lifecycle activity meet the objective and requirements defined for the activity.

3.1.46 Yoking (Spawning, linked navigation)

A method by which specific combinations of related displays and display contents are called up via a single navigation action (commonly used with multiple monitors).

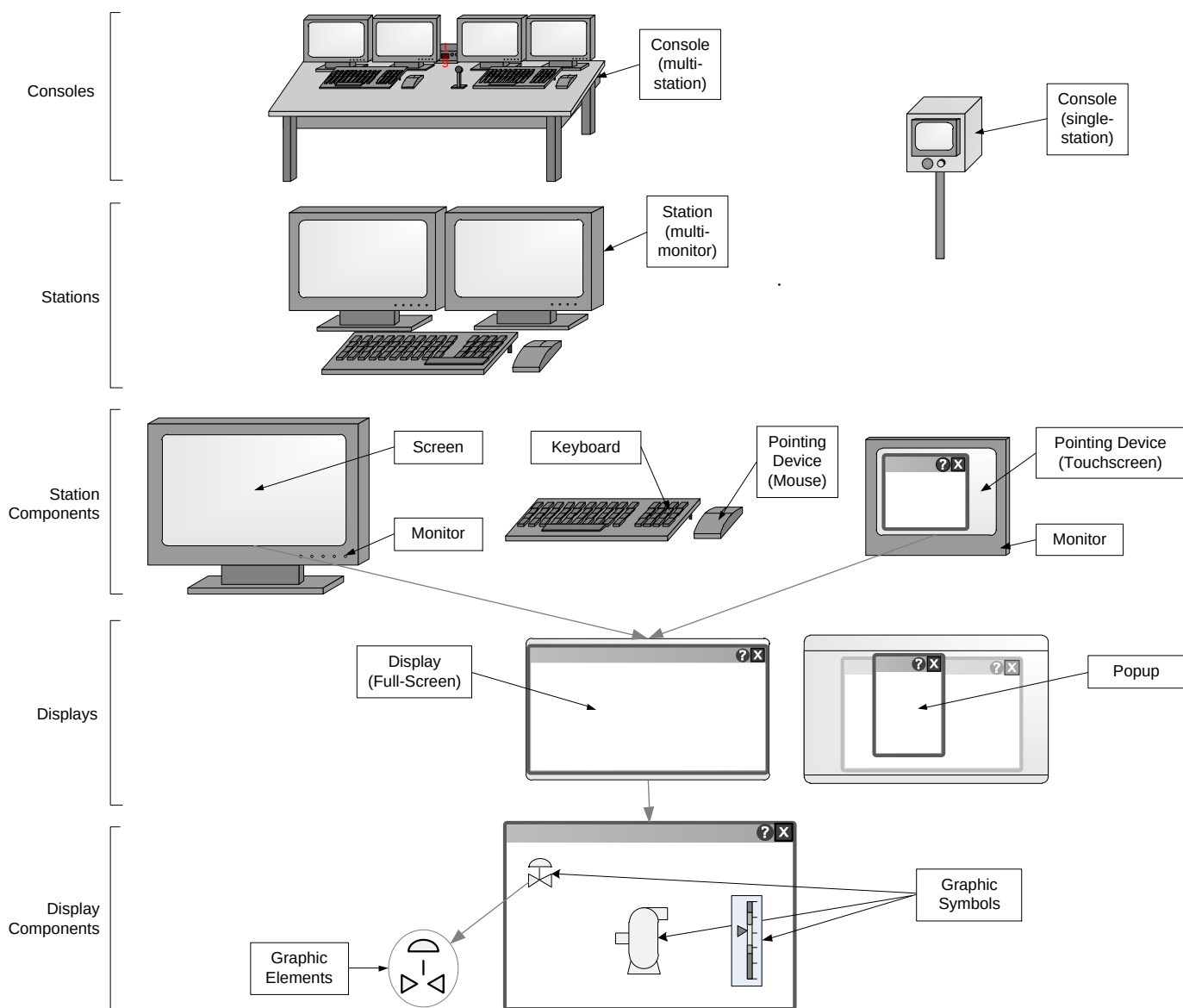


Figure 1 – Selected HMI terms and their interrelationships

NOTE Figure 1 is intended to illustrate selected, defined terms (in boxed text) and their interrelationships only and is not intended as a suggested design. Stations can be fixed or portable with related wired or wireless network connections.

3.2 Acronyms

- 3.2.1 ANSI: American National Standards Institute**
- 3.2.2 CCTV: Closed Circuit Television**
- 3.2.3 DCS: Distributed Control System**
- 3.2.4 FAT: Factory Acceptance Test**
- 3.2.5 HFE: Human Factors Engineering**
- 3.2.6 HFES: Human Factors and Ergonomics Society**
- 3.2.7 HMI: Human Machine Interface**
- 3.2.8 I/O: Input / Output**
- 3.2.9 MOC: Management of Change**
- 3.2.10 P&ID: Piping and Instrumentation Diagram**
- 3.2.11 PFD: Process Flow Diagram**
- 3.2.12 PLC: Programmable Logic Controller**
- 3.2.13 RTU: Remote Terminal Unit**
- 3.2.14 SAT: Site Acceptance Test**
- 3.2.15 SIT: Site Integration Test**
- 3.2.16 SCADA: Supervisory Control and Data Acquisition**

4 HMI System Management

NOTE THIS CLAUSE CONTAINS MANDATORY REQUIREMENTS.

4.1 Introduction

The HMI shall be developed and managed through a lifecycle model; for example, see Figure 2.

System standards shall be created and used to establish the foundation for the HMI lifecycle. The System standards, as shown in Figure 2 include: the HMI philosophy, the HMI style guide and the HMI toolkits. These items should be maintained over the life of a facility. Once created, they are not commonly recreated or significantly modified unless the overall philosophy has changed. Occasionally, project requirements will dictate creation of new standards or drive significant change to the existing system standards.

The HMI main lifecycle stages are design and review, implement and operate. Two entry points are shown Figure 2. The first entry point is at System Standards for a new system or major changes to an existing system which may include migration from a legacy HMI platform. The second entry point is at design for either new display design(s) or display changes.

Two continuous improvement steps are shown in the lifecycle. The first shows a cycle between design and system standards. This recognizes that improvements can be made continuously in HMI design that are reflected back to the system standards. The second continuous improvement process is between operate and design, recognizing improvements to the specific system in operation. Ideas for improvement can occur at any point in the lifecycle, but the major connections are shown where the actual changes occur.

Continuous work processes of Management of Change (MOC), audit and validation are also shown across the entire lifecycle.

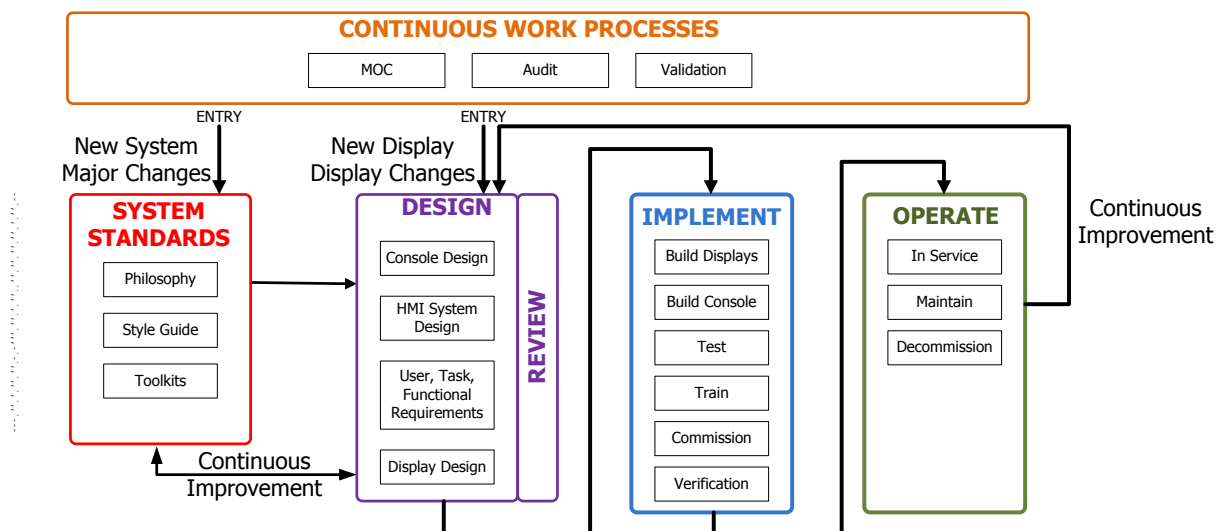


Figure 2 – HMI lifecycle

Each stage of the HMI lifecycle is discussed in detail below. Tables 1-5 below provide some details around the activities integral to all stages of the lifecycle. The tables include the major objectives, inputs and outputs for each stage of the lifecycle.

4.1.1 User types

Throughout this document, the term “user” refers to the various individuals who will use the HMI. The concept of primary and secondary users should be defined, see Clause 3.1.26.

In many cases, there may be different types of users based on their different job functions. Therefore, the unique requirements for each type of user should be identified and understood in the design and lifecycle of the HMI. Each user, or type of user, may have different privileges and levels of access to various displays, diagnostic capabilities, and other functions via the HMI, based on their individual roles. The types of users and their requirements should be included in the design process and be documented in the HMI philosophy. Roles and responsibilities can vary from industry to industry and from facility to facility, examples of types of users are:

- a) Operations-users who monitor and perform control and operation of the plant or facility (this may include both operators in the main control room as well as the extended operations team which may include remote users and users of portable interface devices);
- b) Maintenance-users who perform troubleshooting and/or maintenance of the process, instrumentation and final control elements and rotating equipment;
- c) Engineering-users who perform modifications, additions or deletions to the HMI or control system;
- d) Administrators-users who perform updates to the control system itself, or assign security to other users;
- e) Management-users who monitor the operation of the plant or facility;
- f) Analysts-users who monitor the system to improve plant performance;
- g) Others-users who use or interact with system for other purposes, for example, quality management personnel.

4.2 System standards

The system standards stage of the lifecycle includes development of: the HMI philosophy, HMI style guide and HMI toolkits.

See Table 1 for details on objectives, inputs and outputs for the system standards stage of the example lifecycle.