ENGINEERING AND INSTALLATION STANDARD

FOR

INDICATING LIGHTS, ALARMS

AND

PROTECTIVE SYSTEMS

FIRST EDITION

MAY 2006

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1. SCOPE

This Standard covers the general requirements governing the design, construction and installation of the following:

a) Indicating Lights.

b) Alarm Systems.

c) Protective Systems.

It is intended to be used in oil, gas, and petrochemical industries.

Note: This is a revised version of the standard specification for indicating lights, alarm and protective systems, which is issued as revision (1). Revision (0) of the said standard specification is withdrawn.

2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

API (AMERICAN PETROLEUM INSTITUTE)

RP 554 "Process Instrumentation and Control"

BSI (BRITISH STANDARD INSTITUTION)

BSEN 60085 "Method for Determining the Thermal Classification of Electrical Insulation"

ISA (INSTRUMENT SOCIETY OF AMERICA)

S 5.2 "Binary Logic Diagrams for Process Operations"

S 18.1 "Annunciator Sequences and Specification"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-IN-190 "Transmission Systems"

IPS-G-IN-250 "Distributed Control System"

IPS-G-IN-290 "Engineering and Construction Standard for Programmable Logic Controller (PLC)"

IPS-M-IN-260 "Material and Equipment Standard for Alarm and Protective systems"

IEC (INTERNATIONAL ELECTROTECHNICAL COMMISSION)

IEC 61511

IEC 61508

NEMA (NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION)

MG 1	"Motors and Generators"
ICS 6	"Industrial Controls and System Enclosures"

3. UNITS

This Standard is based on International System of Units (SI), except where otherwise specified.

4. GENERAL

4.1 Control systems for one or more process units shall be usually centralized in control rooms. A centralized alarm system providing visual and audible indication at each control location shall be provided in a method which makes that consistent with the centralized control philosophy.

4.2 Instrumentation for alarm and protective systems shall be reliable. The degree of reliability shall depend on the severity of the following risks involvements:

a) Hazard to personnel.

b) The value of the equipment damaged.

c) The value of the product lost.

d) The effect on the environment.

Because this type of instrumentation may remain inactive for long periods, a means of periodically checking these systems, while the process units are operating, shall be provided.

4.3 In modern digital instrumentation systems, lower priority alarms, called "alerts" are being used extensively as an operating tool. Alerts are generally software-generated. They may be used to signal that controlled variables are outside of relatively tight normal limits, that outputs are approaching upper or lower limits, or that other variables are approaching or will eventually cause critical conditions.

4.4 The specification shall be based on the use of electric system. The pneumatic system may be only used on special cases with approval of purchaser engineer.

4.5 As minimum, solid-state annunciator systems are preferred.

4.6 Wherever possible, the concept of intrinsic safety shall be applied.

4.7 Lists shall be prepared of all alarm and trip settings, showing per circuit: tag number, instrument range, switch point in operating units, and the equivalent setting in bar (g) when initiators are actuated by pneumatic signals.

4.8 Function descriptions as well as basic block diagrams, logic diagrams, etc., shall be made in addition to the engineering drawings.

4.9 Interconnections with electrical department circuits shall be made in an interconnection box. Those relays having contacts in control circuits maintained by electrical department shall be installed in this interconnection box to avoid live parts in the isolated instrument control boxes when maintenance is carried out.

4.10 On large process units where a multiplicity of automatic alarms is installed, consideration should be given to the provision of an automatic logging device in the control room, which will record sequentially all warnings and their time and clearance.

4.11 Instrumentation, alarms, shutdowns and other controls supplied with "Packaged" units, ancillary plant and proprietary equipment shall conform with this Standard. They shall also be the same type and manufacture as selected for the rest of the plant. Any departure from this rule is to receive the prior written approval of the Purchaser.

4.12 Switches in equipment shutdown service shall be direct operated type. Except for flow application (when high accuracy is required).

4.13 Wiring for switches shall be two-conductor and shall not use the common hot wire technique.

4.14 Where more than one process unit is incorporated in the control room, audible horns of different tones shall be used to indicate the location of the alarm.

4.15 Acknowledge and lamp test switches shall be provided for both local and remote annunciator cabinets. Horn test/function test will be added when applicable.

4.16 All critical alarms shall be located on the control house panel board or control consoles, shall be annunciator type, and shall be both visible and audible. Non-critical alarms may be displayed on control room video display units associated with digital instrument systems or computer systems.

4.17 Howlers and buzzers for telephone, fire alarm and toxic gases detection system shall be separate and distinctly different from each other and from the buzzer for the signal system.

4.18 On major items of equipment, e.g. gas compressors, where operator action is required at the equipment itself, a detailed display identifying the fault conditions shall be given local to the equipment and a single unit alarm provided in the control room. In this circumstance, acceptance in the control room shall not alter the state of any local alarm light. Any subsequent fault shall reactivate the single unit alarm.

4.19 Integral switches in standard recording and controlling instrument shall not be used for trip alarm actuation.

4.20 The top half of nameplates shall be engraved in the English language, the bottom half shall be left blank.

5. INDICATING LIGHTS

5.1 Indicating lights serve to indicate on the instrument panel the status of process equipment, such as valves being open or closed, pumps being in operation or stopped, etc.

5.2 When the equipment can only be operated manually and remote indication is needed, a visual indication is sufficient.

When the equipment status can be changed automatically, e.g. starting of stand-by pumps, an audible alarm is also required.

5.3 The following colors shall be used for indicating lights:

- Unsafe condition;	red
- Operative and safe;	white
- Switch in override position;	yellow
- Valve open;	green
- Valve closed;	red
- Motor runs;	green

- Motor stopped; red

5.4 Indication lights shall be kept separate from alarm lights.

6. ALARM SYSTEMS

6.1 Alarms

Alarm and alert systems used in petroleum industries are divided into two broad categories dedicated and integrated style (see Fig. 1).

6.2 Dedicated Alarm Systems

6.2.1 A dedicated alarm system has a separate visual indication for each alarm point as well as a separate actuating device. In some cases, it may be practical to combine a number of actuating devices so that operation of any one of them would produce an indication on a common remote visual alarm. The alarm point of the sensor is determined, either by a set-point adjustment (such as in a pressure or temperature switch) or simply by installation location (such as for a level switch). Wiring between the actuating device and the annunciator shall be direct and separate from other alarms so that a failure of one will not affect others.

6.2.2 In most dedicated alarm systems, each point can be provided with a set of isolated auxiliary output contacts that change state when that point is actuated. These contacts may be used to retransmit alarm signals to other displays.

6.2.3 Dedicated alarms may also accept analog inputs in the form of current, voltage or direct thermocouple and resistance temperature detector signals. The alarm trip point shall be determined by an integral set-point adjustment for each input.

6.3 Integrated Alarm Systems

Integrated alarm and/or alert systems may be in the form of standalone alarm-only units or they may be integral parts of larger distributed or computer-based control systems. For distributed control systems, see IPS-G-IN-250.

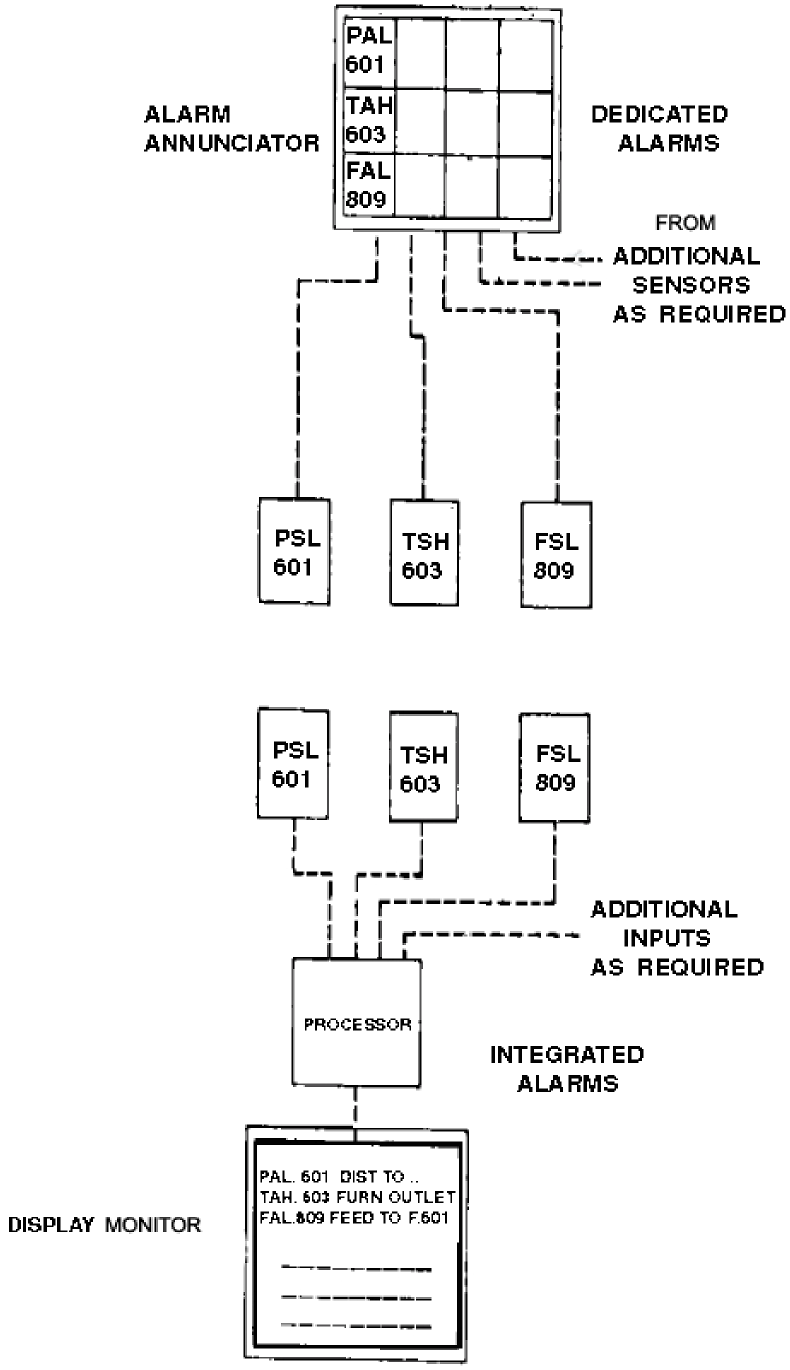
Integrated alarm system visual indication may be via one or more of the following (see Fig. 2):

1) Flashing or colored messages displayed over other information on a monitor.

2) Monitor displays dedicated to alarm indication and formatted accordingly.

3) Indicator lights in various forms.

4) Printed messages on hard copy devices.



KEY

FAL low flow alarm.
FSL low flow sensor.
PAL low pressure alarm.
PSL low pressure switch.
TAH high temperature alarm.
TSH high temperature switch.

SCHEMATIC SHOWING DEDICATED ALARM SYSTEM VERSUS INTEGRATED ALARM SYSTEM

Fig. 1

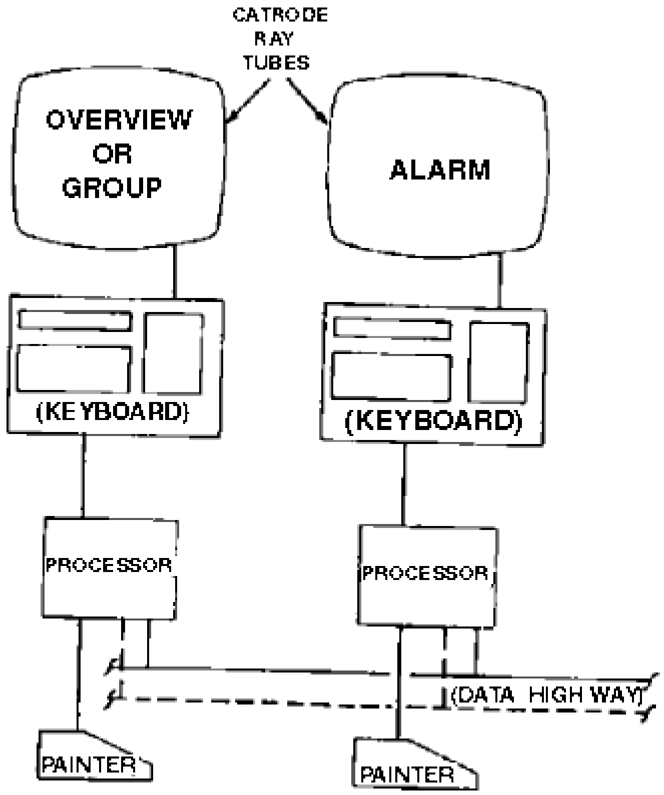
An audible signal indicates the actuation of any alarm. Alarms shall be actuated by:

1) Making or breaking external switch contacts.

2) Monitoring electronic analog inputs in dedicated alarm modules.

3) Internal system logic.

When deciding on system configuration, consideration shall be given to the level of reliability required. For example, extremely critical alarms may require inputs directly from switches connected to the process in field locations. On the other hand, low priority alerts may be software-generated in the intelligence section of the monitor display of a distributed control system. Intermediate requirements may dictate that analog-input alarm devices or main frame computer generated alarm inputs be used.



INTEGRATED ALARM DISPLAY

Fig. 2

6.4 Audible Indication

6.4.1 Alarm systems, whether dedicated or integrated, require an audible indication to alert the operator that an alarm has been actuated. The visual indication shall be used for identification and evaluation.

6.4.2 Audible device can be horns, bells, chimes, buzzers, or speaker operating from adjustable solid state tone generator (industrial type). These audible signals shall be differentiated so that either the location in the plant, or the seriousness of the condition can be indicated. For example, some may merely indicate an upset condition while others indicate to the operator that a shutdown has occurred. Shutdown alarms shall be designed to initiate an audio signal distinct from all other alarms.

6.5 Method of Operation

6.5.1 Upon actuation of a point in a dedicated alarm, an alarm light shall flash and an audible device shall sound. An acknowledge push button shall be provided for silencing the audible device and switching the light to a steady-on state. Another push button shall be provided for testing the alarm lights and, where practicable, for testing the other components of the system. The acknowledge and test switches may be made common to a number of alarm system cabinets.

6.5.2 ISA recommended practice 18.1 shall be used for selection of desired operation sequence. Although different types of sequences are available in ISA 18.1, but type A sequence is the most common type.

6.5.3 Upon actuation of an alarm point in an integrated alarm system, a light shall be illuminated or caused to flash. In monitor systems, an alarm message shall be displayed on the screen in a prominent location, possibly flashing or appearing in a distinguishing color. An audible device shall also sound. One or more acknowledge buttons shall be provided to acknowledge the alarm condition. In some systems, the button may also call up a different display with additional information relative to the alarm condition. A logging system may also be actuated to document the alarm message. In any case, fast indication of the individual alarm variable is essential (see 4.10).

6.5.4 Field contacts and relay contacts of alarm systems shall be designed to open and close in response to power supply and process operating conditions as follows:

PROCESS OPERATING CONDITIONS	**FIELD CONTACTS**	**RELAY CONTACTS**	
	Power either on or off	Power on	Power off
Normal	Close	Close	Open
Abnormal	Open	Open	Open

6.6 First-Out and Sequence of Events Systems

6.6.1 A process system or a piece of equipment such as a compressor may have a number of protective devices that could actuate a shutdown. In such circumstances, it may not be obvious which device initiated the shutdown and as a result it could be time-consuming to locate the source of trouble. Dedicated alarm systems shall have a first-out (firstfailure) feature.

The point that initiated the shutdown shall be identified by means of a fast flashing light (other methods may be used) after the alarm condition has been acknowledged and the audible alarm silenced. See also 7.3.2.

6.6.2 More sophisticated dedicated systems may indicate the exact sequence in which any number of alarm points were actuated. Integrated systems may also accurately indicate a sequence of events if the sequence is relatively slow. However, if the sequence is fast, these systems may not be capable of providing the required time discrimination for a true sequence-of-events indication. Characteristics of the system (scan rate, location, events in the scan, and the priority of events in the communication scheme) shall be considered when using an integrated system for sequence-of-events indication.

6.7 Location

6.7.1 Dedicated alarms shall be combined in a cabinet or in multiple cabinets mounted on instrument panels located in the control room. Such central read-out systems as monitors or printers shall be console or desk mounted, although panel mounting is feasible.

6.7.2 In some instances, it may be advisable to locate an annunciator cabinet with audible alarms in an area close to the equipment that is being monitored. In these instances a remote common trouble alarm shall be installed in the associated control room. This configuration, with the annunciator located to attract immediate attention, could be used for compressors and furnaces to ensure prompt action on the part of field operators. Under some circumstances, it may be necessary to provide an explosion proof annunciator. The selection of the alarm system shall be always comply with the electrical classification of the area in which it is to be installed.

6.8 Installation

6.8.1 The installation of field switches shall be made in accordance with the appropriate section of instrument installation of IPS standards for flow, pressure, level, temperature, and so forth.

6.8.2 Alarm systems installed in a control room shall be positioned for maximum visibility and operator convenience.

The relationship of alarms to other instrumentation may also be important. The proper location of the acknowledge push button is important since it must be used by the operator after each alarm.

6.8.3 The audible device shall be installed where it will attract attention but will not be unnecessarily loud.

6.8.4 Good installation practice requires the use of a pair of wires to each field sensor rather than the use of common wires. This simplifies maintenance and troubleshooting procedures, improves system security, and may be required to achieve intrinsic safety.

6.8.5 Power supply and relay systems for alarm systems shall be installed in the control center basement, back of control panel/or in auxiliary room.

6.9 Electrical Design Requirements

6.9.1 Dedicated alarm annunciators shall be designed for operation from 110-Volt a.c., single-phase, 50-Hz power sources, or 24 V d.c. In integrated systems, the voltage to external contacts shall be direct current at low levels. d.c.-powered annunciator systems (24 V d.c.) is preferred (see 7.4).

6.9.2 In cases where "bouncing" field contacts (such as that experienced on some liquid levels during startup) or other types of repetitive upsets could cause repeated annoying alarms, a separate audible disconnect switch shall be used. An adjustable dead band or a 3- or 4- second time delay shall be used to correct the problem. The elimination of annoyance alarms should not be ignored since an expedient, on-the-spot means will usually be found to circumvent or nullify the alarm altogether if it is a nuisance. Such a situation could be hazardous.

6.9.3 Alarm circuitry shall be designed to prevent feedback to or from interconnected power and control circuits. This situation is especially of concern where common audible, acknowledge, or lamp testing circuits are employed. The use of final control elements operated by more than one sensor may also cause feedback problems. In this situation, the location of power sources for the various parts of the system shall be considered carefully. Problems may develop not only from feedback, but also because of a power failure or interruption. As a result, the system may not produce the signals intended by the designer.

6.9.4 Care shall be taken to ensure that voltage dips and momentary outages do not cause unwanted alarm actuation.

This situation shall be prevented by the use of normally de-energized circuits, or, in the case of normally energized circuits, the use of time delays or uninterruptible alternating or direct current power supplies. Arguments favoring the normally energized systems emphasize the fail-safe characteristics of such a design; those in support of de-energized circuits stress the reduction of nuisance alarms. Other factors such as the likelihood of burnout for continuously energized coils in relays or solenoids or the problems encountered with normally open sensor switches shall be considered.

6.9.5 Experience and good judgment shall be combined in the selection of electrical contacts for relays and sensors.

With the use of low level direct-current voltages in alarm circuits, hermetically sealed contacts shall be used to prevent the effects of dust, corrosion, and contact film. If this type of contact is not available, switches that remain in the closed position during normal operating periods with abnormal process conditions causing the contacts to open shall be used.

Fail-safe circuitry is inherent with this practice. However, circumstances may exist where it is more practical to use contacts that close when the abnormal condition occurs. The corrosive effects of atmospheric contamination along with factors such as heat and vibration shall be evaluated in selecting electrical contacts. If mercury switches are used, they shall be mounted where they are unaffected by vibration.

6.9.6 Enclosures and wiring for the installation of alarm sensors must meet the requirements of the area in which they are located. Intrinsically safe systems eliminate the need for explosion proof enclosures for field sensors in classified areas. Hermetically sealed switch contacts eliminate the need for explosion proof enclosures that are otherwise required in Division 2 areas. Weatherproof enclosures shall be used for outdoor use with intrinsically safe systems and hermetically sealed switches regardless of area classification.

6.10 Alarm Actuation

Alarms may be actuated by changing states of external contacts, by exceeding set-point limits of direct connected analog inputs, or by using logic or computational functions in digital systems (see Fig. 3)

1) Direct connected switches

Direct connected switches shall be separated, independent sensors connected directly to the process equipment. Devices such as temperature, pressure, level, and flow switches are included in this category. These sensors operate an adjustable switch contact through a mechanical linkage if the process variable exceeds predetermined limits. A scale and pointer may be provided to indicate roughly the set point at which the switch will be actuated. As a rule, these devices do not have a means of indicating the value of the measured or process variable, a separate indicator shall be provided, with a separate process connection to facilitate setting and checking calibration. In critical applications, the use of a precise indicating switch that will provide an accurate measurement as well as an indication of set point is probably justified.

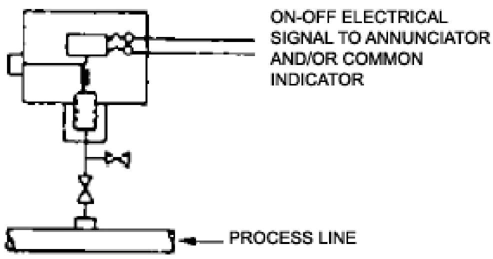
2) Auxiliary switches

Auxiliary switches may be located within an instrument that performs a different primary function such as indicating, recording, transmitting, or receiving the variable to be alarmed. There are many electromechanical methods may be used to operate these switches from changes in a measured variable. The alarm point shall be adjustable but its setting may be not ordinarily indicated. Since a failure of the measuring system in the instrument means the variable is no longer being monitored, as well as a loss of the alarm, auxiliary switches shall be used for less critical applications than direct connected sensors.

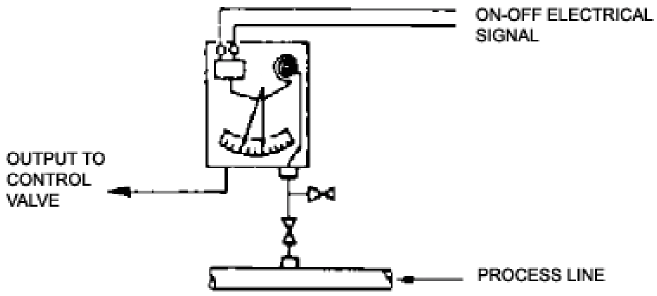
3) Transmitter monitoring switches

Transmitter monitoring switches are alarm switches that measure the output of an analog transmitter. They may be either electronic or pneumatic and can be set to actuate at any value of the transmitter range. They may have a scale with the set pointer indicating the trip point. Some are equipped with an indication of both cut-in and cutout settings.

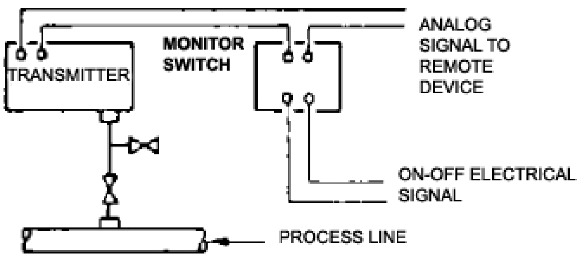
Alarm switches monitoring transmitter outputs shall be easily added to a control system. They shall be located within the control room thus to minimizing wiring costs to a central annunciator. They shall be installed without a process shutdown. They nevertheless suffer from the same limitation as auxiliary switch type of alarm in that they become inoperative upon failure of the transmitter.



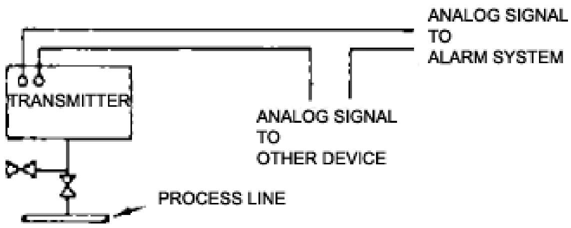
DIRECT COMMITED PRESSURE SWITCH



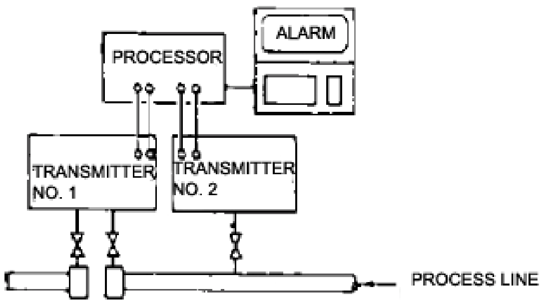
AUXILIARY SWITCH IN LOCAL PRESSURE CONTROLLER



ANALOG TRANSMITTER MONITORING SWITCH



ANALOG SIGNAL DIRECT TO ALARM



CALCULATED INPUT

METHODS OF OBTAINING ALARM SIGNALS

Fig. 3

4) Analog inputs

Analog input alarm systems shall accept standard current, voltage, thermocouple, and resistance temperature detector input signals directly. Each input point shall be provided with set-point and dead-band adjustments, along with integral indicator lights to indicate abnormal conditions. Systems of this type shall include a meter and the necessary selector switches to indicate, on demand, the value of each set point and each input.

5) Calculated inputs

Calculated inputs shall be used with integrated alarm systems. They shall be generally software-generated by computers or distributed control systems. Because of the intelligence available in these units, the variety of parameters that can be alarmed shall be unlimited.

6.11 Testing

Alarms and alarm actuators should be installed in such a way to facilitate check-out of the alarms. The best method of checking is through the operation of the alarm actuator. Where the alarm actuator is a contact in an instrument, or is operated by the transmission medium, ranging of the instrument is a convenient way of verifying the alarm points. Pressure switches in transmission lines can be shut off from the transmission line and calibrated with air pressure from another source. Independent actuators such as level alarms may often be piped so that they can be flooded or drained. Alarm systems should be installed to facilitate regular checks of individual alarms during the operation of the process unit.

6.12 Documentation (Alarm Record)

A complete and accurate record of all alarm set points shall be maintained. This record will be useful when checking out initial installations, and is necessary for testing and communicating changes that might be made in the course of system operation.

7. PROTECTIVE SYSTEMS

7.1 Basic Design

7.1.1 Protective systems shall serve to:

a) Shutdown a process unit to protect equipment and personnel when dangerous conditions are reached.

b) Start-up stand-by equipment when necessary to continue operation.

7.1.2 Each protective system shall be provided with:

a) Overriding (test or by-pass) switches, to be used during process start-up and testing of the system.

b) Emergency switches, to be used for manual initiation of the shut down system in case if emergency.

7.1.3 These switches shall be of the rotary type, push-button switches are not acceptable, unless are used with "enable" push-button which connected in series, or used with a protective rotatable cover.

7.1.4 All protective systems shall be engineered for purchasing from only one supplier as much as possible.

7.1.5 Components of protective systems shall, as far as feasible, be installed in the control room basement or auxiliary room to facilitate maintenance and to reduce the amount of (flame-proof) equipment in the processing areas.

7.1.6 Careful consideration shall be given to the interconnection of related initiating devices in such a way that unnecessary shutdown actions due to failure of individual components is avoided.

7.1.7 Each component of a protective system shall be incorporated in such a way, that the system will go to the safest position in case of component failure.

7.1.8 To increase the reliability of the system, duplication of certain component shall be considered.

7.1.9 Protective systems shall move to their protective positions on loss of energy (e.g. electrical power, instrument air). Protective systems on rotating machinery are exceptions to this and shall not move to the protective position on loss of energy.

7.1.10 Any system that employs multiple sensors (voting) for a sensor application on a protective system shall be designed to employ a "2 out of 3" voting concept. No other voting concept shall be permitted except for dual flame scanners and proximity type shaft vibration detectors which shall use "2 out of 2" voting. Safety instrumented systems (SIS) shall have safety integrity level (SIL) determined by risk analysis according to IEC 61508 and 61511, and certified by TUV, or others approved.

7.1.11 Protective system components shall not be connected to any instrument or control system external to the protective system. Exceptions proposed for microprocessor-based logic equipment shall be submitted for approval by the Purchaser's Engineer.

7.1.12 Protective system actuators shall remain in their protective state after a trip until manually reset, even if any trip initiators return to their normal operating positions. All protective system actuators require local manual reset, unless otherwise specified.

7.1.13 A logic diagram showing functions of the protective system shall be approved by the purchaser's Engineer prior to the start of system fabrication.

7.1.14 Risk analysis procedure shall be prepared and submitted for owner approval according to IEC 61508 and IEC 6161511 standards for classification of the required safety integrity level (SIL) of the protective system.

7.1.15 Risk analysis and SIL classification shall be done according to the above mentioned paragraph (7.1.14), approved procedure, and shall be reported to the owner for final approval.

7.1.16 Protective system configuration, sensors, actuators, logic solver, hardware and software shall meet the required SIL class.

7.1.17 Reliability analysis procedure shall be prepared and submitted for approval according to IEC 61508 and IEC 61511 standards for verification of the specified safety integrity level (SIL) of the protective system.

7.1.18 Reliability analysis and SIL verification shall be done according to paragraph 7.1.17, approved procedure, and shall be reported for final approval.

7.1.19 SIL compliance certificate of a testing authority shall be provided.

7.2 Logic Equipment

7.2.1 All logic equipment shall be comprised of one type of component. Systems containing a combination of different types are not permitted.

7.2.2 Each protective system shall have its own logic equipment installations where one logic system is proposed to protect multiple process units shall be approved by the Purchaser's Engineer.

7.2.3 All logic for one system shall be in the same place, (e.g. single cabinet). All test facilities, including bypass switches, for this logic must be located with the logic equipment. Any exceptions proposed shall be submitted for approval by the Purchaser's Engineer.

7.2.4 Failure of any component or group of components within the logic equipment shall result in the system output going to the desired mode of failure. Specific design features shall be included to ensure a predictable failure mode and these shall be submitted for approval by the Purchaser's Engineer.

7.2.5 All electronic logic equipment shall have electrically isolated sensor inputs that prevent electrical noise, picked from incoming sensor wiring which may cause undesired trips.

7.2.6 All electrical protective systems shall use time delays on all sensor inputs to avoid nuisance trips. Time delay shall be 0.5 seconds except for flame detectors, unless otherwise specified.

7.2.7 Where microprocessor-based logic equipment is used for protective systems the following requirements shall apply:

a) The design of the logic equipment shall employ "2 out of 3" voting, or modified "1 out of 2" voting. Failure of two subsystems in either "2 out of 3" voting or modified "1 out of 2" voting must result in the protective system going to its desired mode of failure.

b) Each microprocessor-based logic subsystem shall have its own self diagnostic tests to detect, locate, and alarm internal faults.

Self-diagnostic tests shall be built-in features, not requiring additional equipment or user programming. Self diagnostic tests shall include as a minimum:

1) Error detection in serial communications.

2) A "time-out" gate to detect halted microprocessor execution.

3) A set of instructions executed at each functional cycle to exercise active system components, including the microprocessor.

4) A periodic memory check.

5) A check of each signal line of a parallel bus before a "read" or "write" operation to input or output component.

c) Manual actuation push-button shall bypass the microprocessor-based logic equipment and allow direct initiation of the protective system actuators. This facility is usually provided through PLC System if not provided should be made over the panel for this purpose.

7.3 Alarm Displays

7.3.1 Protective systems with more than one initiator shall be supplied with a "first-out" feature that provides an indication of which initiator actuated first. This "first-out" feature capability shall be comprised of dedicated hardware, and shall consist of one set for each protective system.

7.3.2 Normal operating sequence of the "first-out" alarm system shall be:

a) Process is normal: alarm lights are out and horn is silent.

b) Process is abnormal: "first-out" alarm is flashing rapidly, other alarms are flashing slowly, and horn is sounding.

c) Acknowledge button is pressed: "first-out" alarm continues to flash rapidly, other alarms become steady, and horn is silenced.

d) "First-out" reset button is pressed: "first-out" alarm becomes steady.

e) Process returns to normal: alarm lights return to normal.

Proposals for alternatives to the operating sequence shall be submitted for approval by the Purchaser's Engineer.

7.3.3 Protective systems shall include a pre alarm. Two separate sensors, one for the pre alarm and one for the protective system shall be used.

7.3.4 Annunciator window indicators that are part of the protective system shall be color coded: red for protective system operation, and orange/amber for pre alarm; and shall be grouped together on the bottom row of the display.

7.3.5 Actuation of each protective system, including those locally mounted, shall be separately alarmed in the main control room.

7.3.6 All thermocouple temperature switch sensors shall have burnout indication and alarm. Burn out indication shall be upscale for low temperature switches and downscale for high temperature switches.

7.3.7 Each protective system shall have a common flashing light indicating that any of the sensors or actuators connected to the system has been bypassed. This bypass action shall be alarmed in the main control room.

7.3.8 Protective system bypass switches shall not bypass the alarm function of a sensor or defeat the "first-out" feature. The sensor shall retain its ability to indicate even though it cannot cause protective system action when bypassed.

7.3.9 Individual bypass indicators for each trip initiating sensor and each actuator must be provided and mounted on a test/bypass panel, and local panel if separate.

7.3.10 A lamp and horn test push-button shall be provided wherever lamps and horns are used as indicators.

7.4 Power Supply

7.4.1 Protective systems are classified as essential instrumentation for power supply. Each electrically powered protective system shall be fed from a UPS.

7.4.2 Power sources for electrical protective systems shall be as follows:

a) Microprocessor-based logic equipment requiring A.C. power shall be fed from a UPS distribution panel capable of transferring from the normal UPS to the stand-by power supply in less than 50 milliseconds.

b) Rotating machinery protective systems shall operate from a D.C. power source at 24 volts.

c) All other electrical protective systems shall operate from a D.C. power source at 24 volts.

7.4.3 D.C. systems shall be fully isolated from ground.

7.4.4 All electrical protective systems shall be fused immediately adjacent to the distribution bus. Both conductors shall be fused and appropriate disconnect switches included. Each individual sensor and actuator circuit shall be separately fused. Sensor and actuator fuses may be located in logic cabinets. Circuit breakers and fuses shall be arranged for selective operation such that the protective device closest to the fault operates first.

7.4.5 Separate fusing shall be provided for indication (lights) circuits and testing circuits.

7.5 Wiring

7.5.1 All power source wiring between power source and individual protective systems shall be isolated from ground.

7.5.2 Individual protective systems shall utilize dedicated junction boxes, or barriers within junction boxes to clearly segregate wiring of different protective systems. Segregated terminal blocks in the control house or other terminating point for field wiring shall be used. All wiring shall be clearly separated on a system by system basis. Where multiple sensors (voting) are used, sensors measuring the same process variable shall be segregated to isolate failures.

7.5.3 A ground fault detector system shall be provided for each protective system that will identify a faulted circuit while the system is in the normal operation. The detector must be capable of identifying the specific protection system or circuit causing a faulted condition.

Electronic fault finding devices or power transfer switching to an additional isolated power supply are acceptable methods to satisfy this requirement.

7.6 Field Elements

7.6.1 Sensors

7.6.1.1 Sensor contacts shall be single point contacts snap acting totally enclosed and made of non-corroding materials, (SPDT) with, slave relays or semiconductor circuits utilized to meet any signal sensor multiple output requirement. System sensors with auxiliary settings and contacts for auxiliary equipment cut-in service are not permitted except for vibration sensors on rotating equipment.

7.6.1.2 All sensors shall have separate process taps. Where a single orifice plate is to be used for liquid flow measurement and protective system sensor purposes, the second set of taps on the orifice flange shall be used for the protective system.

7.6.1.3 Where a flow sensor is used as a protective system input, a dedicated differential pressure transmitter shall be used. Differential pressure switches can be used only with the user's Engineer approval.

7.6.1.4 Electrical switches that utilize mercury ampoules as electrical switch contact are not permitted, unless otherwise specified.

7.6.1.5 If vibration is present at the process tap or normal instruments mounting point, protective system sensors shall be mounted in a separate, more stable location.

7.6.1.6 Where current switches connected to conventional dedicated analog field transmitters are used as sensors for protective systems, individual switches shall be located in a special area dedicated to that function. These switches shall be protected by guards. If current switches are powered from sources other than the analog transmitter loop, such as 110 V A.C. 50 Hz., this power supply shall be designed for essential instrumentation.

7.6.1.7 All electrical level switches included in protective systems shall be external float type. Any exceptions proposed shall be submitted for approval by the Purchaser's Engineer.

7.6.1.8 Proximity switches should be used wherever applicable.

7.6.2 Actuators

7.6.2.1 Bypass valves shall be provided with each actuator valve that fails closed. Block valves alone shall be provided for valves that fail open. Limit switches shall be utilized to actuate an automatic bypass alarm when the bypass valve is opened or when a block is closed. These limit switches shall move from a closed position to an open position as soon as the valve moves from its normal operating position. Bypass valves shall be car sealed closed (CSC.)

7.6.2.2 Protective system valves shall reach a fully closed or fully open position within 10 seconds after a trip signal is initiated by the logic equipment, except where faster closure times are required to meet design specification requirements.

Exceptions to this maximum time shall be submitted for approval by the user’s Engineer. Solenoid valves shall not have delay features.

7.6.2.3 Valves provided in protective systems shall be dedicated solely for protection and not be used for normal regulatory control or any other service. Any exceptions proposed shall be submitted for approval by the Purchaser’s Engineer.

7.6.2.4 Protective system actuators that are powered from energy sources other than the logic trip signal must incorporate a design feature that moves the actuator to its protective position and locks in that position upon loss of any or all other energy sources. Examples of equipment included in this category are pneumatic or hydraulic valves initiated by electrical logic where the two energy sources are separately derived.

7.7 Test and Bypass Facilities

7.7.1 Test (bypass) switches shall be provided on each field circuit for sensor and outputs which will permit the protective system to be tested without affecting plant operations. Bypass switches shall not inhibit any alarm. A separate alarm indicating that a system has been bypassed is required. By-pass switch preferably should be installed in the control room.

7.7.2 The sensor manifold shall allow on-line testing of the sensors and shall be approved by the Purchaser’s Engineer.

7.7.3 Continuous self checking features shall be included in protective systems (If applicable) to help ensure proper operation. This feature also reduce nuisance or unnecessary actions that might result from certain type of system failures.

Self checking systems are usually of a proprietary nature and employ unique signaling and wiring techniques to detect an alarm failure in the protective system.

7.8 Redundancy in Protective Systems

Although testing of protective systems is a means of ensuring a higher degree of reliability, testing can be expensive as well as time consuming. And, because of the need to provide bypassing or deactivating features of some type, testing can be somewhat hazardous. Through the use of additional, or redundant measuring devices, and, in some cases, redundant final control elements, a significant improvement in the security of the system may be achieved. Protective systems using multiple sensors and sophisticated voting logic to initiate action should be used. The investment cost will be greater but the elimination, reduction, or simplification of testing procedures may warrant the added cost.

There are a number of factors that shall be considered to determine whether or not redundancy is warranted. The potential loss caused by a failure, the statistical possibility of a failure, and the potential for adverse consequences such as increased nuisance shutdowns shall all be evaluated. Different systems with varying degrees of reliability shall ultimately be selected for applications with varying degrees of risk.

7.9 Solenoid Operated Valves

7.9.1 Solenoid operated valves should be suitable for 110 volts a.c. /24 volts d.c.

7.9.2 Instead of flame proof execution, consideration shall be given to constructions with potted (hermetically sealed) coils and increased safety terminals, assented for use in division 2 areas.

7.9.3 Each solenoid valve shall be sub-fused separately in the relay box by means of clip-in type fuse terminals.

7.9.4 Manual reset shall be provided for all solenoid valves in safeguarding systems, except for applications where after restoration of the normal situation, no difficulties are encountered, in cases where valves may return automatically to their original position.

In those cases where a manual reset is required this feature shall be incorporated in the electric system by means of an electric push-button mounted in a convenient location close to the solenoid valve.

Where mechanical manual reset is required when special control philosophies are applied the manual reset device shall preferably be of the push-button type in the valve body.

External lever-arrangements with mechanical latching devices shall not be applied.

7.9.5 All inductive devices (e.g. solenoids) shall have suitably rated suppression diodes connected directly across the coils.

7.9.6 Solenoids shall be energized so as not to interfere with the operation of any logic circuits. This may be achieved by separate power supplies or static switches or relays.

7.9.7 Solenoid valves shall be used as pilot valves for instrument air hydraulic systems and shall be sized ½ in. maximum.

7.9.8 The coil shall be energized during normal operating conditions, unless otherwise specified.

7.9.9 Generally solenoid valves should be accessible at grade or permanent platform level and be adequately protected against adverse weather conditions and accidental operation.

8. Documentation

8.1 Alarm and protective system documentation shall be submitted to the Purchaser's Engineer for review at least four weeks prior to the scheduled shop inspection date for check-out of all systems. Documentation shall include (but not be limited to) the following:

> **a)** "As built" logic diagrams of all systems, including one drawing that shows all subsystem interrelated logic, are required in the event that multiple drawings are used to fully describe the system.
>
> **b)** Schematic, connection, and interconnection diagrams for trouble shooting and maintenance.
>
> **c)** Pneumatic system tubing diagram.
>
> **d)** Total equipment list with component manufacturers and model numbers.
>
> **e)** Bill of materials for components.
>
> **f)** Recommended spare parts list for 2 years continuous operation.
>
> **g)** Trouble shooting procedure.

h) Testing procedures.

i) A complete description of the logic system and its operation.

j) A list of inputs and outputs complete with physical addresses.

k) The vendor's standard equipment documentation, including (but not limited to) specifications, installation requirements and operating manuals.

l) Startup and shutdown procedures.

8.2 Alarm and protective systems using microprocessor-based logic equipment shall include the following additional documentation:

a) A block diagram of the system configuration.

b) A flow chart of the program software.

c) A listing of the source program which shall include comment statements to explain the function of each block.

d) A map describing the memory allocation.

8.3 For each alarm and protective system, a complete and accurate record of all alarm and shutdown trip points should be maintained along with proper documentation of corrective actions or shutdown functions performed at each trip point. This information will be needed when testing or troubleshooting a system and is necessary for communicating changes that might be made in the course of system operation.

SPECIFICATION SHEETS FOR ANNUNCIATOR SYSTEMS

	ANNUNCIATORS				SHEET________OF______
	NO	BY	DATE	REVISION	SPEC.NO. REV.
					CONTRACT DATE
					REQ. P.O.
					BY CHRD APPA.

GENERAL	1	Tag No.____________location :____________________
	2	Cabinet size.________rows high by ________________columns wide________________
	3	Mounting flush panel ☐ surface ☐
	4	Cabinet style : plug in light boxes ☐ swing door☐ remote logic cabinet ☐ water tights door☐
	5	raring General purpose ☐ weather proof ☐ explosion proof ☐ class ______zone______________
	6	power supply: 110 V , 50HZ ☐ 110 Vdc ☐ 12 Vdc ☐ 24 Vdc ☐ other :______________________________
DISPLAY	7	Back lighted nameplates : white translucent ☐ other :________________size___________________
	8	Alarm points per light box : one ☐ two ☐ three☐ four☐
		Lams per alarm one ☐ two ☐ three☐ four☐
	9	Bull's-eye type : number of lights_________________color________________________
	10	Other display :______________________________________
LOGIC	11	Logic : electro mechanical relay ☐ solid state electronic ☐ mercury bottle ☐ fluidic ☐ microprocessor base ☐
	12	In display cabinet ☐ remote cabinet ☐ strip chassis ☐
	13	General purpose ☐ weather proof ☐ explosion proof ☐ class ______group____division ___intrinsically safe☐
	14	Field contact voltage : 110 Vac☐ 12 Vdc ☐ 110 Vdc ☐ other:______________________________
	15	On alarm , actuating contacts : open close filed selectable form ____________________________
FEUTURES	16	Required features : lock .in of momentary alarms ☐ auxiliary contacts ☐ sequential alarm circuit ☐
	17	Ring .back circuit : via alarm audible signal ☐ via other audible signal ☐
	18	Fail. safe circuit to signal own failure ☐ operational test ☐ lamp test ☐
	19	Flasher : remote ☐ in cabinet ☐ model No.______________________________________
	20	Acknowledge common☐ unit ☐ light ☐ audible ☐ PB location in cabinet ☐ remote ☐ other ☐
	21	Reset common☐ unit ☐ light ☐ audible ☐ PB location in cabinet ☐ remote ☐ other ☐

SEQUENCE 22	STAGE	VISUAL SIGNAL	AUDIBLE SIGNAL
	Normal		
	Alert,		
	Alert, subsequent		
	Acknowledge, Int.		
	Acknowledge, Subs.		
	Return to normal		
	Reset		
	Test		
	ISA sequence number :		

OPTIONS	23	Horn :
	24	Belt :
	25	Dimmer :
	26	Color caps:
	27	Power supply location :
	28	
	29	Manufacturer: model No
NOTE:		

IPS-G-IN-260a

(to be continued)

(continued)

	ANNUNCIATORS NAMEPLATE SCHEDULE				SHEET________OF______		
					SPEC.NO.		REV.
	NO	BY	DATE	REVISION			
					CONTRACT		DATE
					REQ.	P.O.	
					BY	CHRD	APPA.

COLUMN

ROW		1	2	3	4	5	6	7	8
	1								
	2								
ROW	3								
	4								
	5								
	6								

Alarm tag No.	legend	Row	column	Tag No. of contact	Notes

IPS-G-IN-260b

ANNUNCIATORS

Instructions for IPS Forms G-IN-260 a & b

1) Write in Tag Number of entire Annunciator System.

2) Omit if single unit.

3) Specify cabinet mounting.

4) Specify type of cabinet.

5) Refers only to display and audible.

6) Specify power supply required.

7) Check White Translucent, or write in color of plate and engraving required. Specify window size in height × width.

8) Number of independent displays in one box, or position in cabinet.

9) If individual bull's eyes, specify number and color required. If self-contained unit, specify number of normal and off-normal lights and color of each. (Example-two red independent off-normal and one green common normal light.)

10) Describe display if other than blacklighted nameplate or bull's eye. For example; backlighted prism, electrolumenescent, two-color pneumatically operated.

11) Specify type of logic unit which operates display and audible system.

12) Check required location of logic components.

13) Check enclosure class of logic components and or enclosure. General purpose relays inside an explosion proof housing, or explosion proof relays will both satisfy the hazardous area classification. Use ISA System RP 18.1.

14) Specify voltage across contacts which actuate alarm.

15) Give contact action.

16) Sequential alarm refers to "First Out" System.

17) Specify type of ring back, if applicable.

18) An operational test actuates audible as well as lamps.

19) Specify flasher location and model number.

20) Specify type of acknowledgment, and push-button locations.

21) Specify reset and push-button location.

22) Write in ISA sequence number as described in RP18. 1, Specifications and Guides for the use of General Purpose Annunciators, or fill in the table for the sequence required.

23) Write in the model number, or describe type, if required.

24) Write in the model number, or describe type, if required.

25) Write in the model number, or describe type, if required.

26) Specify number required, and color.

27) Specify power supply location i.e., in logic cabinet, or separate cabinet.

28) For any additional accessories required.

29) Fill in after selection is made.