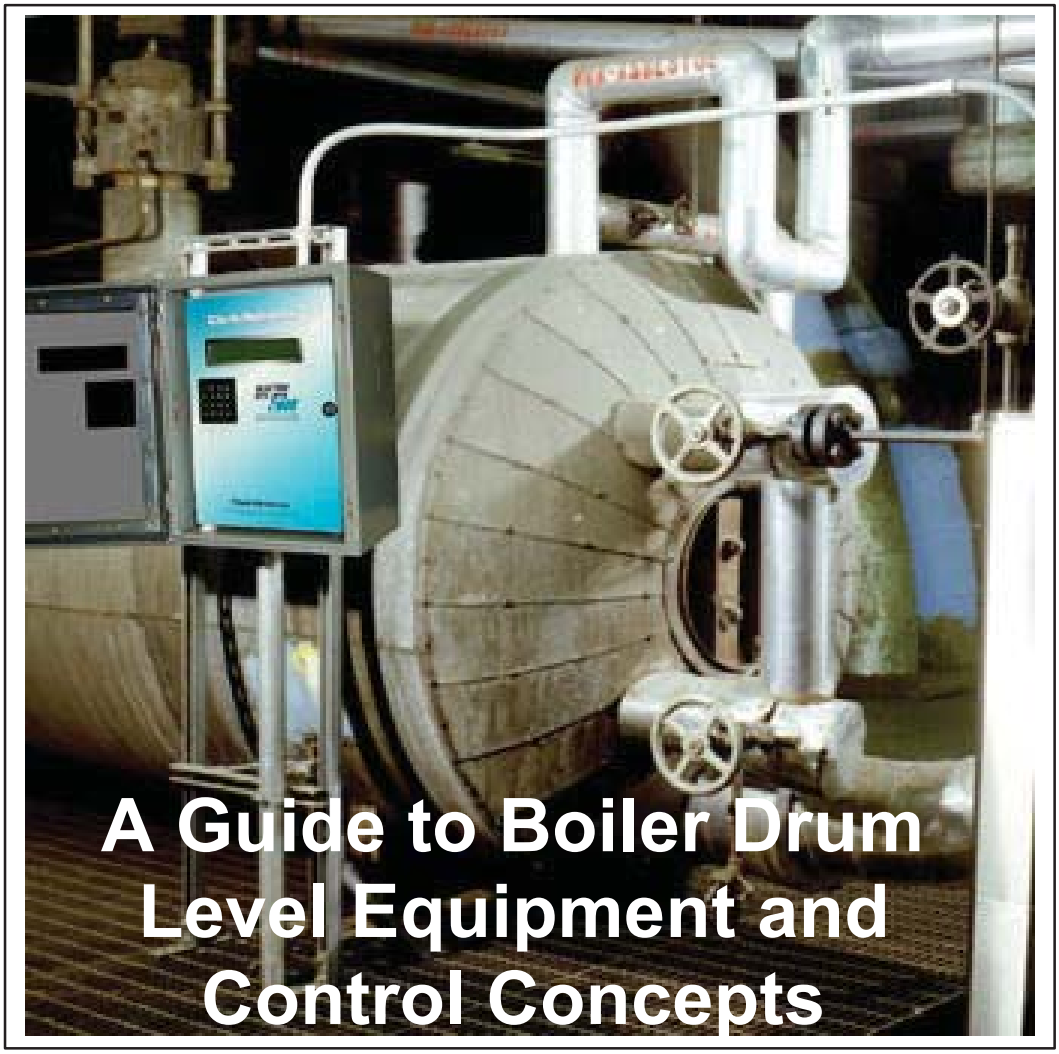
THE BOOK

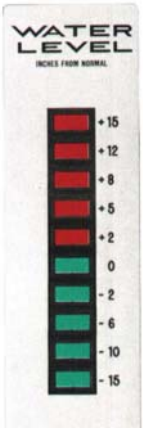


A Guide to Boiler Drum Level Equipment and Control Concepts

Presented by

Clark·Reliance®

THE Boiler Drum Level Measurement GuideBookbook©



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INTRODUCTION:

"***The engineer must be ever vigilant to insure the integrity of the equipment and designs he employs when dealing with critical process applications***". This caution was given by the promoter of a new program for testing control systems. Since there was no "Cookbook" of designs for critical processes any design could now be "modeled" to determine its performance by this new analysis program. For new processes or equipment this may be needed and should prove quite beneficial.

However, some processes have been studied quite thoroughly and necessary control requirements are already well defined. Hundreds of thousands of boilers have been placed in service and the elements needed for proper drum level measurement are well understood. Years of experience have gone into determining satisfactory designs. Unfortunately, a failure to compile and distribute this information has resulted in many engineers going "back to the drawing board" for every new project. Isn't this wealth of experience available somewhere?

New products and methods are being constantly introduced. But how do these new products combine with existing equipment? Are there regulations which these new methods must meet? Is this really a new product, or a research experiment?

The following guide is intended to help in the engineering effort. A sampling of "Tried and true" designs enhanced with the latest developments in equipment and methodology are presented. Hopefully it will provide safer operation of the boiler, save time for the design engineer, and simplify the selection of components that are required to efficiently and safely monitor and control the boiler drum level .

INDEX:

Section:	**Page:**
Objective	1
Application	1
Equipment	1
Direct reading indicators	1
Gage Glasses	1
Gage (try) Cocks	2
Indirect / Remote indicators	2
Water Column Alarm Systems	2
Float Switches	2
Electronic Probe Level Sensors	3
Magnetic Level Indicators	3
Differential Pressure Transmitters	3
Installation	4
Indication, Alarm and Trip Combinations	4
Level Control	5
Conclusion	5
Acknowledgments	6
Attachments	6
Index to Attachments	6
ASME CODE Summary	7
Sample Specifications	8 through 20
Typical Designs	8 through 20

THE OBJECTIVE:

Proper water level indication and limit alarming of Boiler Drums and auxiliary equipment contributes to the safe and efficient operation of the steam generating plant. Unfortunately, the failure of these systems can have catastrophic results resulting in equipment damage and injury to personnel.

The National Board of Boiler Inspectors has repeatedly reported that low water conditions in boilers is the number one cause of boiler related accidents.

Various guidelines are issued to insure the safe design of boilers and associated equipment. Dominant to these guidelines are the recommended practices for design of Boilers and Pressure vessels issued by the American Society of Mechanical Engineers (ASME). Nearly all State regulatory agencies within the United States subscribe in part or whole to the ASME Code.

Section 1 of the ASME Code addresses the requirements for level indication in sub-section PG. 60.1. These guidelines are not intended to prescribe specific products for use but rather give the minimum level of protection considered suitable for safe equipment operation. The interpretation of these guidelines can result in many hours of study and widely varying design practices.

In addition to the requirements of the ASME Code and various local requirements the design Engineer must determine specific products that will provide the best price to performance return on investment. Emerging technologies contribute to make this selection difficult through an ever increasing number of options for monitoring techniques and equipment suppliers.

This booklet is intended to simplify this selection process by offering a number of options based on the particular application. Consideration of Boilers above 400 PSI is the targeted application. At this pressure the use of remote indicators becomes an attractive option. Many engineers may find the basic design elements provided to be of value on lower pressure units as well, when a high degree of performance or safety is desired.

THE APPLICATION:

As stated earlier, this booklet is intended for a limited market. Particularly the level monitoring and safety interlocking on water tube Boilers. Many of the concepts may hold true on other types of steam generators, however a proper consideration of all of the possibilities associated with fire tube or thermal transfer steam generators would require more attention to the subject than this brief guide is intended to provide.

Basically, we address the monitoring of the boiler drum water level within the defined operational limits as determined by the boiler manufacturer. Additionally we consider various methods to generate alarms and fuel cut-off or turbine bypass based on exceeding the Low or High level limits of the Boiler.

The ‘Level Indication, Alarms and Interlocks’, and ‘Level / Feedwater Controls’ are discussed separately.

THE EQUIPMENT:

There are numerous techniques used for determining level. The consideration of these various products can be simplified by dividing them into a few categories.

Direct Reading Devices;

These are instruments which provide for the determination of the level by direct observation such as gage glasses. This device provides for the direct viewing of the liquid level. Various designs are available providing reflex, transparent or refraction (Bi-Color) images.

Gage Glasses:

Two issues are essential in selecting gage glasses. Firstly, the ASME Code requires each fired boiler drum to have a gage glass and two (2) gage glasses for all boilers operating above 400 PSI. The gage glass must be visible to the boiler operator at the location where immediate control action is initiated, or use

some means of re-transmission such as mirrors or fiber optic viewers The number of gages and service requirements can be reduced by using multiple remote indicators.

The second issue is the suitability of the gage. Care should be taken in selection of these devices for use in steam applications. There are gages available that are unsuitable for steam service. Since steam and water can appear very similar, it is important to ensure a continuous view is provided so the observer can see the steam to water interface. In gages which are broken into segments, the segments must overlap or some method, such as bi-color gages with illuminators be employed which provide an obvious difference in the presence of steam or water in the gage.

This gage glass is the final verification method of drum level if all other methods are unavailable. For this reason the ASME Code mandates that all boilers have at least one gage glass at all times.

Gage Cocks (try cocks)

These are a series of valves along the length of a water column. The water level is determined by opening a valve and looking for water. The determination is often difficult, and the release of the live process could be hazardous. These devices were once required by the ASME Code. They are no longer required and typically used only in existing installations.

Indirect/Remote indication

In the event the gage glass is not visible to the operator, or as part of an alternate design philosophy, remote level indicators can be used in place of the gage glass. It is important to consider the level of integrity such a device provides since it is being used in place of a direct reading device.

Indirect level monitors do not offer a direct observation of the level, however they provide additional benefits such as control contacts or analog signals that can be used in the alarm, tripping or control systems.

Water Column Alarm Systems:

The Water Column alarm system was the first style of device to gain wide acceptance in the protection of boilers. The system consisted of a side mounted vessel connected to the drum with pipes above the highest and below the lowest operating limits. Within the column were float assemblies that were connected by a linkage to valves which would release steam from the column and through an externally mounted whistle in the event of a low or high water condition. Many of these systems are in use today as a tribute to their basic simplicity and reliability.

A development on this system replaced the whistle with a switch contact that would allow for the actuation of an audible alarm or automatic control system.

In more recent times the floats have been replaced with electric probes which we will discuss separately in this text.

Float Switches:

Similar in operation to the alarm column is the float switch. This consists of a dedicated housing containing a single float. The float is typically connected to a linkage attached to a magnet. The float, linkage and magnet are within the body of the assembly and subject to the process conditions. A magnet follower which actuates a switch contact is located outside the housing. As the float changes its position, the switch contacts change state. This device is mounted so that the switch contacts transfer at the desired water level.

This device provides no external indication and requires frequent testing to verify operation. Alarm Columns and Float switches are usually combined with gage glasses to form a comprehensive level alarm and indicating system.

Electronic Probe level sensors:

Increasingly popular for remote level indication is the use of probe type level detectors. This device consists of an array of probes that provide an incremental representation of the level. These devices monitor the presence of water electrically and provide both an indication of the level and control contacts. This eliminates the need for separate devices for indication and control.

These probes are installed vertically or horizontally projecting into a water column which is attached to the drum. As the level changes in the drum and column it is detected by the probes. The vertical orientation allows changing the location at which water will be detected by changing the length of the probe. The horizontal method allows for a greater number of probes to be installed but the positions cannot be altered after the column is constructed. Analog transmitters are available but it is important to note that they do not provide a true analog signal. The output from the analog transmitter will be "stepped" as each probe is submerged or removed from the water. The degree of each step is determined by the number of probes in the system. Like gage glasses, a variety of designs are available for probe level monitors. For critical applications such as boiler drum monitoring, consideration of system redundancy, reliability and the failure state of control outputs should be considered. Advanced systems of this type incorporate self checking features that will alert the operator of system failures. Some versions of this device will continue to operate even in the event of a major circuit failure, providing a "Fault Tolerant" system

Magnetic Level Indicators:

The use of Magnetic float type instruments is becoming common in drum level indication. This device benefits by being of an all metal construction and having seals only at a single flange used to install the float or clean the chamber, and at a vent at the chamber top. The addition of local or remote indication and

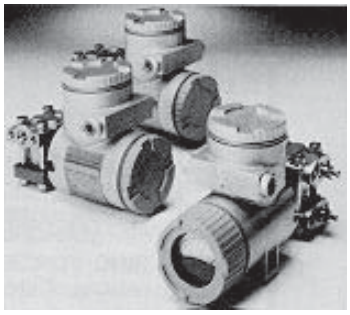
alarm/trip contacts is easily performed by attaching devices externally to the chamber housing the float. It is important for the designer to remember that boiler water will change in specific gravity over the operating range. This change will cause the float to either raise up or sink down in the water. The resulting error will depend on the initial design SG for the float. This inherent error can add to confusion when compared to other instruments during the operating cycle. Unlike the gage glass, where the measurement is direct by vision, or a probe which Is measuring by "touch", the magnetic gage indicates the position of the float, not the actual process fluid. If the float should stick or sink, no means of verifying proper operation is possible without taking the gage out of service.

There has been some confusion in the industry that this device is a direct replacement for the required gage glass. Although the magnetic gage can be used as a local or remote level indicator it does not eliminate the need for the Code mandated gage glass.

Differential Pressure Transmitters:

The most popular device for level monitoring on the boiler drum is the Differential Pressure transmitter. This device Infers the level of the water within the drum by comparing the head pressure generated by the water in the drum to a reference level. Typically this reference is derived from a chamber attached to the drum and filled with condensate derived from the sub cooling of steam.

Connections are made from this reference and from the drum itself to the high and low inputs of the level transmitter. It is important that the two inputs to the transmitter be kept as close together in temperature as possible to prevent errors resulting from differing SG resulting from temperature differences in the two sampling legs and erroneously interpreting this to be a level difference. This device is frequently associated with pressure and temperature transmitters that are used to correct for errors throughout the operating cycle. This type device is subject to calibration shifts or sensor failures. Since the device has no internal diagnostic features it is possible to generate an erroneous indication.



Typically these devices will be installed in a redundant or triplicate configuration which is intended to help provide for a more secure system through an averaging or mean select scheme. Unfortunately, the source power for all of the transmitters is often taken from a single source. The loss of this supply results in a total loss of indication. The increased number of transmitters also increases the potential for failure. Despite these concerns this device provides a continuous analog representation of level which is essential for modulating control. As such, it is an integral component in the analog control system.

INSTALLATION:

The ASME boiler and pressure vessel code stipulates that the level indicators shall be installed on taps to the drum that are not used for any other purpose than level indication. Although not clearly defined it makes good engineering practice to partition the level indicator and safety interlock contacts from the control transmitters. In the event of a failure of the control system the operator would have an independent source to verify the drum level and take manual control.

Conversely, if a problem should develop in the indication and interlocking system, the control transmitters would indicate a level that would allow the operator to take action.

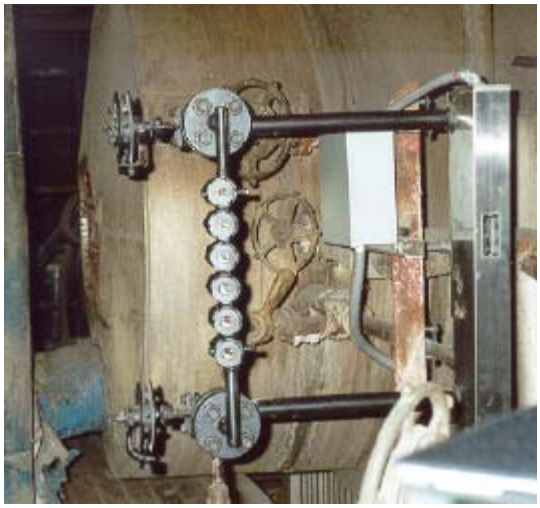
This same segmentation should extend to the indication portion as well. The trend toward main control consoles with all operations presented on the CRT screen must be carefully scrutinized when addressing critical portions of the process.

The traditional approach of using a gage glass, provides an independent signal that is continuously visible to the operator. It stands to reason that any alternate system should retain this same level of performance. Should an alternate design be used that does not provide for the direct reading of the gage glass, the indicator should retain the function of being constantly visible and independent from other equipment. Displaying the drum level on one of many different CRT displays in a centralized control system fails to meet this condition. The obvious question is when should the operator look at the drum level? If he waits until some alarm condition is generated that triggers his checking the level, precious moments are lost in response. If the level was constantly displayed, the change may be observed as it is occurring, allowing additional response time for the operator.

Placement of an indicator at the drum should also be considered. The ASME Code makes provisions for removing one of the two required gage glasses and isolating the remaining gage glass from the process if the remote level indicators are in reliable operation. This practice would leave no indication at the drum other than by placing the gage glass into service. To avoid this situation it would be desirable to have a local indication at the boiler drum for at least one of the remote level indicators.

The design of pipe work connecting the gage(s), water columns, or tie-bars and the placement of isolation valves should be made to facilitate the individual testing or maintenance of each device.

Care should be taken to insure no traps exist that would result in a thermal or physical blockage of the assembly. The arrangement should also balance the heat equally among the various devices.



Some equipment manufacturers offer full “bridle“ assemblies that insure proper selection and connection of devices.
Systems of this type simplify assembly in the field and allow for factory testing prior to connection to the boiler.

INDICATION, ALARM AND TRIP COMBINATIONS:

The selection of specific devices must be determined by the design engineer. This guide is intended to provide information that will assist in determining the features and benefits of each of the various options.

At the end of this guide are some typical design configurations that have been proven to provide reliable performance. They are divided into various designs based on operating conditions and scope of supply. Where ever a gage or water column is depicted, it is a typical arrangement, and other devices with suitable ratings and range of indication may be substituted as the application warrants.

Although each of the designs has specific devices shown it is not limited to the scope of equipment exhibited. It may be desirable to combine one of the probe type remote level indicators with a Magnetic level indicator with a remote display. This would provide a mix of techniques and still satisfy the objective for two remote level indicators in compliance with applicable ASME Code sections.

The Traditional Methods diagram shows a variety of devices that have been used over time. The actual items that would be combined to meet a specific need must be determined on a case by case basis.

Not shown is the use of differential pressure transmitters with indicators as an alternative to gage glasses. The rationale for this omission is that many of these devices are not designed for the rigorous conditions encountered in drum level monitoring. In addition, the need for additional devices to provide temperature and pressure correction, remote indication and alarm switch actuation would result in a complex arrangement that would be equivalent in cost and offer no advantage over the other methods described.

DRUM LEVEL / FEEDWATER CONTROL:

The purpose of level control in the Feedwater circuit is quite different from the alarm and tripping functions. The equipment is therefore specialized for each of these unique tasks. A typical Feedwater control system employs a three element control scheme employing triple differential pressure type level transmitters. The use of a median select or averaging of the transmitter outputs for control should be determined based on the requirements.

Employing fewer transmitters in this control area may be possible dependent on the integrity of the devices used. Integrating a signal from the level indication portion of the system which could be used to validate the proper operation of the level control transmitters would further insure the proper operation of the system.

CONCLUSION:

Low water conditions have been the most common cause of boiler accidents for decades. Typically the incidents have occurred as a result of insufficient or inoperable controls. Many times it is a symptom of improper selection of devices that results in poor performance and a low availability factor for the safety systems. Instances have occurred where as a result of continued failures, devices are removed from service due to frustration caused by continued poor performance even after extensive maintenance effort.

This guide is intended to direct the design engineer towards the basic concerns and methods related to specifying Boiler Drum Trim that will provide years of safe and efficient service.

As new developments in technology emerge it is essential that the use of these new ideas be implemented as appropriate to insure the best performance possible.

The suitability of any specific design or piece of equipment is not warranted by it’s being referenced in this guide. It is strongly recommended that the design engineer consider current engineering standard practices and confirm his design with the proper regulatory authority before incorporating any design into the Boiler.

ACKNOWLEDGMENTS:

Dukelow, Sam G., The Control Of Boilers Second Edition, 1991 *Instrument Society of America* pp. 189-191.

ASME STANDARD No. TDP-1-1980, Recommended Practices for the Prevention of Water Damage to Steam Turbines Used for Electric Power Generation, Sec. 3.1.3 *ASME* 1980

Factory Mutual System Loss Prevention Data 12-37, LOW-WATER PROTECTION, Sec. 2.1.1; 2.1.10; 2.2.2; 2.3.2; 4.1.2 and A-1.5, *Factory Mutual Systems*, July 1990

ASME Boiler & Pressure Vessel Code 1995 The American Society of Mechanical Engineers, New York, NY

Rob Swanekamp Common Design and operational problems in cogeneration power stations *Proceedings of the Cogeneration conference , January 22-25, 1994*

ATTACHMENTS:

Some typical specifications have been provided relating to various different boiler pressures and types of trim equipment . Each of these specifications is followed with a short list of issues relating to the system design or equipment selected. These topics might be worth considering when choosing a specific design concept.

A reference to which drawing and specific items coincide with the specification is noted at the bottom of each specification sheet.

INDEX TO ATTACHMENTS:

Drum PSI	*Indication & Tripping Concept*	*PG. #*	*Ref. DWG.*
250	2 gage glasses + whistle alarms + Float switches	9	DRUM1 (select items)
1500	2 gage glasses + probe type alarms	10	DRUM1 (select items)
1500	2 vertical probe columns with remote Indication & alarms + 1 gage glass	12	DRUM2
1500	2 horizontal probe columns with remote Indication & alarms + 1 gage glass	14	DRUM3
3000	2 horizontal probe columns with remote Indication & alarms + 1 gage glass	16	DRUM4
1100	2 Magnetic level gages for remote indication & alarms + 1 gage glass	18	DRUM5
As Req'd	3 element control with triple redundancy D/P	20	DRUM7

A.S.M.E. Code for Power Boilers

The following excerpts are intended to serve as a quick reference for application of Level instruments to Drum type boilers

PG-60 Requirements for Miscellaneous Pipe, Valves and Fittings

60.1 Water Level Indicators

60.1.1 Each boiler, except forced-flow steam generators with no fixed steam and water line, and high temperature water boilers of the forced circulation type that have no steam and water line, shall have at least one water gage glass. Except for electric boilers of the electrode type, boilers operated at pressures over 400 psi shall be provided with two water gage glasses which may be connected to a single water column or connected directly to the drum.

Two independent remote level indicators may be provided instead of one of the two required gage glasses for boiler drum water level indication in the case of power boilers with all drum safety valves set at or above 900 psi. When both remote level indicators are in reliable operation, the remaining gage glass may be shut off, but shall be maintained in serviceable condition.

When the direct reading of gage glass water level is not readily visible to the operator in *the area where immediate control actions are initiated,* two dependable indirect indications shall be provided, either by transmission of the gage glass image or by remote level indicators. *A gauge glass image transmitted to the operator's working area by means of a fiber optic cable, with no electrical modification of the optical signal is considered to provide direct reading of the gage glass water level.*

The lowest visible part of the water gage glass shall be at least 2 in. above the lowest permissible water level, *as determined by the boiler Manufacturer.* When remote level indication is provided for the operator in lieu of the gage glass, the same minimum level reference shall be clearly marked.

PG-60.2 Water Columns

PG-60.2.1 The Water Column shall be so mounted that it will maintain its correct position relative to the normal waterline under operating conditions.

PG-60.3 Connections

PG-60.3.1 Gage Glasses that are required by PG-60.1 shall be connected directly to the shell or drum of the boiler or to an intervening water column.

PG-60.3.2 The lower edge of the steam connection to a water column or gage glass in the boiler shall not be below the highest visible water level in the water gage glass. There shall be no sag or offset in the piping which will permit the accumulation of water.

PG-60.3.3 The upper edge of the water connection to a water column or gage glass and the boiler shall not be above the lowest visible water level in the gage glass. No part of this pipe connection shall be above the point of connection at the water column.

PG-60.3.4 Connections from the boiler to the water column shall be at least NPS 1. Connections for gage glasses connected directly to the boiler shall be at least NPS 1/2. Connections from the boiler to the remote level indicator shall be at least *NPS* 3/4 to and including the isolation valve and from there to the remote level indicator at least 1/2 in. O.D. tubing. These connections shall be completely independent of other connections for any function other than water level indication. *(Items in italics are changes as issued in the 1995 Code.)*

Code case 2109 Dated 5/16/91 States:

Inquiry: May two remote level indicators be used to replace one of the two required gage glasses for drum level indication for boilers with all drum safety valves set at or above 400 psig per Section 1 PG-60.1.1?

Reply: It is the opinion of the Committee that two remote level indicators may be used to replace one of the two required gage glasses for drum water level indication for boilers with all drum safety valves set at or above 400 psig. When both remote level indicators are in reliable operation, the remaining gage glass may be shut off, but shall be maintained in serviceable conditions. This Case number shall be shown on The Manufacturer's Data Report.

Interpretation I-89-53 to Section 1, PG-60.1 (6/1/90)

Question (1): May a computer remote terminal be used to provide an independent remote boiler water level indication in accordance with PG-60.1.1?

Reply (1): Yes

Question (2): Is continuous, uninterrupted indication of Boiler water level required of two remote level indicators in order to shut off the gage glass as provided by PG-60.1.1?

Reply (2): Yes

Interpretation I-95-07 to Section 1, PG-60.1 (2/21/95)

Question (1): May a power plant distributed digital control system (DCS) with cathode-ray tube (CRT) screens providing graphic drum water level displays in the control room be considered to provide an independent remote water level indication in accordance with PG-60.1.1?

Reply (1): Yes, Note that two such independent displays are required in order to omit one of the two normally required gage glasses for boilers whose MAWP is 900 psi or greater.

Question (2): May a power plant distributed control system (DCS) be considered to provide an independent remote level indication as described in PG-60.1.1 if the displays are interruptable, non-continuous displays which may require a keystroke to become visible?

Reply(2): No.

Interpretation I-92-96 to Section 1,PG-60.2 (06/13/94)

Question (1): Is a magnetic level gage which provides a local, indirect visual indication of the boiler drum level considered to be a gage glass as required by PG-60.1.1?

Reply:(1): No.

Interpretation I-95-04 to Section 1, PG-60.1.1 (11/15/94)

Question: May a pressure and temperature compensated differential pressure drum level transmitter with a remote readout be considered a remote level indicator?

Reply: Yes.

SECTION VII - C5.100

It is recommended that each automatically fired boiler have two independent low water cutoffs.

On modern units designed with centralized control rooms including complex instruments, controls and data loggers, the firsthand observation feature is unrealistic under normal operating conditions. In these cases redundancy must be provided in the instrumentation so that the operator is ensured of accuracy and reliability. *Revised: 08/21/96*

SAMPLE SPECIFICATION:

Boiler Drum Level Indication and Alarm / Trip Interlocking Control for Boilers up to 250 PSI incorporating Prismatic Gage Glasses and Water Columns with Float Style Alarm/Control Systems.*

Scope of Supply:

The Boiler trim package shall incorporate all devices required for the indication of water level and provision of alarm and trip contact closures for actuation of alarm and control systems.

Approvals:

The system shall include devices and designs as required and recommended by the ASME Boiler and pressure vessel Code Section PG. 60.1, and other applicable local regulations.

All electrical indicators shall be approved by Factory Mutual Research and have approval certifications on file.

Gage Glasses:

The gage glasses shall be designed and constructed from materials suitable for steam applications at the rated design service. Bodies shall be fabricated from Cast Iron. Clamping plates shall bolt into or through the gage body. Gage glass shall be of high pressure borosilicate glass. The device shall use Grafoil gaskets with a stainless steal insert for sealing against the process. Cushion gaskets shall be made of an asbestos free compressed fiber composition. Nipples shall be provided for assembly to gage valves.

Gage Valves:

Gage valves shall be of quad thread (1/4 turn) union bonnet construction. Lever handles with chain extensions shall be provided. Bodies shall be of ASME Code Bronze. Valves shall incorporate stainless steel stems with Grafoil cartridge packing assemblies. Valves shall be provided in sets with 3/8" tap in lower valve for blowdown connection.

Water Columns:

Water columns shall be of Cast Iron construction and designed in accordance with ASME B31.1 Power Piping Code requirements. Connections for process and gage glass connections shall be made in accordance with the data form.

Level Alarms:

Alarm contacts shall be provided for low and high water level conditions. Alarms shall be generated by Float type sensors assembled into the provided water column. Alarm floats shall be connected to a Whistle alarm which shall generate two different tones for signaling high or low water conditions

Trip / Interlock Switches:

Control switch contacts for generating signals to the burner control panel shall be provided by Float Switch assemblies. Separate switches shall be used for high and low alarm conditions. Switch contacts shall be rated for 5 A @ 125 VAC. Float switch bodies shall be of ductile Iron and provide 1" NPT female fittings for connection to piping. Floats shall be of Stainless Steel construction and use Alnico V actuating magnets

SYSTEM CONSIDERATIONS:

KEY PRODUCT FEATURES	*ADVANTAGES*	*DISADVANTAGES*
Prismatic gage glasses	Direct reading Clear indication of steam / water Low Cost	Indication is only function Limited to 250 PSI & Low pH High Maintenance
Cast Iron Water Column with Bronze gage valves	Simple assembly Low Cost	Pressure limitation
Float type Whistle Alarms	No electricity required Adjustable alarm positioning	no automatic control function
Float type Level Switches	No electricity required	Frequent testing required Complex assembly to process

*Components incorporated in this specification are identified as items 2,3,8 & 5 on Drawing DRUM1

SAMPLE SPECIFICATION:

Boiler Drum Level Indication and Alarm / Trip Interlocking Control for Boilers up to 1500 PSI incorporating Transparent Gage Glasses and Water Columns with Probe Style Alarm/Control Systems. *

Scope of supply:

The Boiler trim package shall incorporate all devices required for the indication of water level and provision of alarm and trip contact closures for actuation of alarm and control systems.

Approvals:

The system shall include devices and designs as required and recommended by the ASME Boiler and pressure vessel Code Section PG. 60.1, and other applicable local regulations.

All electrical indicators shall be approved by Factory Mutual Research and have approval certifications on file.

Gage Glasses:

The gage glasses shall be designed and constructed from materials suitable for steam applications at the rated design service. Bodies shall be fabricated from ASTM Grade carbon steel. Gage glass shall be of high pressure borosilicate glass. A protective mica shield of no less than 7 mils thickness shall be placed between the glass and process fluid. The device shall use Grafoil gaskets with a stainless steal insert for sealing against the process. Cushion gaskets shall be made of an asbestos free compressed fiber composition. Nipples shall be provided for assembly to gage valves.

Illuminators:

Gage glass illuminators shall provided with mercury lamps and required ballast transformers suitable for 120 VAC operation. A weatherproof housing of stainless steel construction suitable for outside installations shall be provided to cover the illuminator assembly.

Gage Valves:

Gage valves shall be of quad thread (1/4 turn) outside screw and yoke design with integral bonnets. Lever handles with chain extensions shall be provided. Bodies shall be of ASTM A 105 forged steel. Valves shall incorporate stainless steel stems and hardened, replaceable seats with Grafoil cartridge packing assemblies. Valves shall be provided in sets with 3/8" tap in lower valve for blowdown connection.

Water Columns:

Water columns shall be of all steel construction and designed in accordance with ASME B31.1 Power Piping Code requirements. Connections for process and gage glass connections shall be made in accordance with the data form.

Level Alarms:

Alarm contacts shall be provided in number and purpose as specified on the data form. Alarms shall be generated by probe type sensors assembled vertically into the provided water column. Alarm probes shall be connected to a low voltage (max. 12 volt AC) sensing circuit. System shall be powered by 117 volt AC (nom.) source. Two form "C" contacts rated for a minimum of 5 A @ 30 VDC/240 VDC shall be provided for each alarm point.

SYSTEM CONSIDERATIONS:

KEY PRODUCT FEATURES	*ADVANTAGES*	*DISADVANTAGES*
Transparent gage glasses	Direct reading Low Cost	Indication is only function High Maintenance
Mercury lamp Illuminators	Superior visibility of level	greater cost than incandescent models
Probe type Alarms	High reliability No moving parts Adjustable alarm positioning	Requires power to operate

*Components incorporated in this specification are identified as items 2,4,8 & 9 on Drawing DRUM1

SAMPLE SPECIFICATION:

Boiler Drum Level Indication and Alarm / Trip Interlocking Control for Boilers up to 1500 PSI incorporating Transparent Gage Glass and Water Columns with Probe type remote Level Indication, Alarm & Control systems.*

Scope of supply:

The Boiler trim package shall incorporate all devices required for two remote indications of water level and alarm and trip contact closures for actuation of control systems. A Transparent gage glass and Isolation valves shall be provided.

Approvals:

The system shall include devices and designs as required and recommended by the ASME Boiler and pressure vessel Code Section PG. 60.1, and other applicable local regulations.

All electrical indicators shall be approved by Factory Mutual Research and have approval certifications on file.

Gage Glasses:

The gage glasses shall be designed and constructed from materials suitable for steam applications at the rated design service. Bodies shall be fabricated from ASTM Grade carbon steel. Gage glass shall be of high pressure borosilicate glass. A protective mica shield of no less than 7 mils thickness shall be placed between the glass and process fluid. The device shall use Grafoil gaskets with a stainless steal insert for sealing against the process. Cushion gaskets shall be made of an asbestos free compressed fiber composition. Nipples shall be provided for assembly to gage valves.

Gage Valves:

Gage valves shall be of quad thread (1/4 turn) outside screw and yoke design with integral bonnets. Lever handles with chain extensions shall be provided. Bodies shall be of ASTM A 105 forged steel. Valves shall incorporate stainless steel stems and hardened, replaceable seats with Grafoil cartridge packing assemblies. Valves shall be provided in sets with 3/8" tap in lower valve for blowdown connection.

Water Columns:

Water columns shall be of all steel construction and designed in accordance with ASME B31.1 Power Piping Code requirements. Connections for process and gage glass connections shall be made in accordance with the data form.

Level Detection System:

Level Indication shall be generated by probe type sensors assembled vertically into the provided water column. Level sensing probes shall be connected to a low voltage (max. 12 volt AC) detection circuit. The System shall be powered by two 117 volt AC (nom.) sources. Loss of one of the two sources will not result in the total loss of indication. Each detection circuit shall be fuse protected to prevent short circuits from affecting multiple probe channels.

Level Alarms:

Two form "C" contacts rated for a minimum of 5 A @ 30 VDC/240 VDC shall be provided to indicate the status of each probe.

Level Indicators:

Indication of drum level will be displayed at the Control unit (local) and in the Operators Console (remote). Indicators shall indicate red for steam and green for water as detected at the probes.

SYSTEM CONSIDERATIONS:

KEY PRODUCT FEATURES	*ADVANTAGES*	*DISADVANTAGES*
Probe Type Level sensors with dual Remote Indicators	High Reliability / Clear Indication. Gage glass can be isolated. Indication & Control in single unit	higher initial cost Requires power to operate
Water Column with vertical probes	Adjustable position of water detection points	Maximum of 6 indication points per Column

*Components incorporated in this specification are identified on Drawing DRUM2

SAMPLE SPECIFICATION:

Boiler Drum Level Indication and Alarm / Trip Interlocking Control for Boilers up to 1500 PSI incorporating Transparent Gage Glass and Water Columns with Probe type remote Level Indication, Alarm & Control systems.*

Scope of supply:

The Boiler trim package shall incorporate all devices required for two remote indications of water level and alarm and trip contact closures for actuation of control systems. A Transparent gage glass and Isolation valves shall be provided.

Approvals:

The system shall include devices and designs as required and recommended by the ASME Boiler and pressure vessel Code Section PG. 60.1, and other applicable local regulations.

All electrical indicators shall be approved by Factory Mutual Research and have approval certifications on file.

Gage Glasses:

The gage glasses shall be designed and constructed from materials suitable for steam applications at the rated design service. Bodies shall be fabricated from ASTM Grade carbon steel. Gage glass shall be of high pressure borosilicate glass. A protective mica shield of no less than 7 mils thickness shall be placed between the glass and process fluid. The device shall use Grafoil gaskets with a stainless steal insert for sealing against the process. Cushion gaskets shall be made of an asbestos free compressed fiber composition. Nipples shall be provided for assembly to gage valves.

Gage Valves:

Gage valves shall be of quad thread (1/4 turn) outside screw and yoke design with integral bonnets. Lever handles with chain extensions shall be provided. Bodies shall be of ASTM A 105 forged steel. Valves shall incorporate stainless steel stems and hardened, replaceable seats with Grafoil cartridge packing assemblies. Valves shall be provided in sets with 3/8" tap in lower valve for blowdown connection.

Water Columns:

Water columns shall be of all steel construction and designed in accordance with ASME B31.1 Power Piping Code requirements. Connections for the process shall be made in accordance with the data form.

Level Detection System:

Level Indication shall be generated by probe type sensors assembled horizontally into the provided water column. Level sensing probes shall be connected to a low voltage (max. 12 volt AC) detection circuit. The System shall be powered by two 117 volt AC (nom.) sources. Loss of one of the two sources will not result in the total loss of indication. Each detection circuit shall be fuse protected to prevent short circuits from affecting multiple probe channels.

Level Alarms:

Two form "C" contacts rated for a minimum of 5 A @ 30 VDC/240 VDC shall be provided to indicate the status of each probe.

Level Indicators:

Indication of drum level will be displayed at the Control unit (local) and in the Operators Console (remote). Indicators shall indicate red for steam and green for water as detected at the probes.

SYSTEM CONSIDERATIONS:

KEY PRODUCT FEATURES	*ADVANTAGES*	*DISADVANTAGES*
Probe Type Level sensors with dual Remote Indicators	High Reliability / Clear Indication. Gage glass can be isolated. Indication & Control in single unit	higher initial cost Requires power to operate
Water Column with horizontal probes	Reduced cost	fixed probe locations

*Components incorporated in this specification are identified on Drawing DRUM3

SAMPLE SPECIFICATION:

Boiler Drum Level Indication and Alarm / Trip Interlocking Control for Boilers up to 3000 PSI incorporating Bi-Color Gage Glass with illuminator and Probe Columns with remote Level Indication, Alarm & Control systems.*

Scope of supply:

The Boiler trim package shall incorporate all devices required for two remote indications of water level and alarm and trip contact closures for actuation of control systems. A Bi-Color gage glass with Illuminator and Isolation valves shall be provided.

Approvals:

The system shall include devices and designs as required and recommended by the ASME Boiler and pressure vessel Code Section PG. 60.1, and other applicable local regulations.

All electrical indicators shall be approved by Factory Mutual Research and have approval certifications on file.

Gage Glasses:

Indication of steam or water in the gage shall result in a red image for steam and a green image for water projected through the gage lenses by the Illuminator. The gage body shall be manufactured from Stainless Steel. Gage glass segments shall be made of aluminosilicate glass and provided with a protective Mica shield. The Glass modules shall each be held in place by a single packing nut assembly. Illuminator shall have a stainless steel housing and use 50 watt halogen lamps.

Gage Valves:

Gage valves shall be of outside screw and yoke design with integral bonnets. and Chain wheel. Bodies shall be of ASTM A 105 forged steel. Valves shall incorporate type 303 stainless steel stems and Grafoil cartridge packing assemblies. Process connections shall be 1" female socket weld. Gage connections shall be ANSI ½" CL 2500 RJF. Valves shall be provided in sets with 3/8" pipe and female socket weld in lower valve for blowdown connection.

Probe Columns:

Columns shall be of all steel construction and designed in accordance with ASME B31.1 Power Piping Code requirements. Locations for probes and type of process connections shall be made in accordance with the data form.

Level Detection System:

Level Indication shall be generated by probe type sensors assembled horizontally into the provided Probe column. Level sensing probes shall be connected to a low voltage (max. 12 volt AC) detection circuit. The System shall be powered by two 117 volt AC (nom.) sources. Loss of one of the two sources will not result in the total loss of indication. Each detection circuit shall have a dedicated power regulator, probe detection circuit, and indicator driver circuit and be individually fuse protect against common mode failures. The system shall contain self diagnostic features to identify and alarm the loss of power or probe circuits.

Level Alarms:

Two form "C" contacts rated for a minimum of 5 A @ 30 VDC/240 VDC shall be provided to indicate the status of each probe.

Level Indicators:

Indication of drum level will be displayed at the Control unit (local) and in the Operators Console (remote). Indicators shall indicate red for steam and green for water as detected at the probes.

SYSTEM CONSIDERATIONS:

KEY PRODUCT FEATURES	*ADVANTAGES*	*DISADVANTAGES*
Probe Type Level sensors with dual Remote Indicators	High Reliability / Clear Indication. Gage glass can be isolated. Indication & Control in single unit	higher initial cost Requires power to operate
Water Column with horizontal probes	Reduced cost no limit on probe qty or locations	fixed probe locations after construction.

*Components incorporated in this specification are identified on Drawing DRUM4

SAMPLE SPECIFICATION:

Boiler Drum Level Indication and Alarm / Trip Interlocking Control for Boilers up to 1100 PSI incorporating a Transparent Gage Glass and Magnetic Level Gages for Indication, Alarm & Control systems.*

Scope of supply:

The Boiler trim package shall incorporate all devices required for two remote indications of water level and alarm and trip contact closures for actuation of control systems. A Transparent gage glass and Isolation valves shall be provided.

Approvals:

The system shall include devices and designs as required and recommended by the ASME Boiler and pressure vessel Code Section PG. 60.1, and other applicable local regulations.

Gage Glasses:

The gage glasses shall be designed and constructed from materials suitable for steam applications at the rated design service. Bodies shall be fabricated from ASTM Grade carbon steel. Gage glass shall be of high pressure borosilicate glass. A protective mica shield of no less than 7 mils thickness shall be placed between the glass and process fluid. The device shall use Grafoil gaskets with a stainless steal insert for sealing against the process. Cushion gaskets shall be made of an asbestos free compressed fiber composition. Nipples shall be provided for assembly to gage valves.

Gage Valves:

Gage valves shall be of quad thread (1/4 turn) outside screw and yoke design with integral bonnets. Lever handles with chain extensions shall be provided. Bodies shall be of ASTM A 105 forged steel. Valves shall incorporate stainless steel stems and hardened, replaceable seats with Grafoil cartridge packing assemblies. Valves shall be provided in sets with 3/8" tap in lower valve for blowdown connection.

Magnetic Level Gage :

Magnetic level gage columns shall be of SCH 40 #316 Stainless steel construction and designed in accordance with ASME B31.1 Power Piping Code requirements. Connections for process connections shall be made in accordance with the data form.

Level Sensing System (mechanical):

Level Indication shall be provided by an arrangement of high temperature Alnicol-8 magnets contained within a non-pressurized float which generate a field corresponding to the surface level of the water. A mechanical indicator consisting of "wafers" which indicate a change in color or a "spool" which changes position to indicate the corresponding position of the float shall be provided.

Level Sensing System (electrical):

Independent sensing circuits shall be provided at various positions along the Float column to determine the level within the column. A form "C" contact rated for 1 A @ 30 VDC/240 VDC shall be provided at the positions specified in the data form.

Illuminated Level Indicators:

Indication of drum level will be displayed at the Control unit (local) and in the Operators Console (remote). Indicators shall consist of LED lamps and indicate red for steam and green for water as detected at the Float Column. Number and position of lamps shall be as specified in the data form.

SYSTEM CONSIDERATIONS:

KEY PRODUCT FEATURES	*ADVANTAGES*	*DISADVANTAGES*
Magnetic Float level gage	All metal construction Requires no power Easy to add options	subject to temperature changes difficult to detect failures
Bi-Color remote indicator	Clear Indication/compatible with other boiler level indications. Variable number of points	Requires power.

*Components incorporated in this specification are identified on Drawing DRUM5

SAMPLE SPECIFICATION:

Three Element Feedwater Control system with Pressure and Temperature Compensation. Triple Differential Pressure Level Transmitters for averaging or voting selection by control system provided.*

This portion of the guide is provided to demonstrate a typical arrangement of equipment that could be used in the control system.

The actual selection of instruments is best determined on a case by case basis related to the requirements of the particular control concepts and hardware to be used.

Consideration should be given to the following criteria::

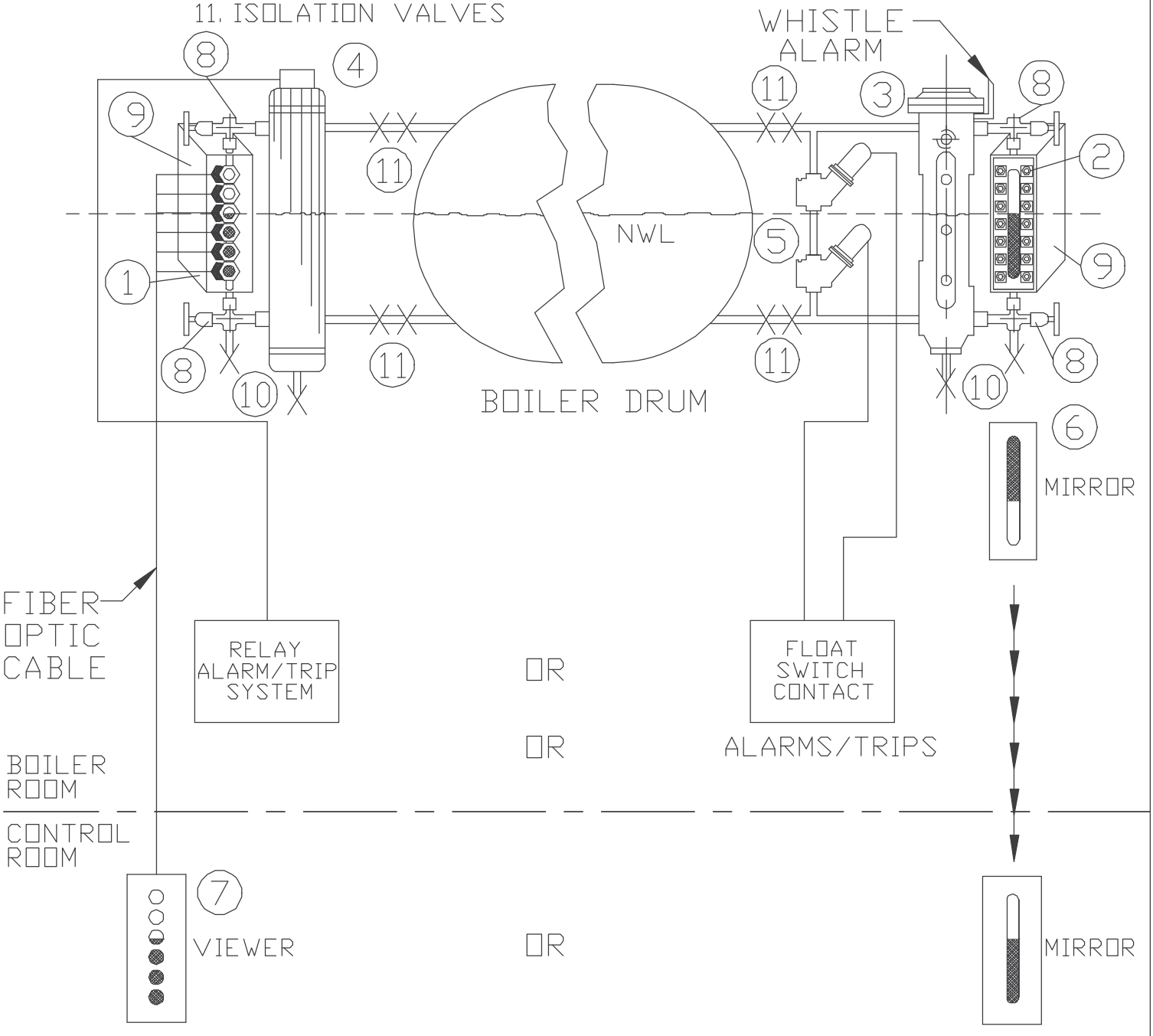
Scope of Supply:
Approvals:
Equipment construction:
Product Performance:

* Components incorporated in this specification are identified on Drawing DRUM7

CLARK-RELIANCE CORP. STRONGSVILLE, OHIO, U.S.A.	ASME SECTION 1 TRADITIONAL METHOD HIGH AND LOW ALARM	DRAWING NUMBER: DRUM1	REV. X1
DRAWN: SSM	DATE: 5/6/96	SCALE: NONE	CHECKED: X

B.O.M.

1. SIMPLIPORT GAGE GLASS
2. REFLEX/TRANSPARENT GAGE GLASS
3. ALARM WATER COLUMN
4. PROBE ALARM WATER COLUMN
5. FLOAT ALARM SWITCH
6. RETRANSMISSION MIRROR
7. FIBER LEVEL SYSTEM
8. GAGE VALVE
9. ILLUMINATOR
10. DRAIN VALVE
11. ISOLATION VALVES



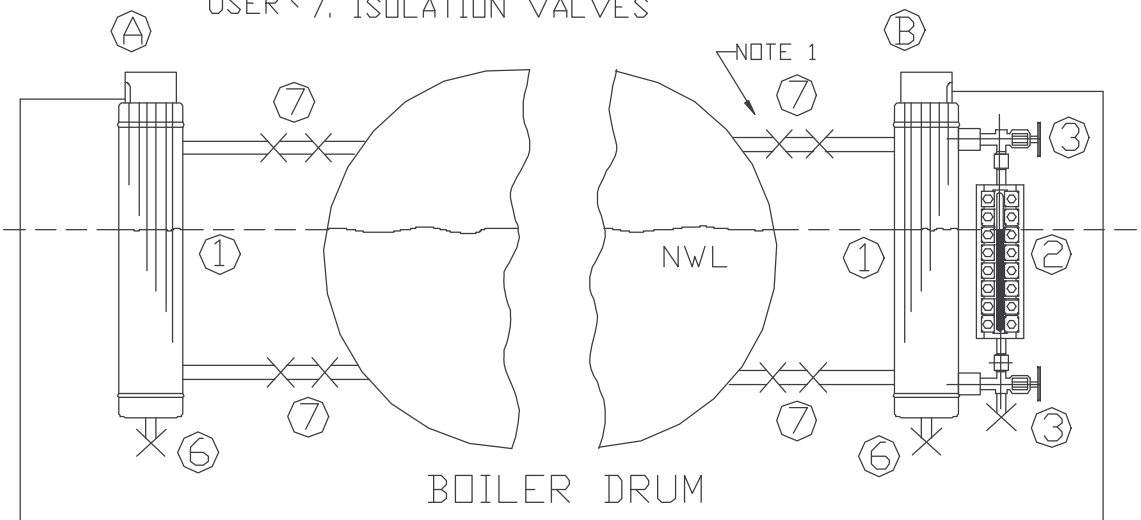
CLARK-RELIANCE CORP. STRONGSVILLE, OHIO, U.S.A.	ASME SECTION 1 WATER COLUMN SYSTEM FOR SMALL BOILERS UP TO 6 POINTS OF INDICATION	DRAWING NUMBER: DRUM2	REV. X1
DRAWN: DAS	DATE: 8/3/95	SCALE: NONE	

FOR USE UNDER 1000 PSI

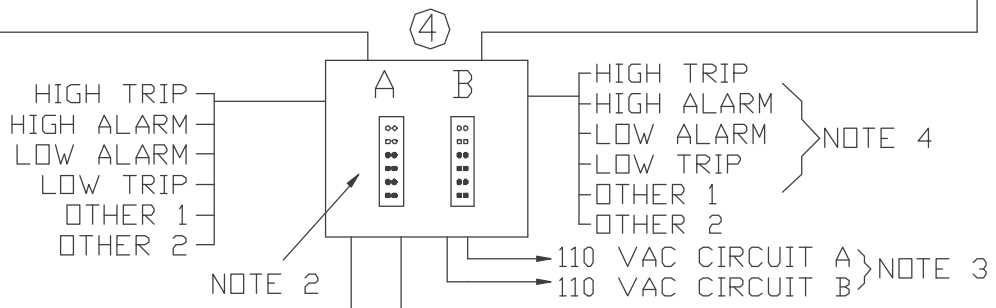
B.O.M.

1. WATER COLUMN
2. SIGHT GLASS
3. GAGE VALVE
4. ELECTRO EYE-HYE
5. REMOTE INDICATOR

BY USER
6. DRAIN VALVE
7. ISOLATION VALVES

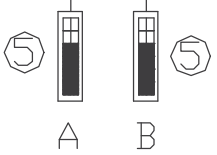


BOILER DRUM



BOILER ROOM

CONTROL ROOM

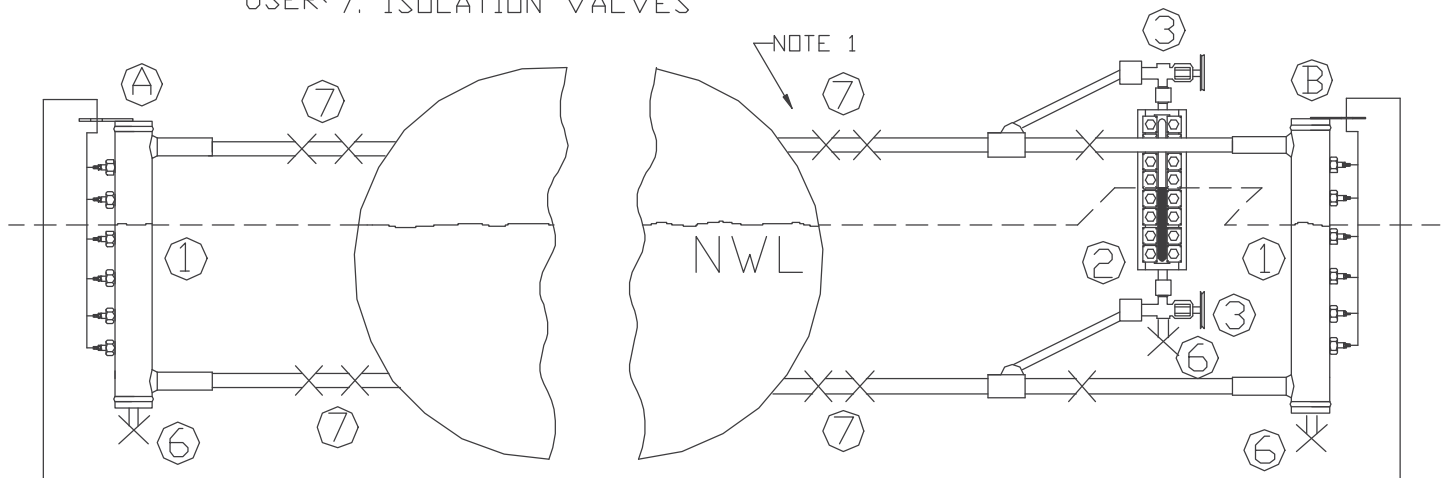


NOTES

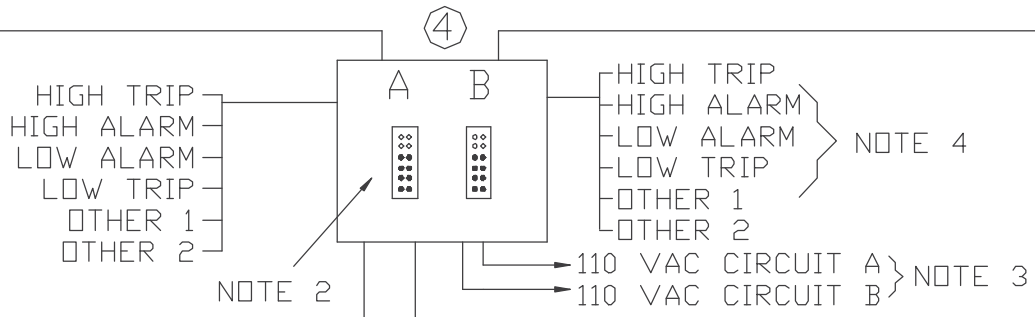
1. DOUBLE ISOLATION VALVES RECOMMENDED
2. LOCAL DISPLAY RECOMMENDED IF GAGE GLASS TO BE ISOLATED
3. DUAL POWER RECOMMENDED
4. 6 SETS CONTACTS @5A 110 VAC ALARM AND TRIP POINTS MUST COINCIDE WITH PROBE LOCATIONS

CLARK-RELIANCE CORP. STRONGSVILLE, OHIO, U.S.A.	ASME SECTION 1 TWIP COLUMN SYSTEM FOR SMALL BOILERS UP TO 6 POINTS OF INDICATION	DRAWING NUMBER: DRUM3	REV. X1
DRAWN: DAS	DATE: 8/7/95	SCALE: NONE	

B.O.M.
1. TWIP COLUMN
2. SIGHT GLASS
3. GAGE VALVE
4. ELECTRO EYE-HYE
5. REMOTE INDICATOR
BY USER { 6. DRAIN VALVE
7. ISOLATION VALVES

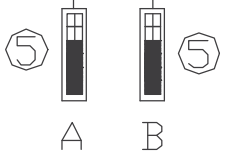


BOILER DRUM



BOILER ROOM

CONTROL ROOM



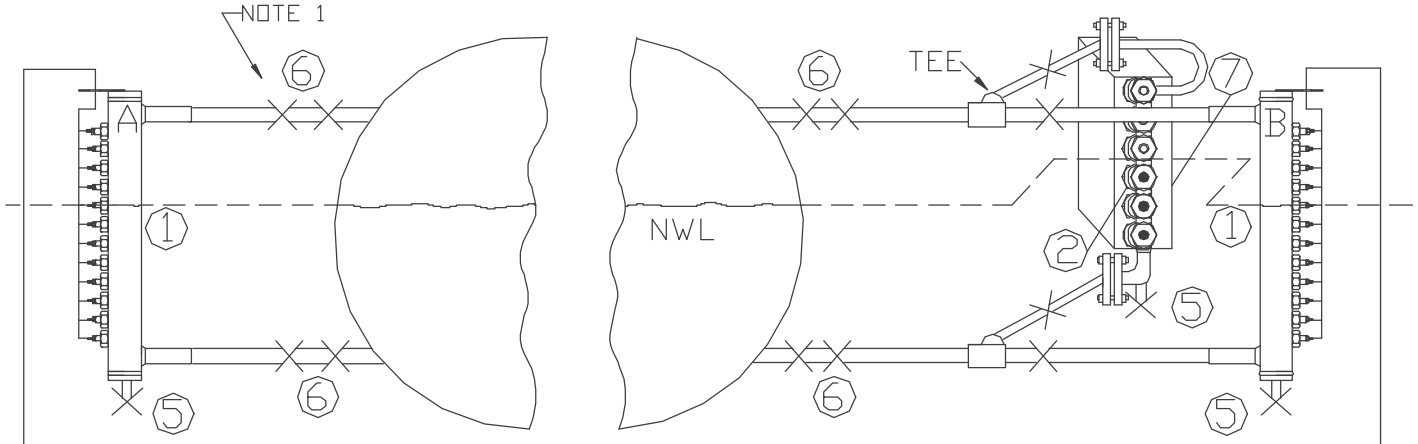
NOTES
1. DOUBLE ISOLATION VALVES RECOMMENDED
2. LOCAL DISPLAY RECOMMENDED IF GAGE GLASS TO BE ISOLATED
3. DUAL POWER RECOMMENDED
4. 6 SETS CONTACTS @5A 110 VAC ALARM AND TRIP POINTS MUST COINCIDE WITH PROBE LOCATIONS

CLARK-RELIANCE CORP. STRONGSVILLE, OHIO, U.S.A.	ASME SECTION 1 ELECTROLEV SYSTEM UP TO 12 POINTS OF INDICATION	DRAWING NUMBER: DRUM4	REV. X1
DRAWN: DAS	DATE: 8/7/95	SCALE: NONE	

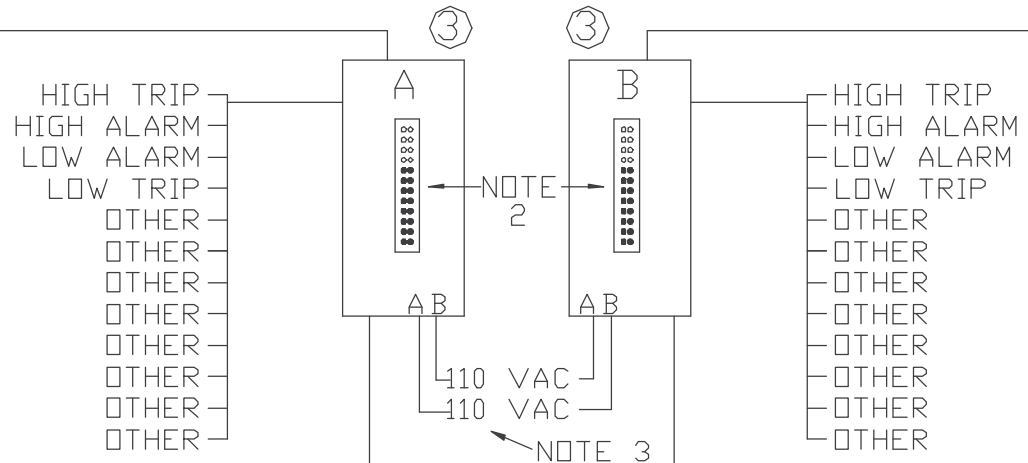
B.O.M.

1. TWIP COLUMN
2. SIGHT GLASS
3. ELECTRO EYE-HYE
4. REMOTE INDICATOR

BY USER
5. DRAIN VALVE
6. ISOLATION VALVES
7. ILLUMINATOR



BOILER DRUM



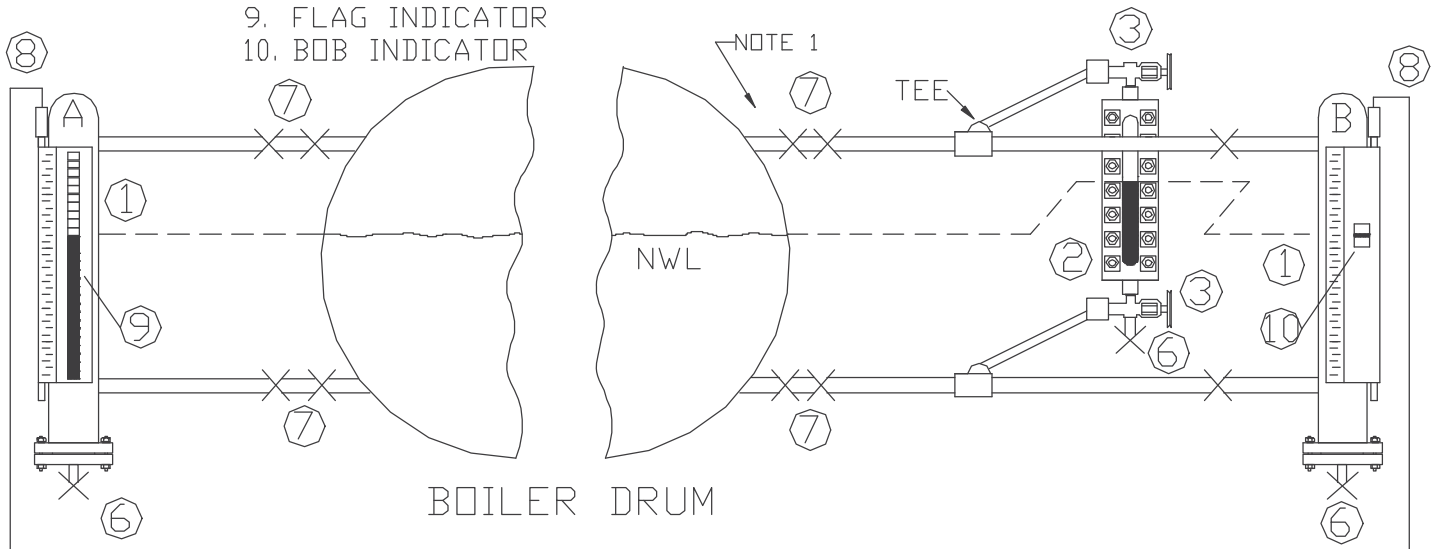
NOTES

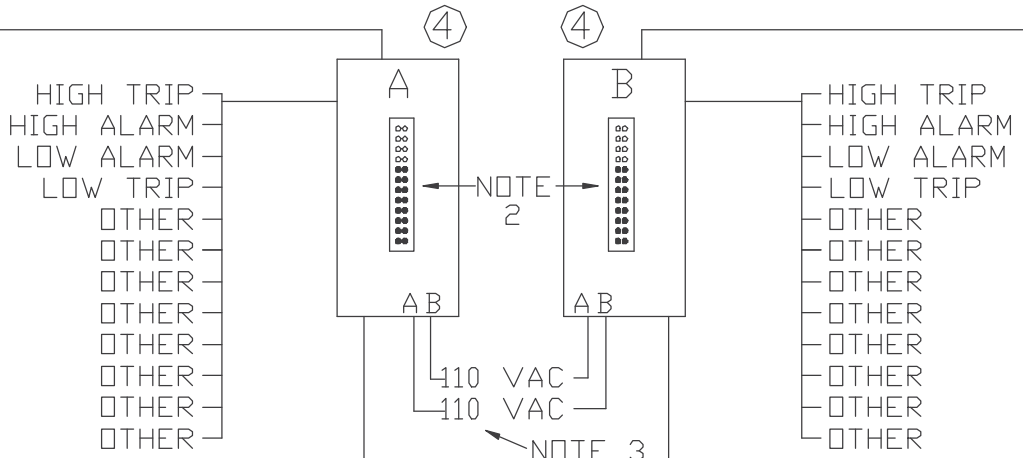
1. DOUBLE ISOLATION VALVES RECOMMENDED
2. LOCAL DISPLAY RECOMMENDED IF GAGE GLASS TO BE ISOLATED
3. DUAL POWER RECOMMENDED
4. 12 SETS CONTACTS @5A 110 VAC ALARM AND TRIP POINTS MUST COINCIDE WITH PROBE LOCATIONS

CLARK-RELIANCE CORP. STRONGSVILLE, OHIO, U.S.A.	ASME SECTION 1 MAGNOLEV SYSTEM UP TO 12 POINTS OF INDICATION	DRAWING NUMBER: DRUM5	REV. X1
DRAWN: DAS	DATE: 8/7/95	SCALE: NONE	

B.O.M.

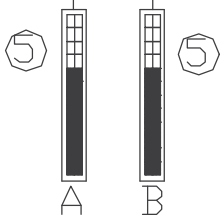
1. MAGNICATOR
2. REFLEX/TRANSPARENT GAGE GLASS
3. GAGE VALVE
4. MAGNO EYE-HYE
5. REMOTE INDICATOR
6. DRAIN VALVE (BY USER)
7. ISOLATION VALVES (BY USER)
8. REED SWITCH ASSEMBLY
9. FLAG INDICATOR
10. BOB INDICATOR





BOILER ROOM

CONTROL ROOM



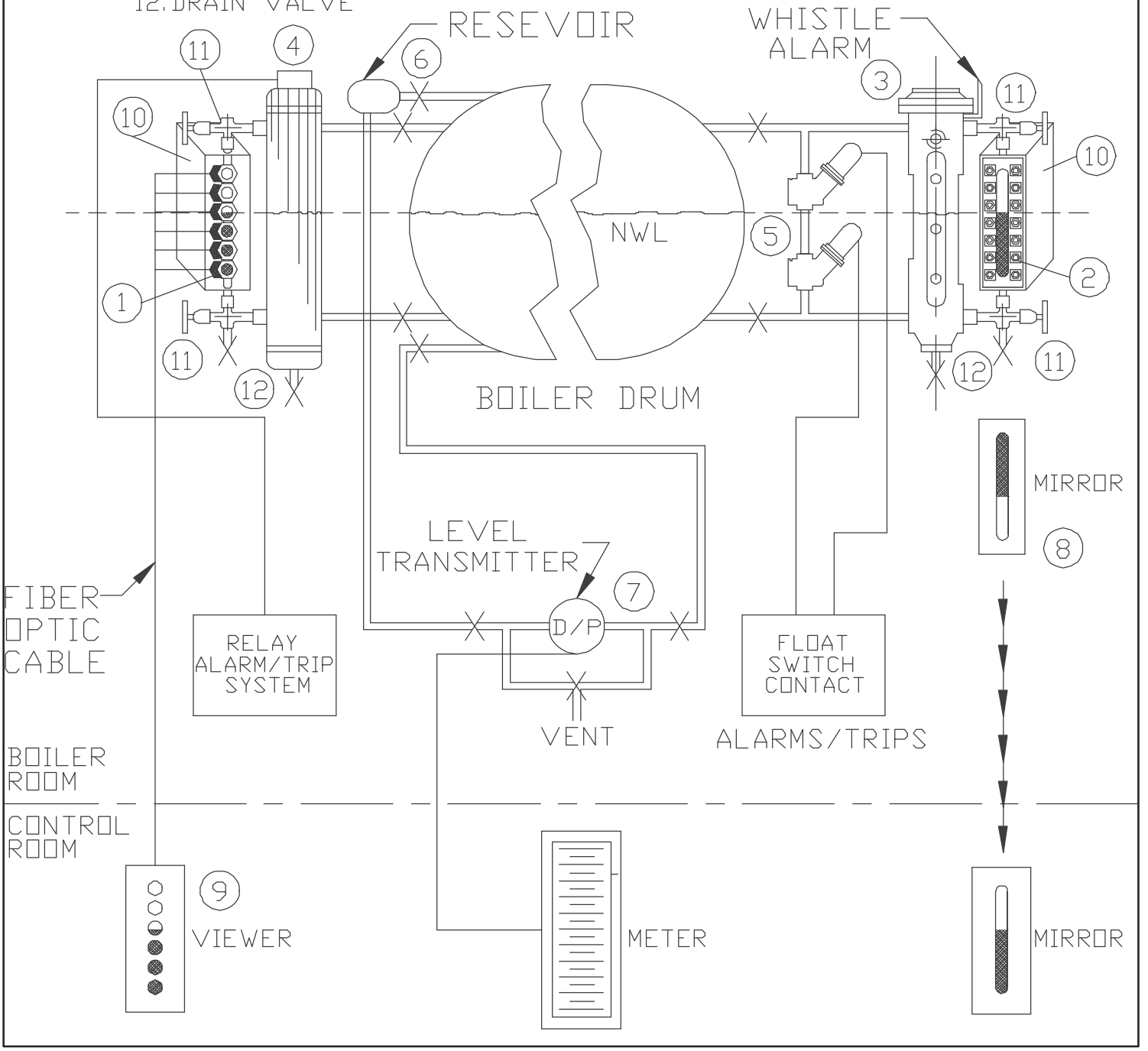
NOTES

1. DOUBLE ISOLATION VALVES RECOMMENDED
2. LOCAL DISPLAY RECOMMENDED IF GAGE GLASS TO BE ISOLATED
3. DUAL POWER RECOMMENDED
4. 12 SETS CONTACTS @5A 110 VAC OPTIONAL ALARM CONTACTS COINCIDE WITH SWITCH LOCATIONS

CLARK-RELIANCE CORP. STRONGSVILLE, OHIO, U.S.A.	ASME SECTION 1 TRADITIONAL METHOD HIGH AND LOW ALARM	DRAWING NUMBER: DRUM6	REV. X2
DRAWN: SSM	DATE: 5/6/96	SCALE: NONE	CHECKED: X

B.O.M.

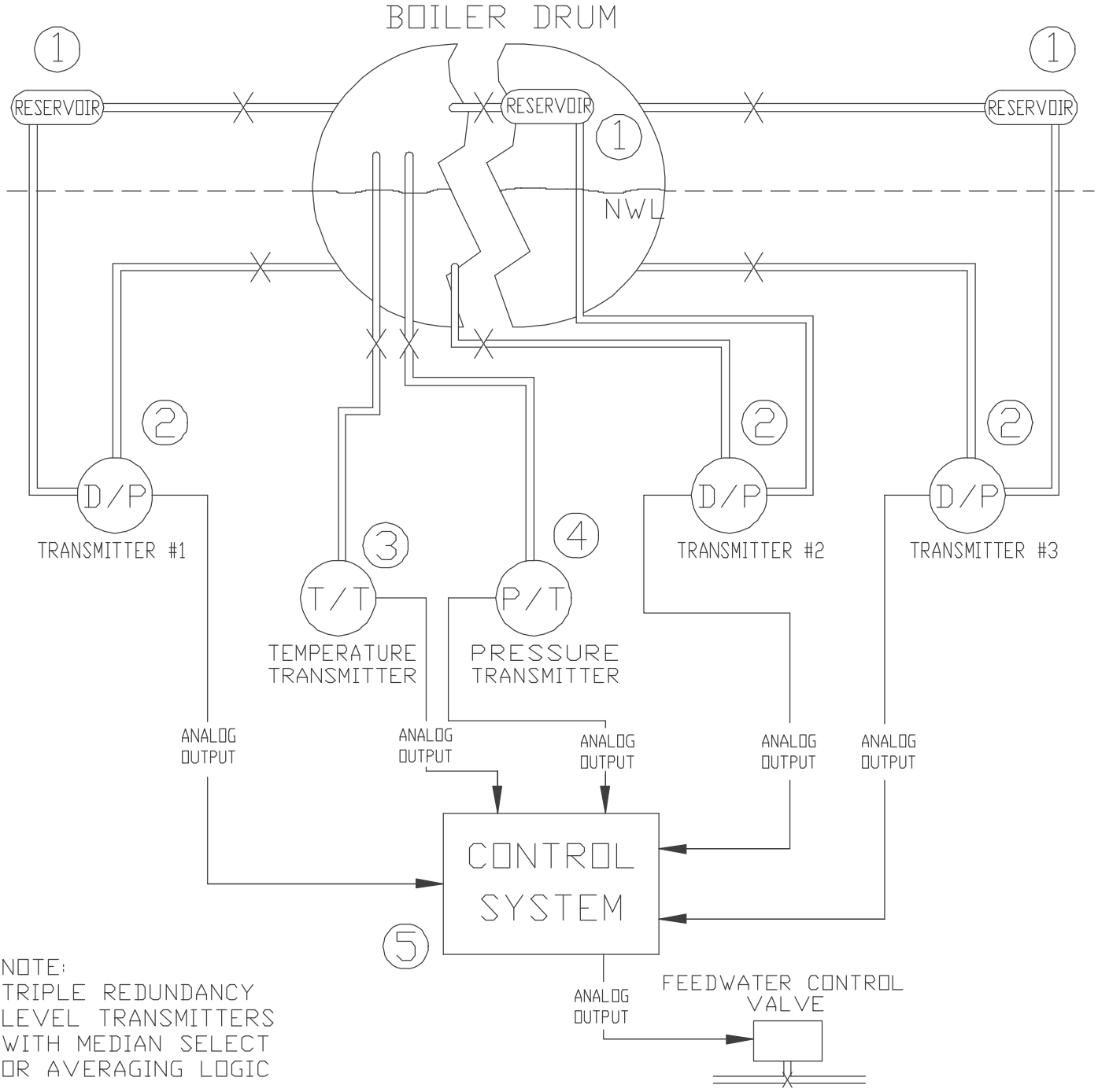
1. SIMPLIPORT GAGE GLASS
2. REFLEX/TRANSPARENT GAGE GLASS
3. ALARM WATER COLUMN
4. PROBE ALARM WATER COLUMN
5. FLOAT ALARM SWITCH
6. CONDENSATE CHAMBER
7. DIFFERENTIAL PRESSURE TRANSMITTER
8. RETRANSMISSION MIRROR
9. FIBER LEVEL SYSTEM
10. ILLUMINATOR
11. GAGE VALVE
12. DRAIN VALVE



CLARK-RELIANCE CORP. STRONGSVILLE, OHIO, U.S.A.	DRUM LEVEL CONTROL W/PRESSURE & TEMP. COMPENSATION	DRAWING NUMBER: DRUM7	REV. X1
DRAWN: SSM	DATE: 5/6/96	SCALE: NONE	CHECKED: X

B.O.M.

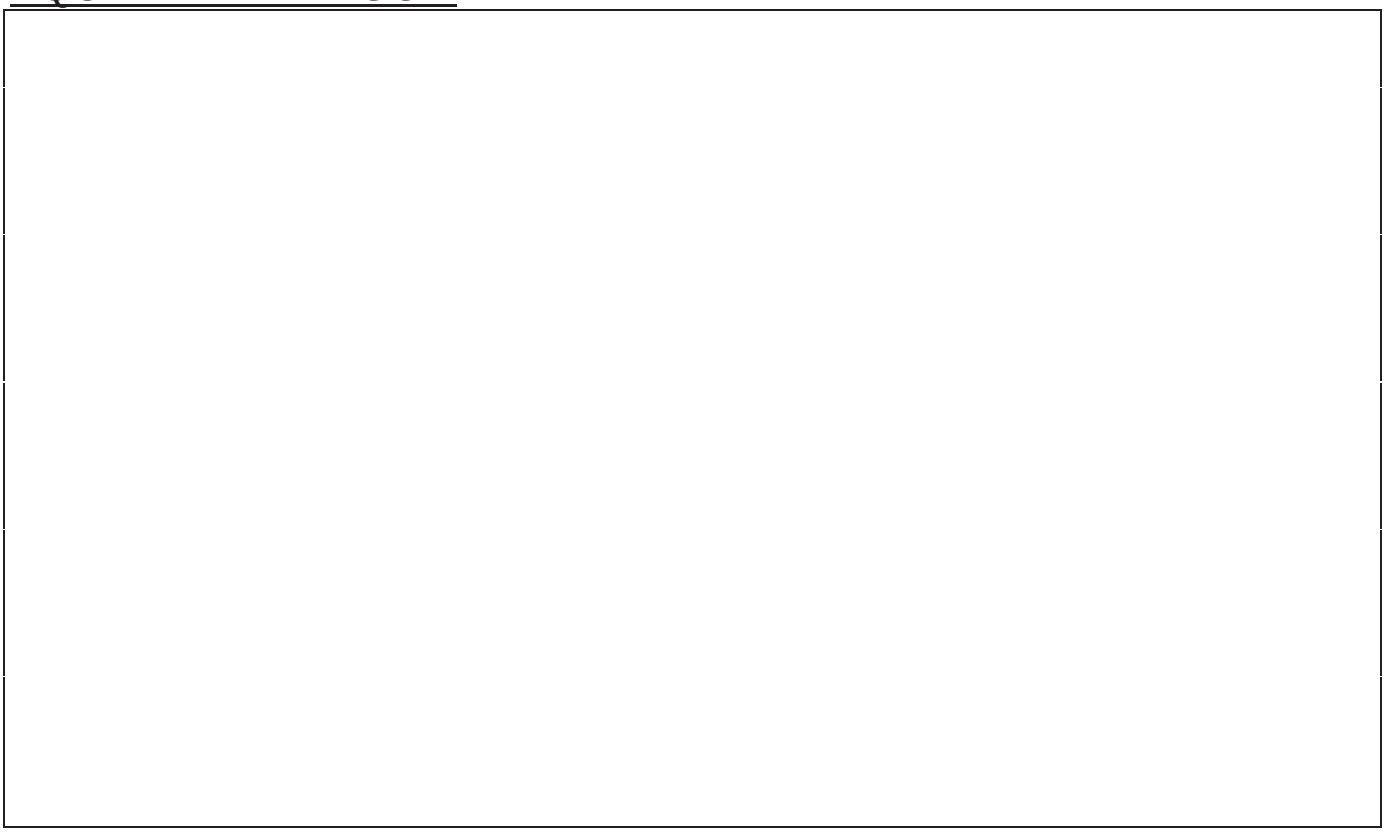
1. CONDENSATE CHAMBER
2. DIFFERENTIAL PRESSURE TRANSMITTER
3. TEMPERATURE TRANSMITTER
4. PRESSURE TRANSMITTER
5. DCS/PC CONTROL



NOTE:
TRIPLE REDUNDANCY LEVEL TRANSMITTERS WITH MEDIAN SELECT OR AVERAGING LOGIC

NOTES:

EQUIPMENT LAYOUT:



Clark•Reliance®

Founded in 1884, Clark-Reliance continues to be the global leader in the level instrument design, development and application industries. Clark-Reliance is dedicated to supplying the largest and broadest product line in the instrumentation industry as the single-source for all types of level measurement and control. The last two decades fulfilled strategic initiatives including product and distribution positioning as well as key acquisitions that solidified Clark-Reliance as a leader in the separation and filtration industries. Extensive capital investment in manufacturing technologies and business systems helps Clark-Reliance deliver the highest quality products with economical benefits - you save money. Being the leader in quality systems, Clark-Reliance was first in establishing ISO 9001 Certified Quality Systems. That was in 1992. Today, Clark-Reliance is fully committed and dedicated to providing the lowest "cost-of-ownership", innovative products and solutions. In 2000, Clark-Reliance launched the first of its kind - an authorized and trained network of service and repair centers - PLANT-OP CENTERS. Local sales, service , parts- and dedicated people.

Products	*Anderson Separators* *Jacoby-Tarbox Sight-Flows* *Magne-Sonics*	*Clark-Reliance Boiler Instrumentation* *Jerguson Gages and Valves* *National Filtration systems*
Gas Turbine HRSG Market	*Fuel Gas Conditioning* *Separation & Filtration* *Air / Gas / Steam / Liquid* *Magnetic Level Gages* *Transmitters & Switches* *Liquid Level Gages & Valves* *Illuminators and Valves*	*Boiler Level Instrumentation* *- Gages & Columns* *- Alarms & Pump Control* *Remote Level* *- Indicators & Controls* *Turbine Water Induction Protection* *Sight-Flow Indicators* *Safety Glass / Windows*
Fossil Market	*Fuel Gas Conditioning* *Separation & Filtration* *Air / Gas / Steam / Liquid* *Magnetic Level Gages* *Transmitters & Switches* *Liquid Level Gages & Valves* *Illuminators and Valves*	*Boiler Level Instrumentation* *- Gages & Columns* *- Alarms & Pump Control* *Remote Level* *- Indicators & Controls* *Turbine Water Induction Protection* *Sight-Flow Indicators* *Safety Glass / Windows*
Specialty Steam / Skid Market	*Low Pressure Boiler Level Instrumentation* *- Gages & Columns* *- Alarms & Pump Controls* *Fuel Gas Conditioning* *Separation & Filtration* *Air / Gas / Steam / Liquid*	*Capacitance Instrumentation* *Level Transmitters & Switches* *Non-Contact & Ultra-Sonic* *Magnetic Level Gages* *Transmitters & Switches* *Liquid Level Gages & Valves* *Illuminators and Valves*

The goal of Clark-Reliance is to provide World Class Customer Service, Product Quality, and Innovation to the petrochemical, refining, and power generation industries. In order to achieve this goal, Clark-Reliance listens carefully to the customer, designs and develops product specifications consistent with the customer's use for that product, and ensures that all products and services conform to their established quality specifications.

Contact us to discuss your application requirements

Clark•Reliance
CORPORATION

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