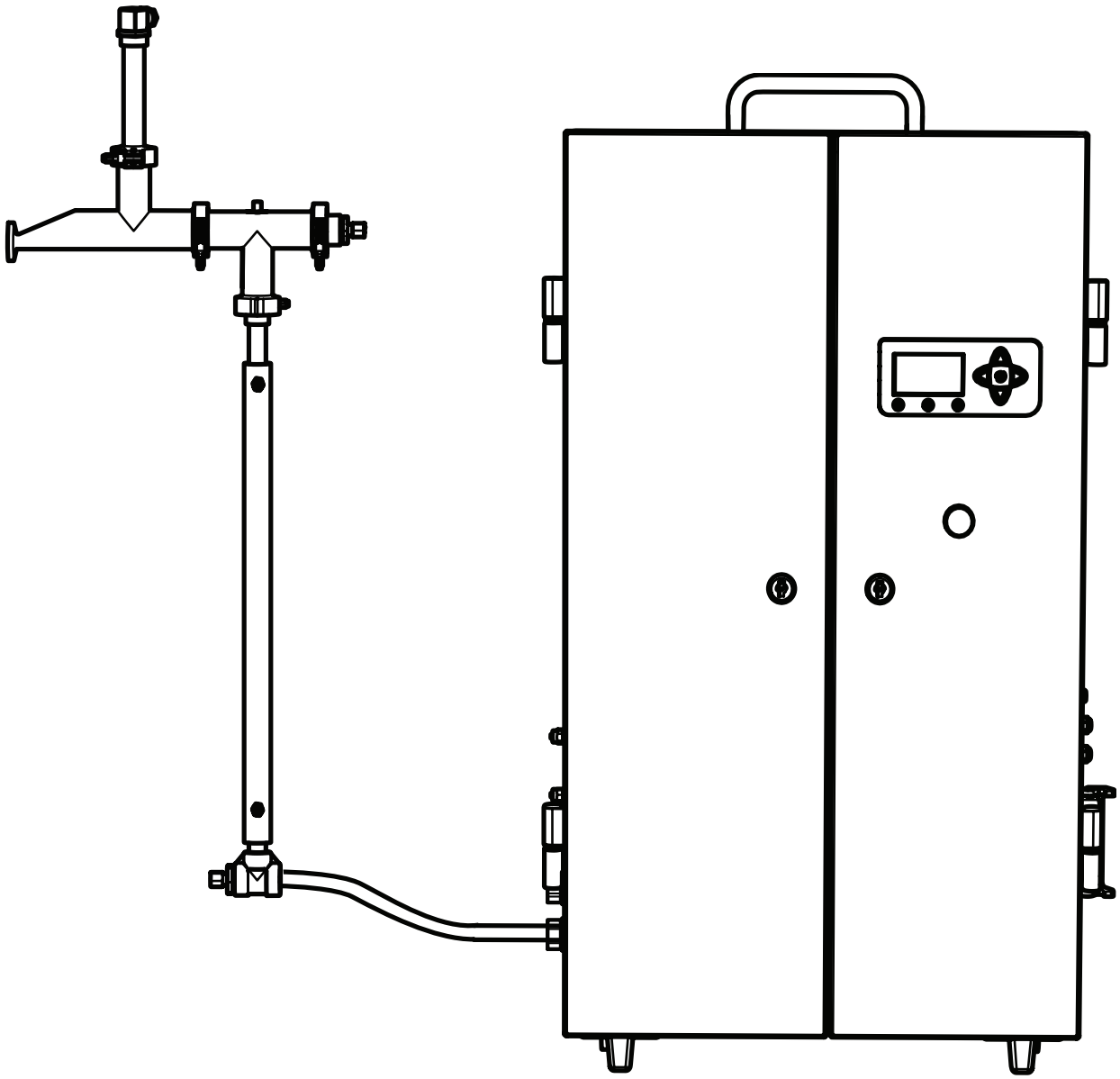
Steam QM-3 Steam Quality Monitor
Installation and Operation Manual



Certified by CE Intertek

IOM-245-V2.2

Keep this manual with equipment for future reference.

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Revision History

Version	Release Date	Description of Changes
1.0	28/11/2013	Initial
1.1	22/01/2013	Temperature transmitter T (T1, T2, T3) - Design Modification
2.0	17/03/2016	Tee and Adapter - Design Modification page 5: update of the calorimeter assembly graphic according to new design. page 6: update of the cabinet exterior graphic according to new design. page 7: update of the cabinet interior graphic according to new design. page 9: update of the calorimeter assembly and cabinet exterior graphics. correction: dimension conversion lenght 3m => 118" page 10: update of the typical installation for vertical or side of horizontal steam line graphic. Add comment on the cable connecting Harting Plus to sensors. page 11: update of the typical installation for top of horizontal steam line graphic. page 12: Text modifications for point 5, 8 and 9 Add "Drain Hose Specifications" chart. page 17: Special Screens. Advanced Setting Menu: updates of the Screen with adding of the Serial Mode information. Special Screens. Calibration Menu Screen: update of the data into the screen (V230). page 18: Add drain menu procedure. page 25: adding List of component and parts. page 26: update of the ETL Electrical Safety Listings logo. page 29, Appendix Three: update data logger (MODBUS) connection (master and slave modes). All document: SteamLog eWon data logger not available anymore, all references deleted from document. Yokogawa information deleted from document.
2.1	31/07/2020	page 8: Electrical parmameter - add : (±10 %) page 9: add Indore use and Pollution Degree 2 to General Consideration (Site Selection) §
2.2	28/02/2022	page 13: Add note 2 regarding power cord supply specifications.

Safety

Icon Legend

Indicates Power On

Indicates Power Off

Indicates important information concerning potential for personal injury or damage to equipment

Indicates electrical hazard

Indicates hot surface

Burn hazard! Uninsulated components upstream of cabinet may be hot.
- Do not touch when unit is working.
- Allow to cool before moving or servicing unit.

Live steam will cause burns; condensate water may cause them. Skin exposure to 140 °F (60 °C) water for only five seconds may cause a second degree burn.

Keep unit away from heat-sensitive equipment and installations.

Shock hazard! High voltages present inside equipment.
- Electrical installation must be performed by qualified personnel.
- Disconnect power before performing any electrical service.

Read this manual. It contains important information.

This device must be installed in accordance with appropriate local, national, and international standards, codes, and practices.

Installation should always be accompanied by competent technical assistance.
Improper installation, start-up, operation, maintenance, or service may void warranty.
You are encouraged to contact Armstrong International or its local sales representative for additional information.

Service must be performed by a qualified person.

Equipment must be disposed of according to applicable environmental requirements.

Abbreviations and Acronyms

Term	Meaning	Explanation
ΔP	Differential Pressure	ΔP1: Difference between water column in NCG vessel and atmosphere. ΔP2: Difference between water column in condensate vessel and atmosphere.
Al	Alarm	Indicates an out-of-limit situation, but has no impact on operation. Al1: Dryness below user-defined set point longer than two seconds. Al2: Four consecutive calculations of NCGs are over the user-defined limit. This calculated value is displayed on the main screen and updated every 30 seconds. Al3: T1 above 257 °F (125 °C) longer than two seconds.
C	Celsius	
cm	Centimeter	
Df	Default	Indicates failure. Turns off power to heating element and opens EV0 to drain. Df4: T3 above 185 °F (85 °C) longer than two seconds. Df5: No condensate from condenser in last ten minutes. Df6: T2 above 356 °F (180 °C) longer than two seconds.
DIN	Deutsches Institut für Normung eV	
dP	Differential Pressure	
EC	European Community	
EEC	European Electrotechnical Commission	
EN	European Norm	
EV	Electronic Valve	
F	Fahrenheit	
gal	Gallon	
h	Hour	
imp	Imperial [measure]	
in.	Inch	
kg	Kilogram	
L	Liter	
lb(s)	Pound(s)	
max	Maximum	
min	Minimum	
mm	Millimeter	
NCG	Non-Condensable Gases	NCGmax is the limit of the NCG rate. Alarm 2 indicates the limit has been exceeded. Range is 0–15%. Default is 3.5%.
P	Pressure	P is steam pressure upstream of calibrated orifice. Modbus sends data as bar even with imperial measure selected.
ppm	Parts per Million	
psi(g)	Pounds per Square Inch (gauge)	
Q	Steam Flow	
QM	Quality Monitoring	
R	Resistance	Shown as watts.
R/O	Reverse Osmosis	
sec(s)	Second(s)	
SI	International System of Units	
S_T	Superheat	
T	Temperature	T1: Temperature after pressure reduction to atmosphere. T2: Temperature after heating resistance. T3: Temperature after condenser.
X	Dryness Fraction (sometimes called steam quality or moisture content)	Xmin is the lower dryness limit. Alarm 1 indicates the limit has been exceeded. Range is 0.85–0.95. Default is 0.95.

General Description

Steam QM-3 is intended to replace manual testing of pure steam and provide real-time data proving that steam quality meets applicable requirements.

Advantages over manual testing are:
- Improved safety
- Ease of use
- Reduced time per test
- Reduced cost per test
- More accurate and objective results
- Ability to trend data over time

Steam QM-3 is set up and calibrated to test for parameters defined in EN285 standard. It performs three tests:
- Calculating dryness
- Calculating superheat
- Quantifying non-condensable gases (NCG)

(NCG measurement is performed first. If it is within range, dryness and superheat measurements will be performed.)

Armstrong strongly recommends that the Steam QM-3 unit be installed in one location and not used for checking multiple steam outlets.
It is possible to use one unit for multiple locations and it could be installed for portability at customer's preference. Note however that:
- Calorimeter assemblies and cabinets are matched sets and are **not** interchangeable.
- Moving both calorimeter and cabinet to alternate locations as a unit is preferred.
- If one cabinet is connected to a different calorimeter, it must be recalibrated prior to use.

Data from Steam QM-3 can be recorded using a data historian with Modbus output (see appendix three on p. 29 for connection information.)

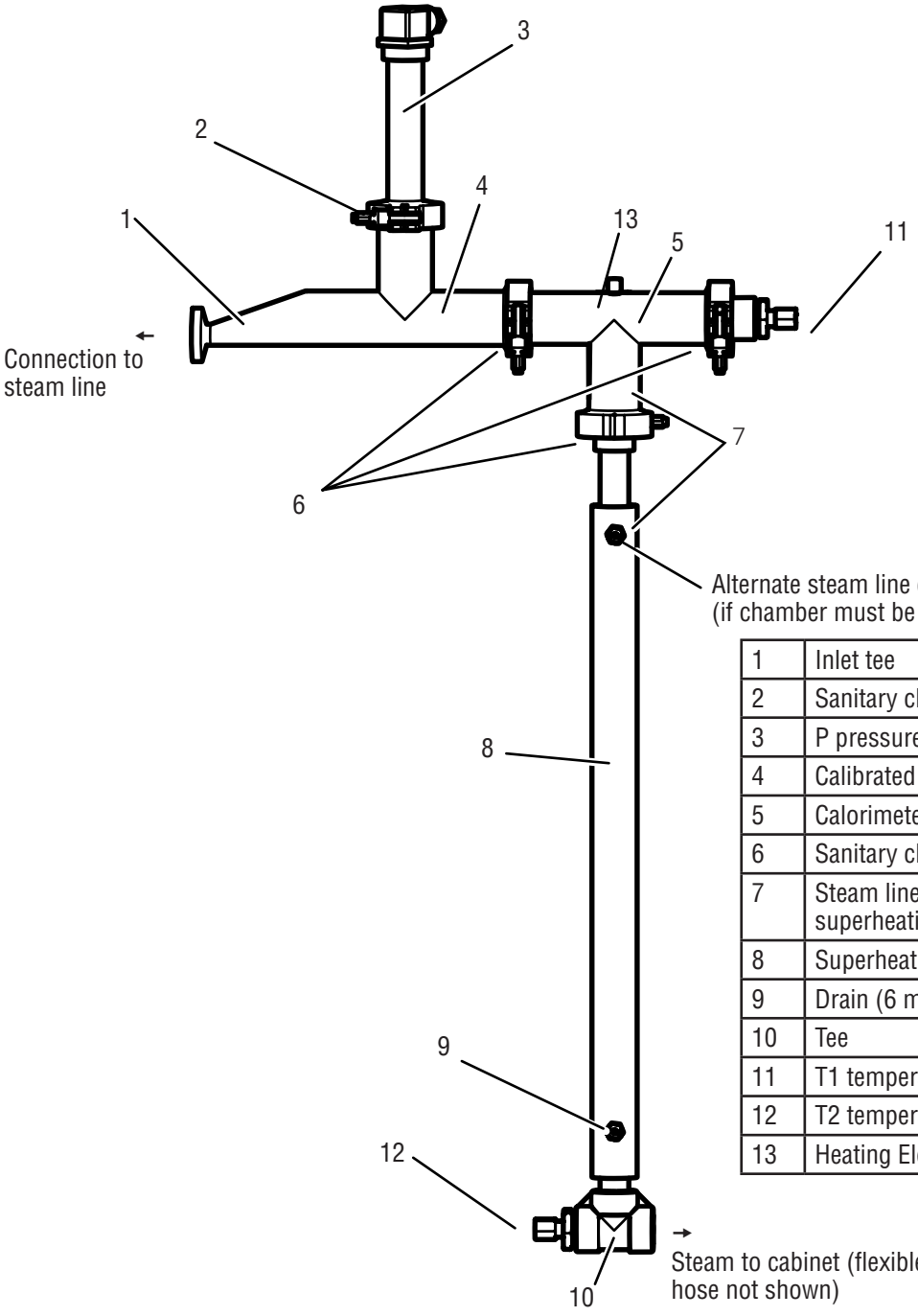
Materials of construction comply with all standards known at the time of manufacture.

Armstrong reserves the right to make design or specification changes without notification.

Calorimeter Assembly

Note: The assembly shown below is configured for connection to a vertical steam line.

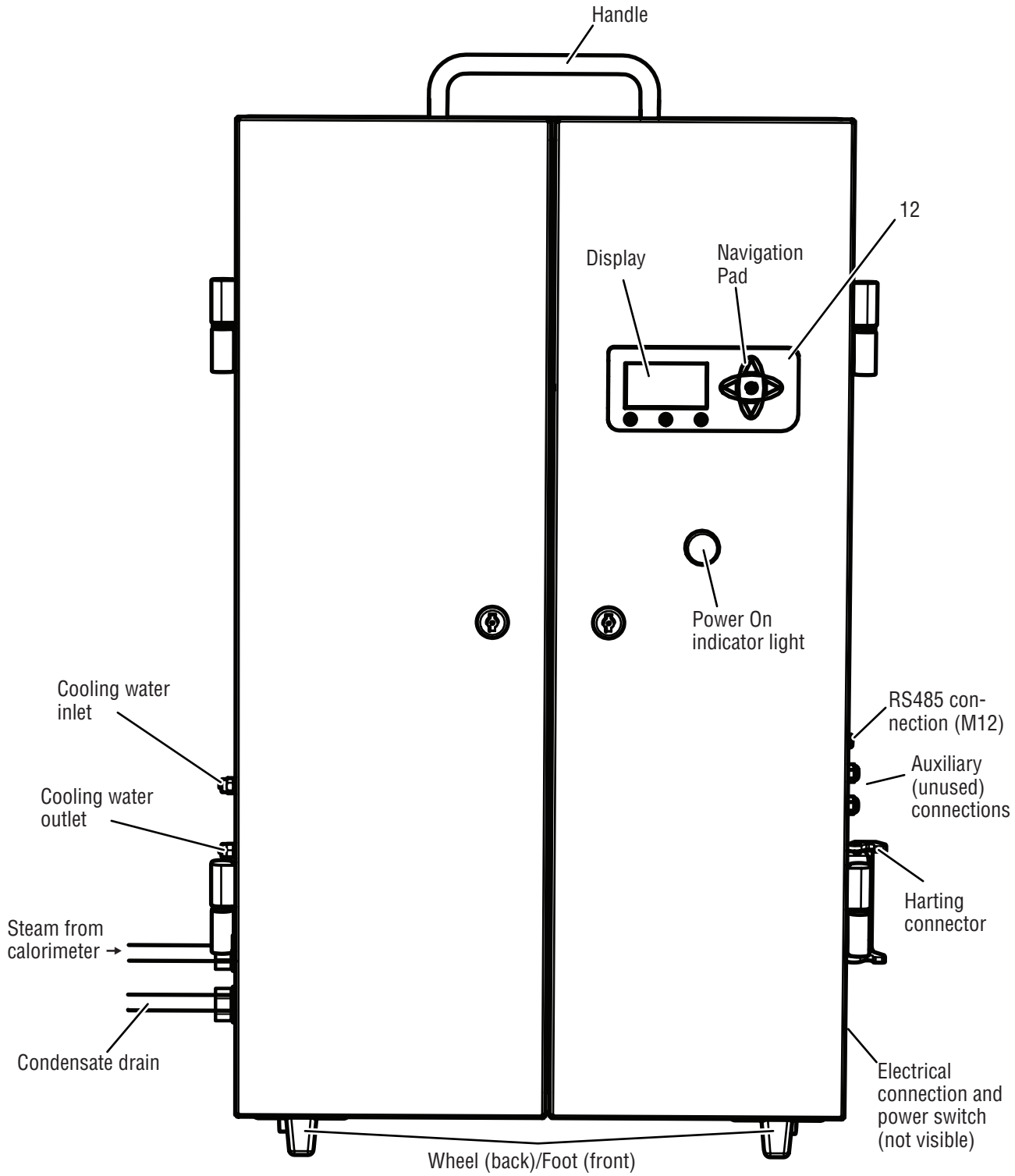
Calorimeter assembly weighs approximately 11 lbs (5 kg).



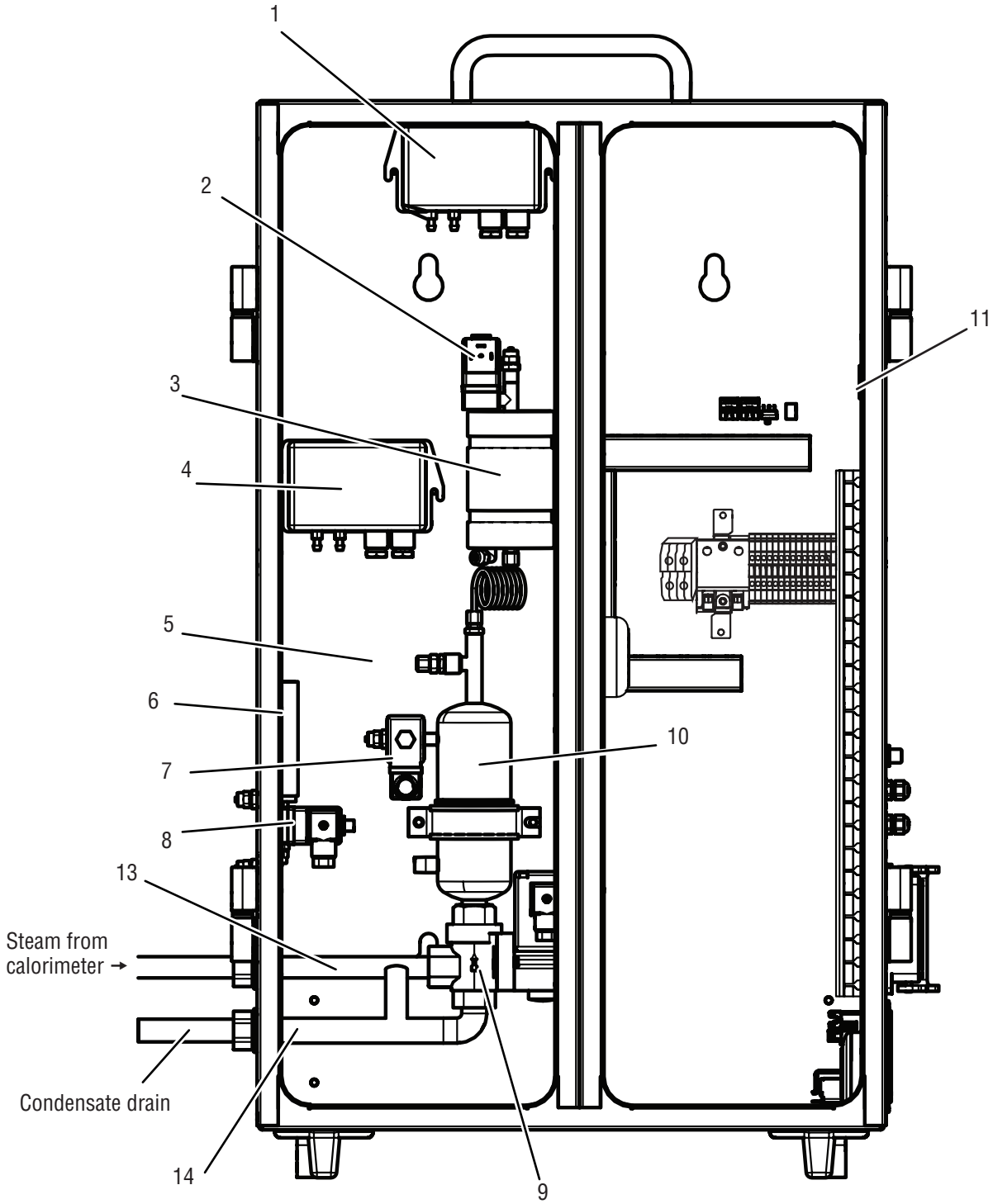
1	Inlet tee
2	Sanitary clamp
3	P pressure transmitter
4	Calibrated orifice (inside connection)
5	Calorimeter
6	Sanitary clamp
7	Steam line from calorimeter to superheating chamber (not visible)
8	Superheating chamber
9	Drain (6 mm)
10	Tee
11	T1 temperature transmitter
12	T2 temperature transmitter
13	Heating Element

Cabinet Exterior

Cabinet weighs approximately 42 lbs (19 kg).



Cabinet Interior



1	NCG pressure differential sensor	8	EV2 solenoid valve
2	EV1 solenoid valve	9	EV0 solenoid valve
3	NCG burette	10	Condenser
4	Condensate pressure differential sensor	11	Relay board with solenoid LED
5	T3 temperature sensor	12	Main screen (consult page 6)
6	Condensate burette	13	Cabinet steam inlet
7	EV3 solenoid valve	14	Cabinet condensate outlet

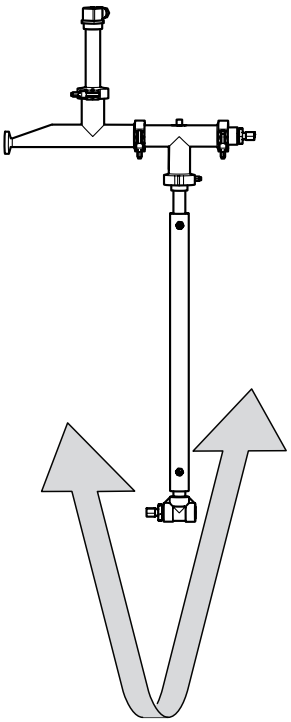
Specifications

Parameter	Specification
Calorimeter operating temperature range (T1)	0 –150 °C (32 – 302 °F)
Maximum allowable calorimeter temperature (T1)	180 °C (356 °F)
Calorimeter operating saturated steam pressure range (P)	0,5 – 4 barg (7 – 60 psig)
Superheated steam operating temperature range (T2)	0 – 180 °C (32 – 356 °F)
Dryness fraction	0,85 – 1
Dryness fraction accuracy	± 0,01 of display
Non-condensable gases content	≤ 15%
Condensate temperature range (T3)	0 – 80 °C (32 – 176 °F)
Operating condensate temperature (T3)	65 °C (149 °F)
Estimated steam consumption	1,5 kg/h (3,3 lbs/h) @ 3 barg (45 psig)
Estimated water consumption	15 L/h (4 gal/h) @ 10 °C (50 °F)
Electrical	115/230 VAC (±10 %) 50/60 Hz 100 W

General Considerations (Site Selection)

Ambient temperature must be 5–60 °C (41–140 °F)
Relative humidity must be 30–80%
Altitude must not exceed 2000 m (6562 ft)
Indore use
Pollution Degree 2

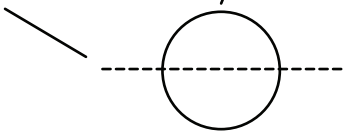
Attachment to vertical steam line is optimal.

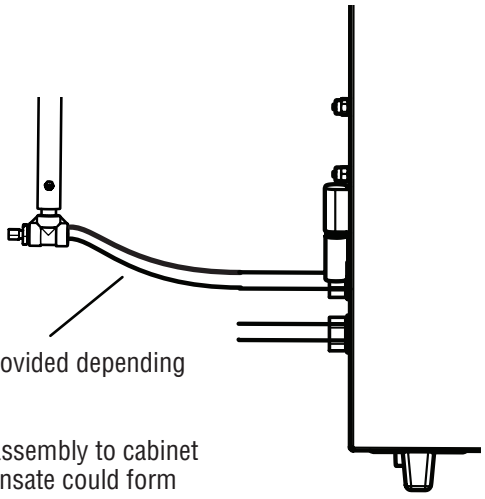


Superheating chamber must be installed within 45° of vertical to front or back.

Connecting to top of horizontal line may result in elevated dryness readings.

Attachment to horizontal steam line must be at center line or above.





- Use one or both sections of flex hose provided depending on installation
- Length must not exceed 3 m (118 in.)
- Hose must run down from calorimeter assembly to cabinet with no low spots where pools of condensate could form

Note: Where necessary outlet on heating chamber can be rotated 180° to accommodate left or right cabinet position. See instructions below (p. 11).

Mounting both calorimeter and cabinet is required. Cabinet must be mounted on a wall. Mounting hardware is supplied.

Unit must be installed with the following utilities nearby:
- Cooling water supply
- Drain
- Grounded power source with required voltage (alternative grounding of unit is permissible, but grounding is required)

Typical Installation

Note:
- Unit is shipped assembled for vertical steam line as shown below. Connecting to top of a horizontal line will require changing some components as shown on following page.
- Installation is highly variable based on site requirements.
- Connections shown below are typical.
- Contact Armstrong for variations as required.

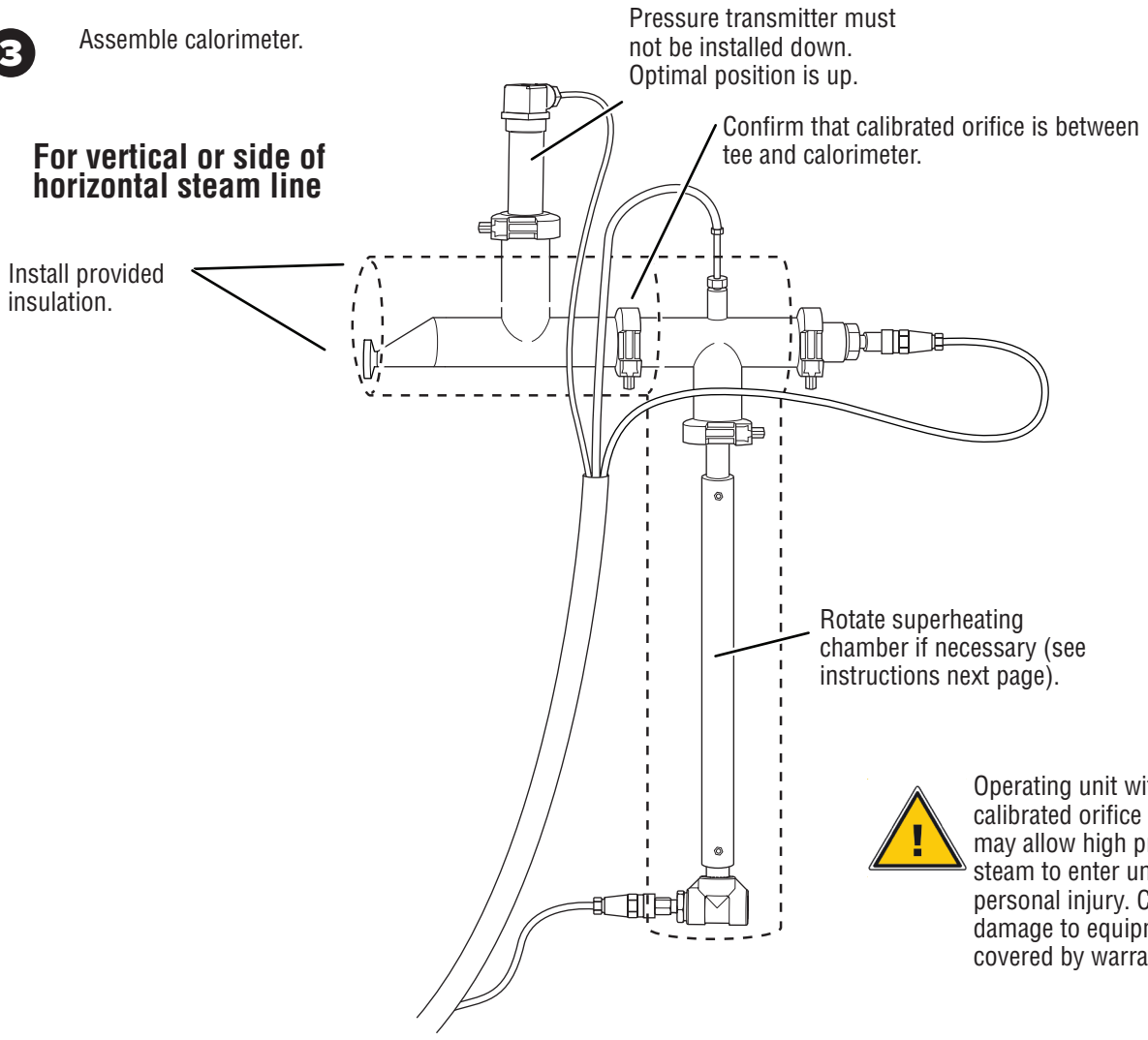
- The cable connecting Harting Plug to the sensors can not be looped.
- Avoid electro-magnetic influence.

1. If steam line has no connection, install ½" valved connection.

2. If connecting to an existing steam line connection, outlet must be valved.

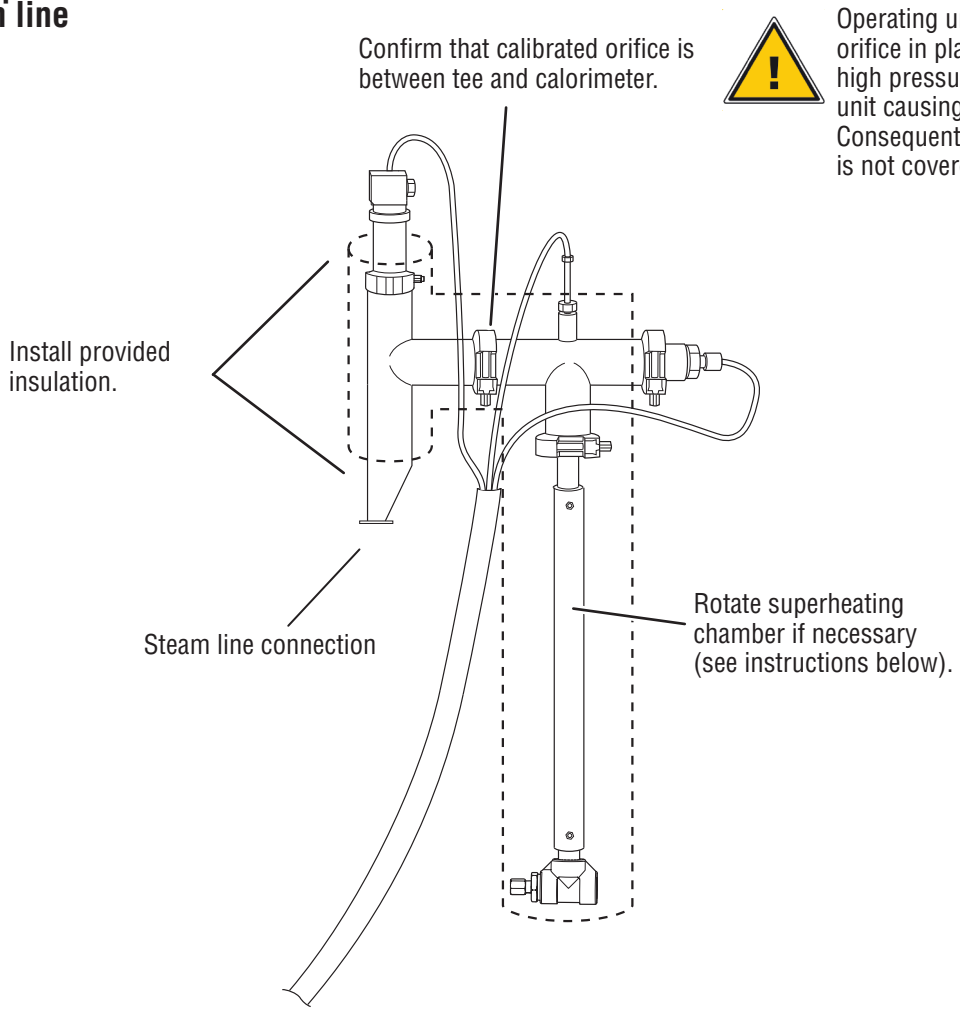
3. Assemble calorimeter.

For vertical or side of horizontal steam line

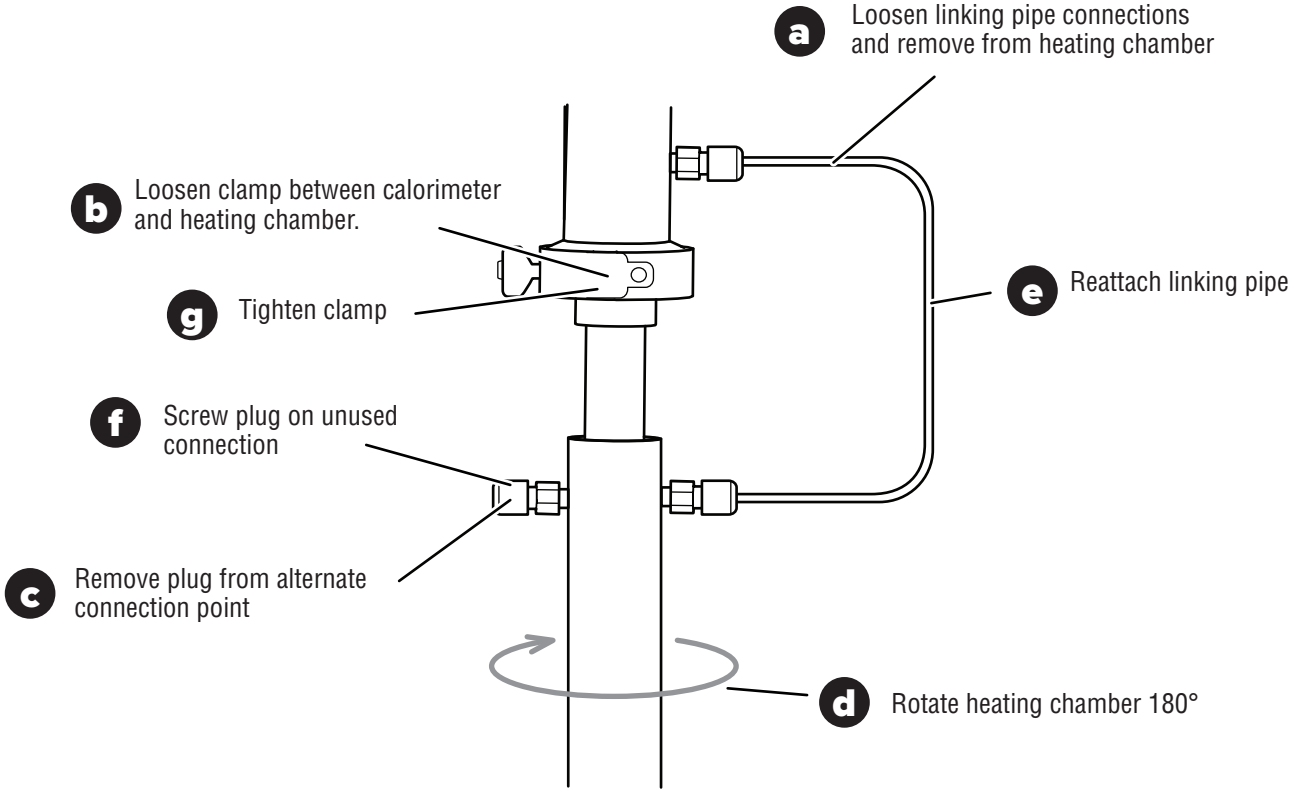


Operating unit without calibrated orifice in place may allow high pressure steam to enter unit causing personal injury. Consequent damage to equipment is not covered by warranty.

For top of horizontal steam line



4 Rotate superheating chamber if necessary.



Typical Installation

5. Connect calorimeter to the steam line using a ½" sanitary fitting (50,3 mm - 1.98 inch) and secure using the supplied clamp and gasket.
Note: Distance from main steam line to calorimeter assembly inlet should not exceed 6" (152 mm). Extending distance may affect test results.

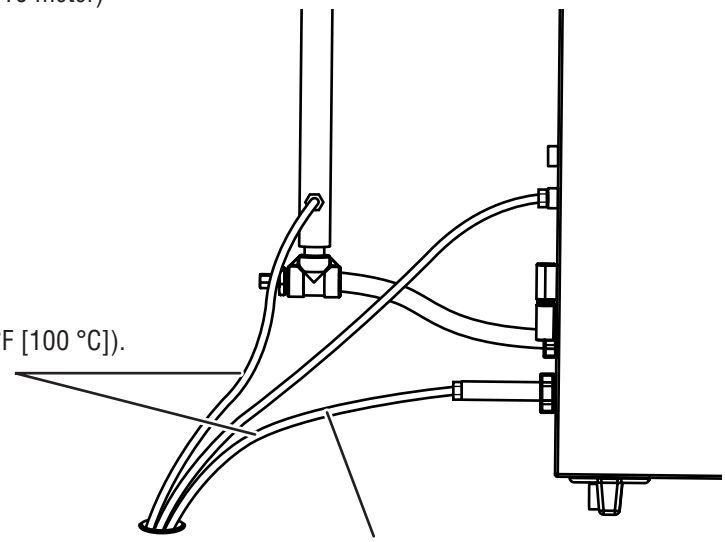
6. Position cabinet and attach flex hose between heating chamber and cabinet using gaskets provided.
Note: Avoid low spots where condensate could collect.

7. Connect sensor cables to cabinet.
Note: securing sensor cables to calorimeter assembly to relieve stress is recommended.

8. Connect cooling water supply (push in fitting to insert or remove tubing). Maximum inlet pressure is 90 psi (6 bar). Tubing diameter is 0.23" (6 mm).
Note: Armstrong recommends deionized, R/O, or softened water, although tap water is permissible.
Armstrong provides as a standard a 394" (10 meter) hose.

9. Plumb both cooling water and condensate discharges to drain.

Condensate water may be hot (up to 212 °F [100 °C]). Plumb with appropriate material.



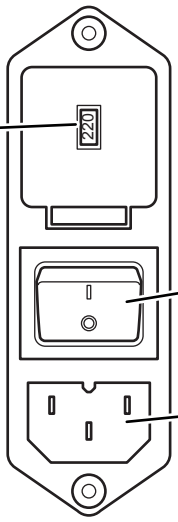
Cabinet condensate line must be below discharge of EV0.

Drain Hose Specifications

	Connection	Max. Temperature	Max. Pressure
Double Jacket drain	¼" (6 mm) push in	230 °F [110 °C]	4 barg
Cooling water inlet	¼" (6 mm) push in	185 °F [85 °C]	6 barg
Cooling Water drain	¼" (6 mm) push in	185 °F [85 °C]	6 barg
Condensater drain	½" BSP	230 °F [110 °C]	4 barg

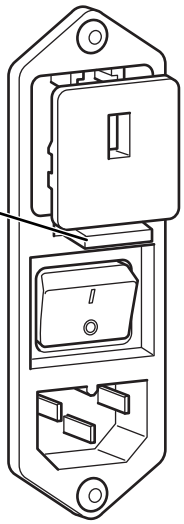
Typical Installation

10 Confirm voltage (shown above power switch).
Note: Unit is shipped set to 220/230 VAC.

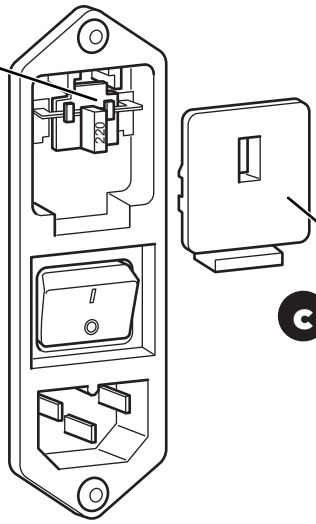


To change voltage:

a Release tab and pull out fuse cover.



b
- Pull out white voltage module
- Rotate module 180° and reinsert



c Reinstall cover.

Note 1: If main power voltage was changed to 110/115 VAC, change setting on calibration menu screen to change display. See "Calibration Menu Screen" on p. 18.

Note 2: Detachable power cord specification: min. 230VAC 10A grounding. Do not replace the detachable main power cord with another undersized one.

11 If connecting to a control system or MODBUS, interface RS485 (M12) with Modbus protocol.
Note: Modbus settings may need to be changed; see "Advanced Setting Menu" on p. 17.
(See appendix three on p. 29 for Modbus connection information.)

Start-Up Procedure

1. Confirm all connections:
   - Power
   - Cooling water inlet
   - Cooling water outlet
   - Condensate drainage from EV0 and heating chamber
   - Sensor lines

2. Open cooling water supply.

3. Turn on unit. Indicator light will come on and main screen will display.

4. Slowly open steam valve upstream of calorimeter.

Caution: Uninsulated components outside cabinet will become hot once steam is applied.

Note: Parameters will display in about 10 minutes (may require up to 30 minutes if condenser is empty).

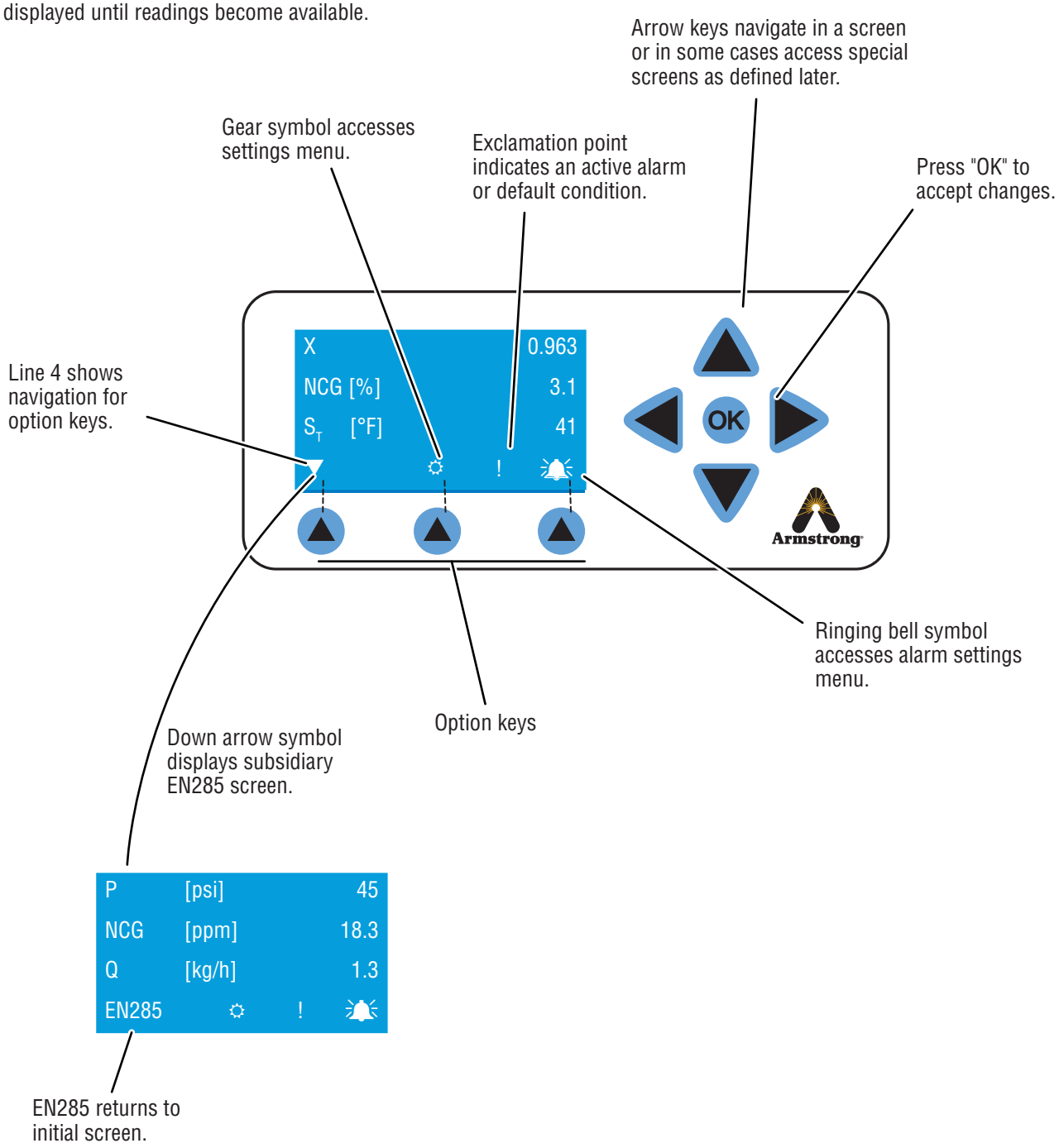
5. Check for leaks and tighten connections as necessary.

Software Navigation

Standard Screens

EN285 Screen (Main Screen)

Note: During initialization, a progress bar is displayed until readings become available.

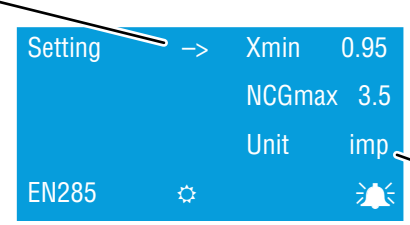


Settings Menu

Scroll settings using up/down arrows (▲ or▼). Move arrow to value (activate selection) by pressing right arrow (▶).

With arrow (–>) at left of digits, change value by pressing up/down arrows (▲ or▼). To save change press left arrow (◀) or exit screen.

Arrow (–>) indicates active parameter.



Unit switches between imperial and SI units.

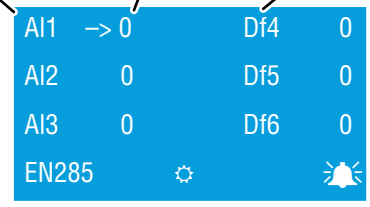
Alarm Menu

Alarm indicates an out-of-limit situation, but has no impact on operation.

Active alarm or default indicated by number "1."

Default indicates failure.

Note: A default condition turns off power to heating element and automatically opens EV0 to drain.



To reset alarm or default:

- Navigate arrow (–>) to alarm or default using arrow keys (◀▶▼▲) as appropriate.
- Press "OK."

Note: Alarms and defaults cannot be reset over Modbus connection.

Special Screens

Code Menu

Access menu by pressing ◀ and ▶ at same time.

Navigate between digits by pressing ◀ or ▶.

Change value for digit by pressing ▲ or ▼.

Press "OK."

Version

Advanced Setting Menu

Access code is 007.

Scroll using up/down arrows (▲ or▼). Activate selection by pressing right arrow (▶).

With arrow (–>) at left of digits, change value by pressing up/down arrows (▲ or▼). Press left arrow (◀) to save change.

"logger Add" specifies Modbus address of MODBUS (default is "1").

Arrow (–>) indicates active parameter.

This can be Master or Slave. For more details see Appendix 3 Modbus communication.

Calibration Menu Screen

Note: This screen is shown only for voltage change. See p. 13.

Access code for this screen is 152. Navigation is same as screen above.

Scroll using up/down arrows (▲ or▼). With arrow (–>) at left of digits you want press ok.

Calibration			PSensor
P1	0barg		3barg
EV1	0		1
	115	V	230

Drain Menu

The unit can be damaged if steam and water supplies are not disconnected before accessing this menu.

Access this menu only after disconnecting steam and water supply to the cabinet.

After a shut-down of the unit, condensate accumulates inside the cabinet. In case of long term storage the unit has to be fully drained to avoid contamination risks.

Access code is 143.

This menu will open all the QM-3's valves. They will be closed when you get out of the menu.

Sensor Information Screen

Access screen by pressing ▲ and ▼ at same time.

Scroll using up/down arrows (▲ or▼). Activate selection by pressing right arrow (▶).

With arrow (–>) at left of digits, change value by pressing up/down arrows (▲ or▼). Press left arrow (◀) to save change.

Note:
- Information displayed is real time values, which may be irrelevant if unit is not connected to steam.
- This screen is for information only, and is intended for use during commissioning, debugging, etc. Values cannot be changed on this screen.

P1	3.0	T1	101.2
ΔP1	208	T2	118.3
ΔP2	225	T3	64.3
P_R	21		974

X value. Displays:
- 2000 during initialization
- 10 if T1 < 212 °F (100 °C) (no steam)
- > 1000 if superheated steam
- 850–1000 (dryness fraction x 1000) during normal operation

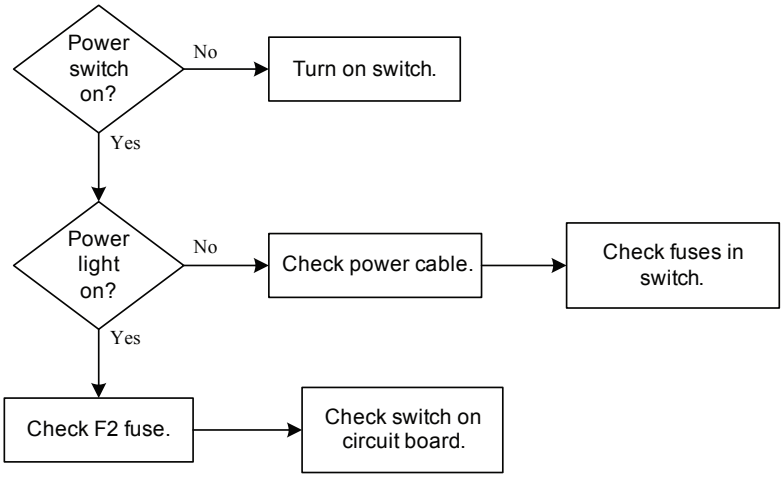
Troubleshooting

Components and water may be hot.

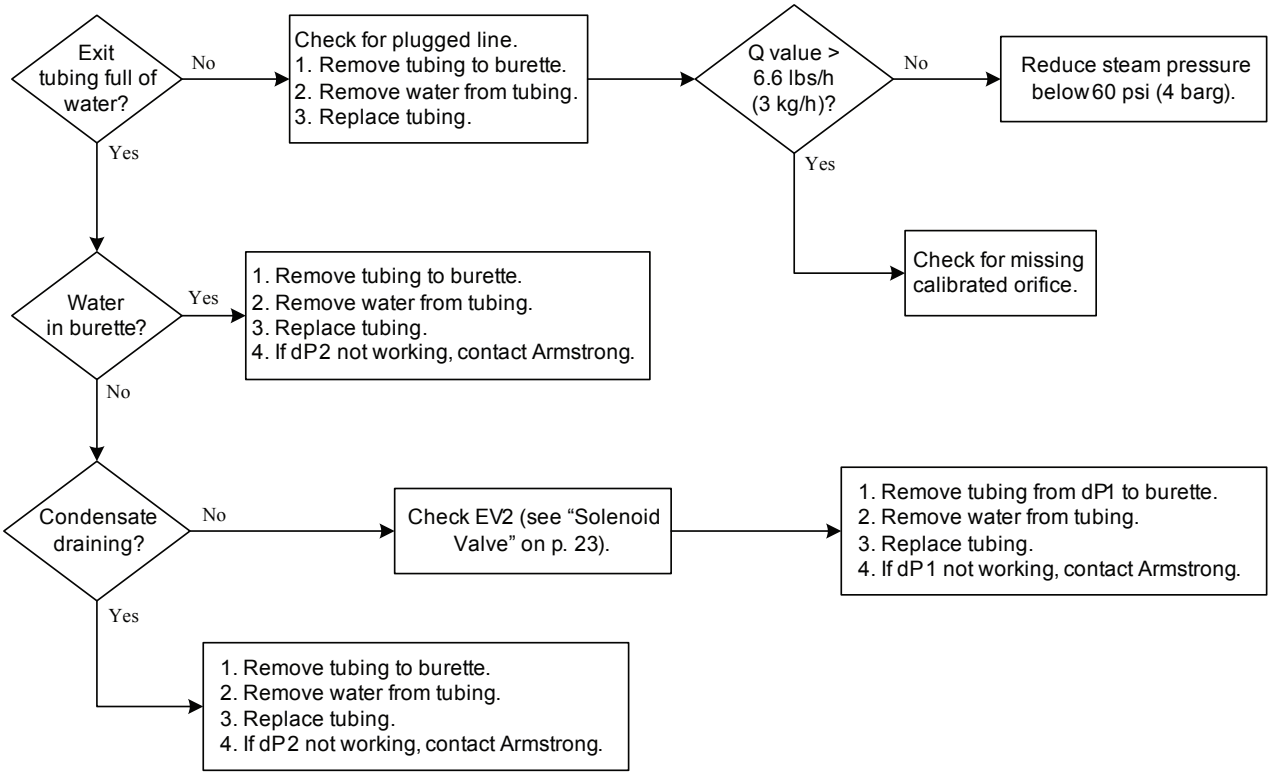
Disconnect power before performing electrical work.

If problem cannot be resolved, contact Armstrong.

Power Light/Display Off



NCG Burette Overflowing



Condensate Burette Overflowing

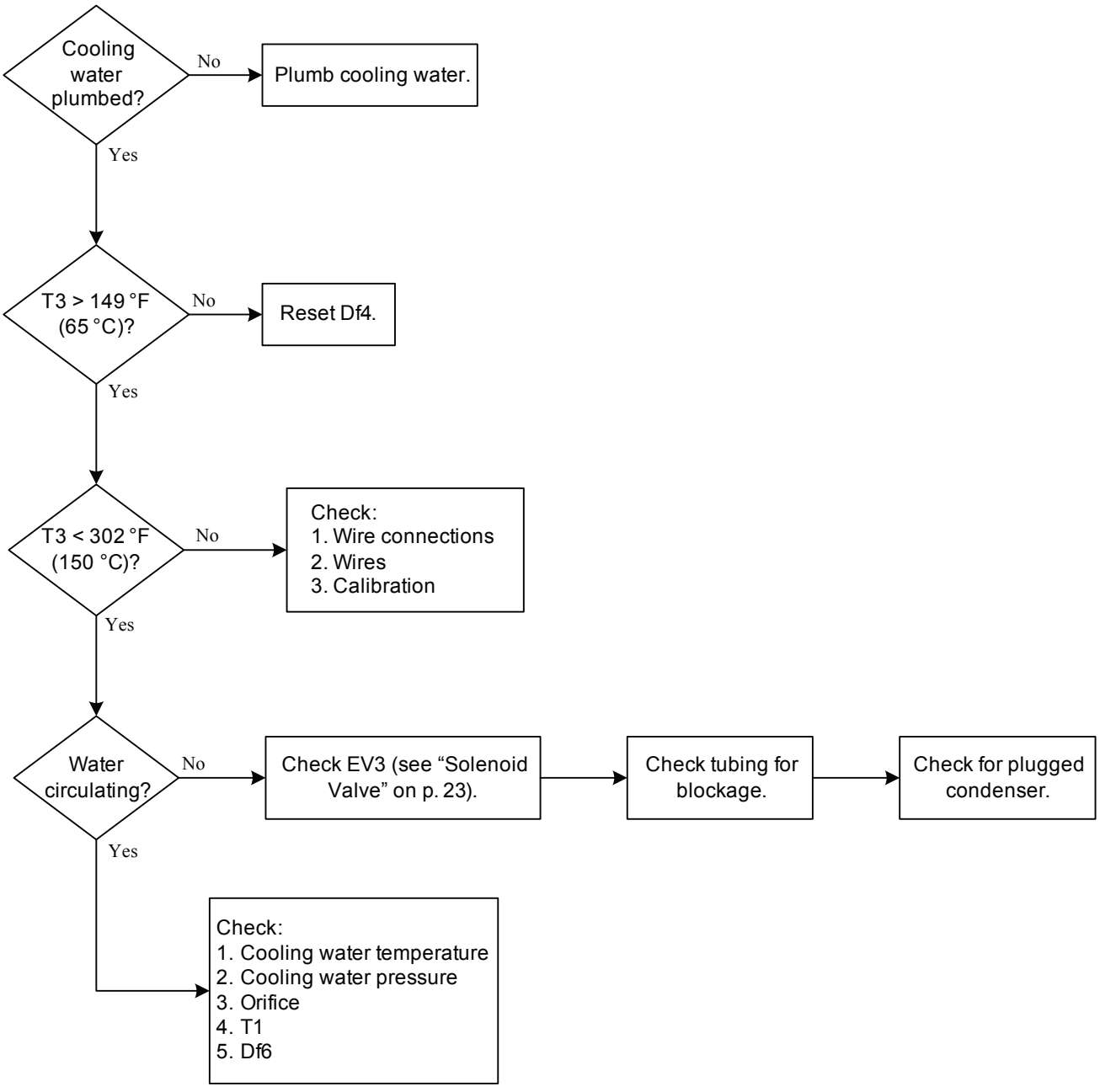
1. Remove tubing from burette.
2. Remove water from tubing.
3. Replace tubing.

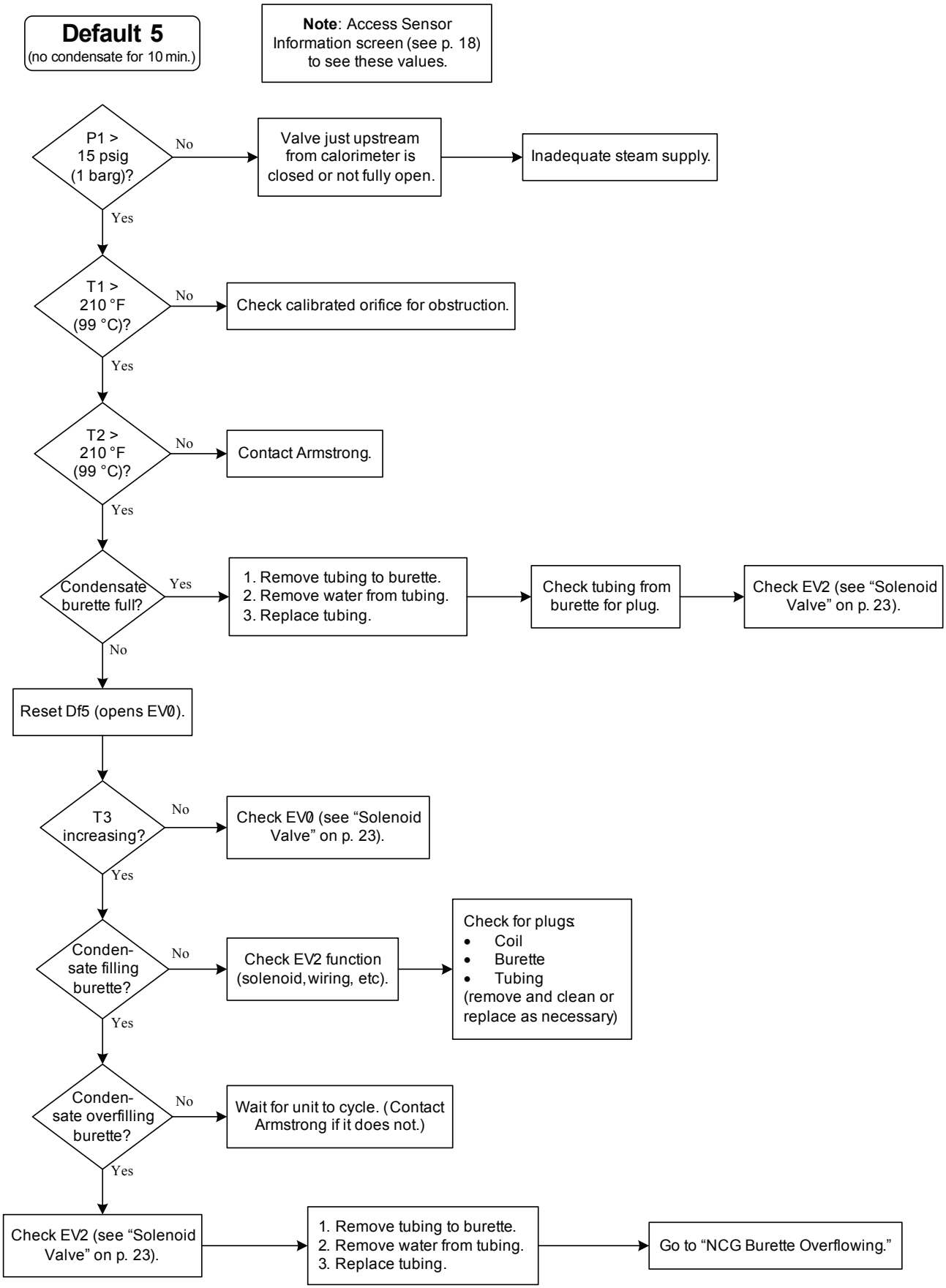
→ Check EV2 (see “Solenoid Valve” on p. 23).

Default 4

(T3 > 185 °F [85 °C] > 2 secs)

Note: Access Sensor Information screen (see p. 18) to see these values.

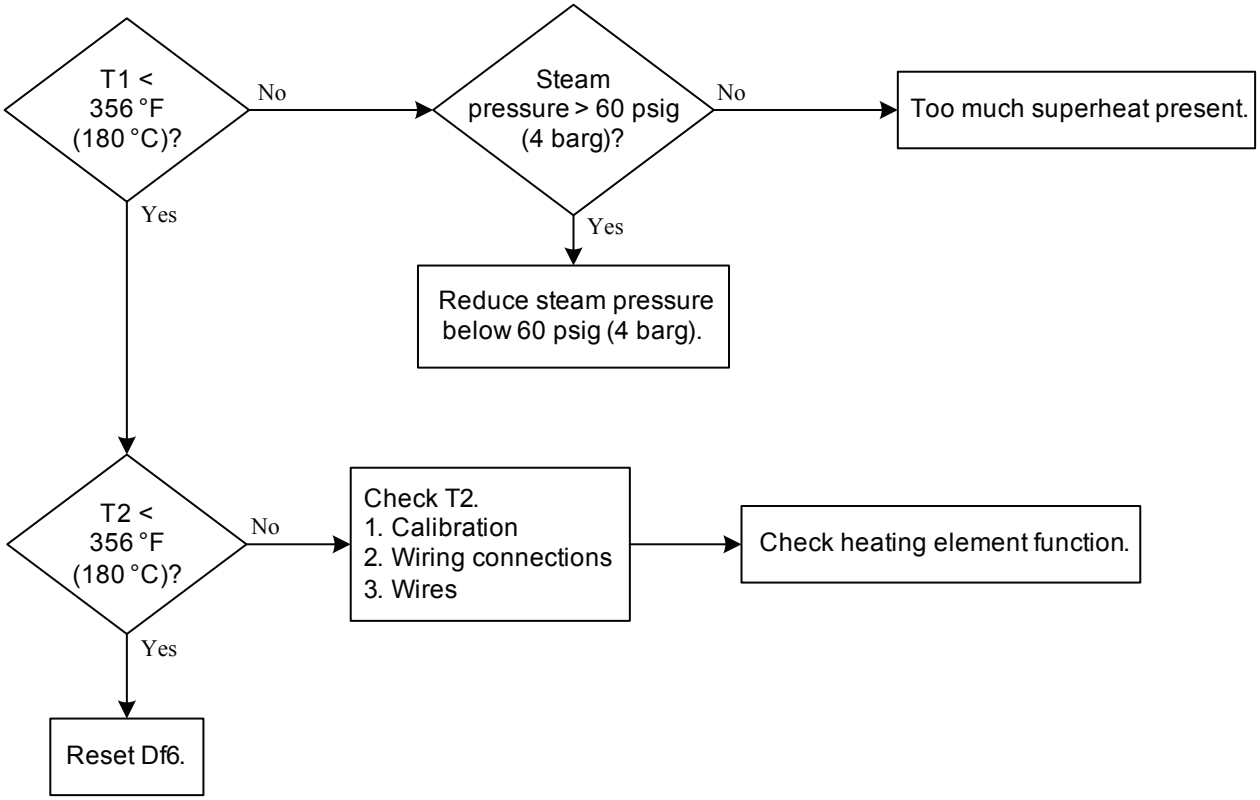



Default 5
(no condensate for 10 min.)
Note: Access Sensor Information screen (see p. 18) to see these values.
P1 > 15 psig (1 barg)?
No
Valve just upstream from calorimeter is closed or not fully open.
Inadequate steam supply.
Yes
T1 > 210 °F (99 °C)?
No
Check calibrated orifice for obstruction.
Yes
T2 > 210 °F (99 °C)?
No
Contact Armstrong.
Yes
Condensate burette full?
Yes
1. Remove tubing to burette.
2. Remove water from tubing.
3. Replace tubing.
Check tubing from burette for plug.
Check EV2 (see "Solenoid Valve" on p. 23).
No
Reset Df5 (opens EV0).
T3 increasing?
No
Check EV0 (see "Solenoid Valve" on p. 23).
Yes
Conden-sate filling burette?
No
Check EV2 function (solenoid, wiring, etc).
Check for plugs:
• Coil
• Burette
• Tubing
(remove and clean or replace as necessary)
Yes
Conden-sate overfilling burette?
No
Wait for unit to cycle. (Contact Armstrong if it does not.)
Yes
Check EV2 (see "Solenoid Valve" on p. 23).
1. Remove tubing to burette.
2. Remove water from tubing.
3. Replace tubing.
Go to "NCG Burette Overflowing."

Default 6

(T2 > 356 °F [180 °C] > 2 secs)

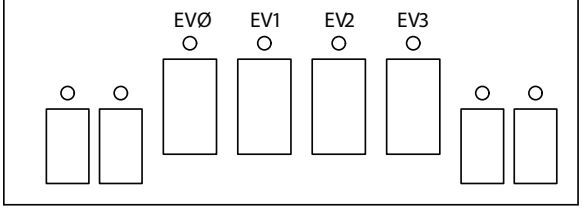
Note: Access Sensor Information screen (see p. 18) to see these values.



Solenoid Valve

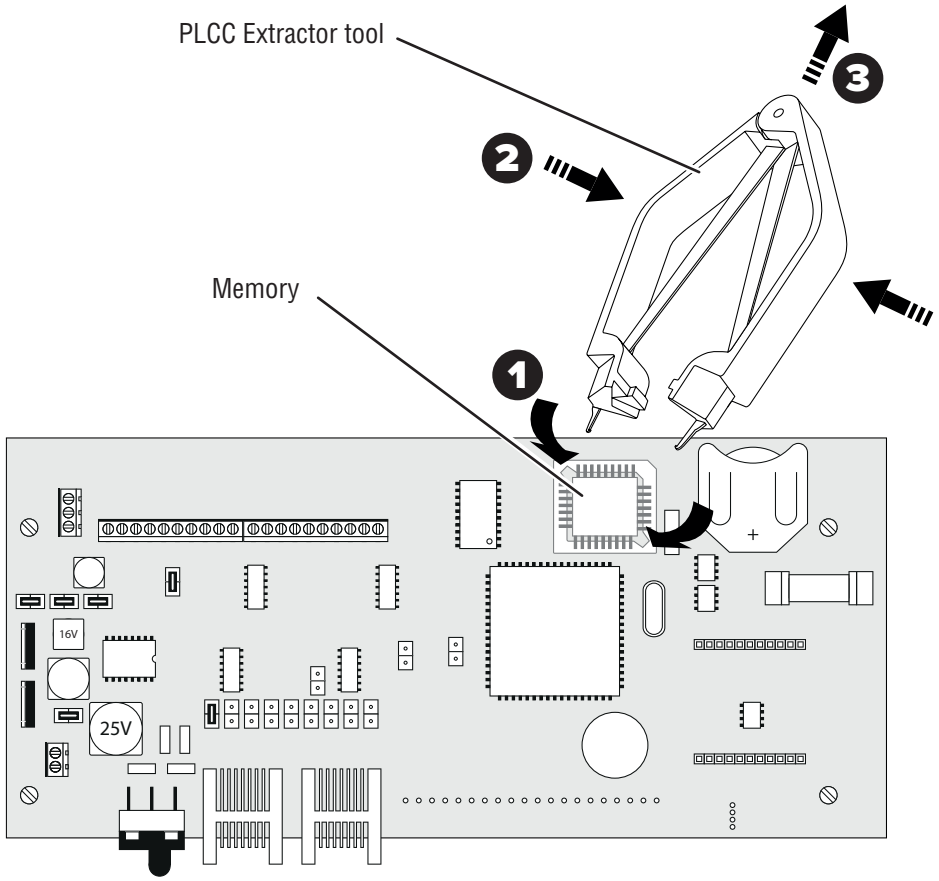
Note: See principle schematic (appendix two on p. 28) to ascertain whether applicable valve is normally open or closed.

Solenoid Valve LEDs
(Located on upper right inside wall of cabinet.)



Software update

1. Turn off QM-3 and unplug from power source.
2. Open right door (where electrical components are located).
3. Find the electronic board on the back of the door.
4. Remove cautiously the memory with the adapted tool (like a PLCC extractor).



5. Replace the memory (with your thumb, push cautiously respecting the coded pin).
6. Plug and turn on the QM-3, light is ON and screen is activated.
7. Check the version software in the code menu (press simultaneously on ◀ and ▶).

Component and Parts List

Components

Description	Part Nr.
Steam Quality Monitor QM-3 Package	D44212

Parts

Description	Part Nr.
Insulation jackets (2pcs)	D43805
Stainless Steel Wall mount	D44160
Calorimeter assembly	D49150
Condenser with fittings	D79386
Main board with display	D44124
Relay board	D44125
Vessel Non Condensable Gases assembly with expansion coil	D44126
Vessel Condensate flow meter assembly with fittings	D46738
JUMO PT100 (T1 and T2)	D44110
JUMO Pressure transmitter	D44117
Heating element	D44118
BURKERT 3/2 solenoid valve (EV0)	D44119
BURKERT 2/2 solenoid valve (EV1 and EV3)	D44120
BURKERT 3/2 solenoid valve (EV2)	D44121
JUMO PT100 (T3)	D44122
JUMO Differential pressure sensor	D44123
Orifice Plate with Gasket	D40020
Gasket PTFE for 1/2'' flexible hose (bag with 3 pieces)	D53335

Product Certifications

CE Directives

Electromagnetic Compatibility Directive: 89/336/EEC, 2004/108/EC
Low Voltage Directive: 73/23/EEC, 2006/95/EC
Machinery Directive: 98/37/EC Amending Directive 89/392/EEC

Conforms to the following standards:

- EN 61000-6-3: Electromagnetic compatibility generic requirements (residential, commercial and light industries)
- EN 55022: class B (conducted and radiated emission limits)
- EN 61000-6-2: Electromagnetic compatibility (EMC) – Generic standards – Immunity for industrial environments
- EN 61000-4-3: Radiated, radio frequency, electromagnetic field immunity test
- EN 61000-4-6: Immunity to conducted disturbances induced by radio frequency fields
- EN 61000-4-4: Electrical fast transient/burst immunity test
- EN 61000-4-5: Surge immunity test
- EN 61000-4-2: Electrostatic discharge immunity test
- EN 60204-1: Safety of machinery – Electrical Equipment of machines – Part 1: General requirements
- EN 292 Parts 1 & 2: Safety of machinery basic principle mechanical design

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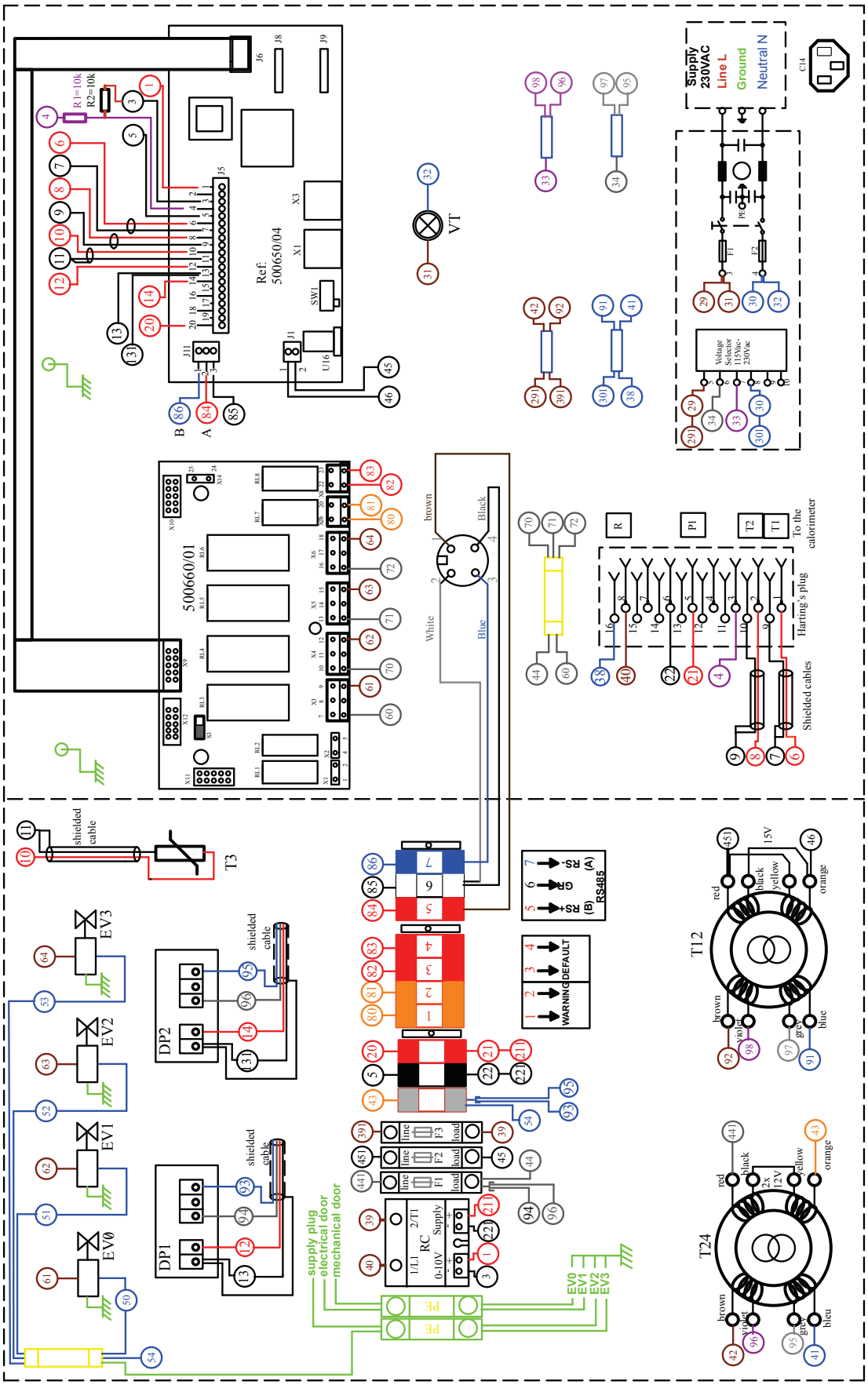
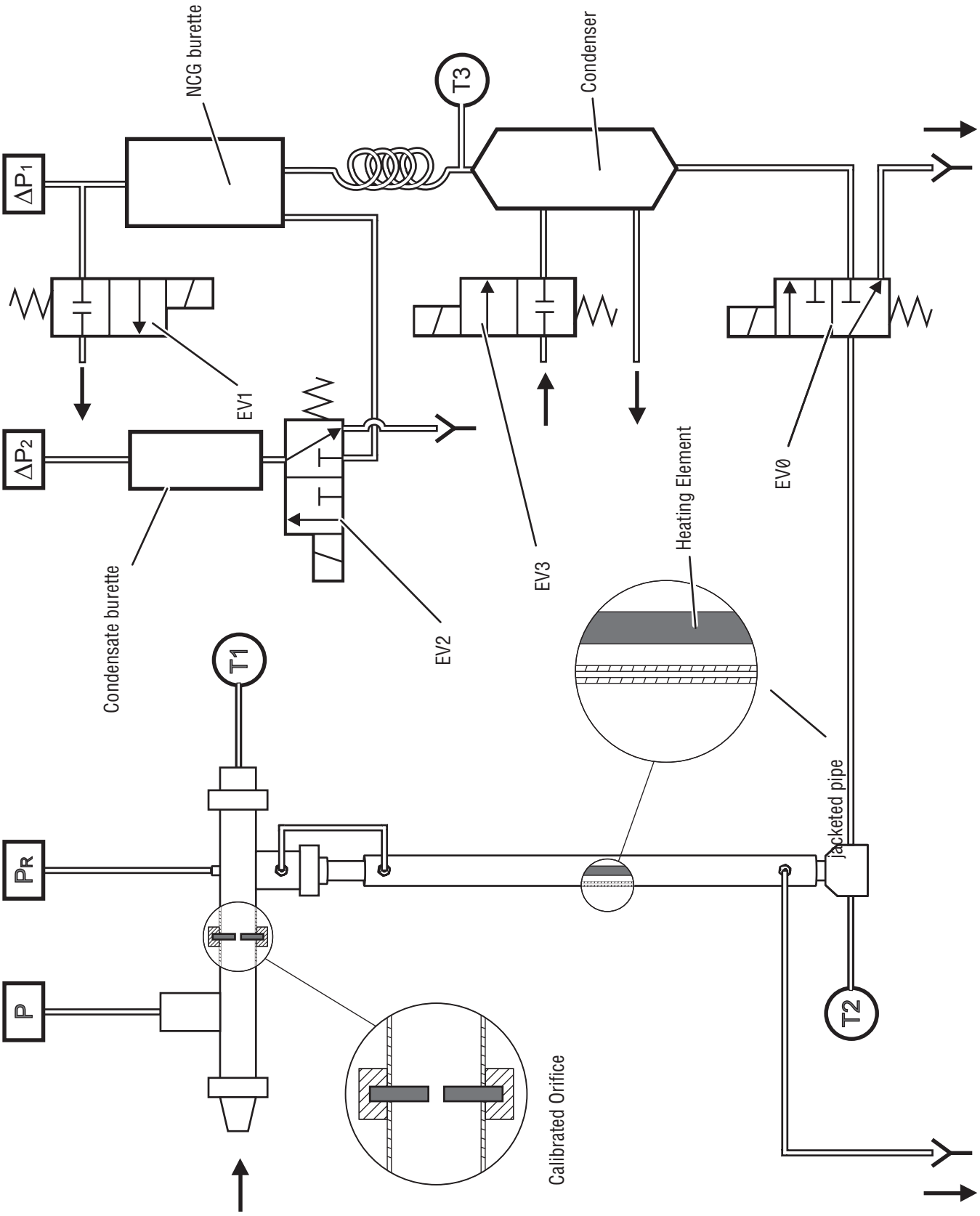
CONFORMS TO
UL STD 61010-1
CERTIFIED TO CSA
STD C22.2 NO. 61010-1

Appendix One: Wiring Diagram



Appendix Two: Principle Schematic



Appendix Three

MODBUS Connection

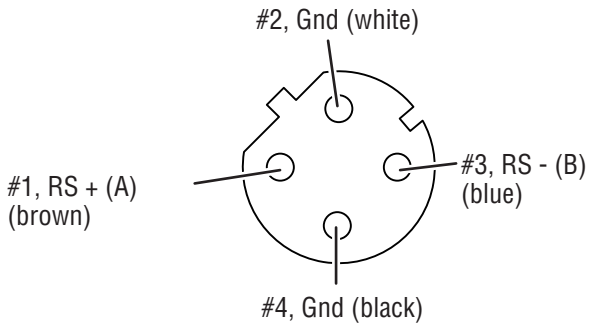
Note: The information on this page applies to any MODBUS data logger. A 9 ft (3 m) cord is provided with an M12 connector for Steam QM-3 cabinet connection.

The logger end of the cord must be wired by the customer.

Program the logger with the following information.
Note: The Modbus address and the mode of communication is define in the Steam QM-3 Advanced Setting Menu, see p. 17.

Parameter	Value
Baud Rate	9600 bauds/sec
Data Length	8 bits
Parity	None
Handshaking	N/A
Address	From 1 to 80
Mode	Master or slave

Cord end



Master Mode

Data are sent in different registers as shown in the table below using Modbus function 16 (0x10).

All values are SI units. If conversion is required, it must be done manually.

Decimal values are not used. Readings are shown as whole numbers, e.g., 19.2 will show as 192.

Register	Name	Factor	Unit	Data Type
40 001	T1	x 10	°C	(Integer value)
40 002	T2	x 10	°C	(Integer value)
40 004	P1	x 10	bar[a]	(Integer value)
40 007	X	x 1000	N/A	(Integer value)
40 008	Q	x 10	kg/h	(Integer value)
40 011	% NCG	x 10	N/A	(Integer value)
40 012	Alarms	N/A	N/A	Bit 1: Alarm 1 Bit 2: Alarm 2 Bit 3: Alarm 3 Bit 4: Default 4 Bit 5: Default 5 Bit 6: Default 6 Bit 7: Not used Bit 8: Not used

Slave Mode

In slave mode: you can send query's with function 0x02 and 0x04, according the register maps below.

Note: The length of the query and response must remain less than 23 bytes (max 3 register per query).

Function 0x02 Read Discrete Inputs				
Register	**Name**	**Factor**	**Unit**	**Description**
10001	Alarm1	N/A	0: disable - 1: enable	Toggle to 1 when the alarm 1 is on
10002	Alarm2	N/A	0: disable - 1: enable	Toggle to 1 when the alarm 2 is on
10003	Alarm3	N/A	0: disable - 1: enable	Toggle to 1 when the alarm 3 is on
10004	Default4	N/A	0: disable - 1: enable	Toggle to 1 when the default 4 is on
10005	Default5	N/A	0: disable - 1: enable	Toggle to 1 when the default 5 is on
10006	Default6	N/A	0: disable - 1: enable	Toggle to 1 when the default 6 is on

Function 0x04 Read Inputs Registers				
Register	**Name**	**Factor**	**Unit**	**Description**
30001	T1	10x	°C	Integer (16 bits)
30002	T2	10x	°C	Integer (16 bits)
30004	Alarm3	10x	Bar [a]	Integer (16 bits)
30007	Default4	1000x	-	Integer (16 bits)
30008	Default5	10x	Kg/hr	Integer (16 bits)
30011	Default6	10x	-	Integer (16 bits)

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