

# High Pressure Gauges

## Series RHR & THR



**PENBERTHY®**

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# Penberthy RHR & THR Gages

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## 1. Introduction

From its beginning in 1886 with the boiler feedwater injector to present-day ISO 9001 certification, Penberthy has utilized advanced technology to anticipate customer needs and solve problems. Many years of research and development, lab and field product testing, and product performance monitoring have resulted in a superior product line used in oil and gas production, transportation, refining, petrochemical, chemical, and power generation industries

## 2. Warranty

Clark-Reliance warrants its manufactured goods as being free from defects in material and workmanship for one (1) year from the date of shipment. If any of the goods are found by the seller to be defective, such goods will be replaced or repaired at the seller's cost. Refer to Clark-Reliance's Terms & Conditions for full warranty details.

## 3. About This Manual

This manual is designed to aid and guide in the installation, operation, and maintenance of the Penberthy RHR & TH family of large chamber gauges. Authorized personnel must read and understand all instructions before attempting to install, operate, or maintain this equipment. Only persons certified to perform work described herein should attempt any actions suggested. Safety precautions and company safety standards should be adhered to at all times when performing the activities described in this manual.

## 4. Inspection and Delivery

Upon receiving weld pad gages, check all components carefully for damage incurred during shipping. Sign for the shipment noting "damaged" and immediately notify the shipping firm of any such damage and request damage inspection. Confirm that the product model number, and pressure / temperature ratings (on nameplate) meet application specifications. Also confirm that the material of construction is compatible with both the process fluid and surrounding atmosphere.

## 5. Product Description

Penberthy liquid level gages are used to allow direct visualization of liquid level in vessels. By peering through the glass, it is possible to monitor color, clarity and level of a gas/liquid interface. Gages are available in varying lengths and configurations (end connect, side connect, multiple sections, NPT or flange connections, etc.). Visual indication can be enhanced by using reflex glass or illuminators (accessory).

Penberthy Series LC gages comprise six basic components. Each component may vary slightly, depending on the desired physical and mechanical properties for the gage.

- **Chamber:** provides a pressure-retaining metallic channel for the liquid to enter and be viewed. Slot(s) are machined into the chamber to provide direct visualization of the process fluid.
- **Gaskets:** seal the gap and prevent leakage between the chamber and the glass. Gaskets are available in a variety of materials for compatibility with the media in the gage.
- **Glass:** allows for visual observation of the process fluid in the chamber.
- **Cushion:** acts as a protective buffer between the glass and the cover. For proper sealing, cushions must be as hard or harder than the gasket material.
- **Cover:** protects the glass assembly from external hits and provides a flat, rigid surface that is used to compress the gage assembly evenly.
- **Bolting:** compresses the components between the covers (transparent gages) or cover and chamber (reflex gages).
- **Shield:** (optional on transparent gages) used to prevent the process media from contacting the glass.

# Penberthy RHR & THR Gages

## 6. Selection Guide

<b>Example:</b>	4	RHR	7	C	C	C	X	C	B	X
<b>No. of sections</b>										
1	1 Section									
2	2 Section									
3	3 Section									
4	4 Section									
<b>Gage type</b>										
RHR	HP Reflex gage with recessed gasket chamber and cover									
THR	HP Transparent gage with recessed gasket chamber and cover									
<b>Glass size</b>										
1	Size 1									
2	Size 2									
3	Size 3									
4	Size 4									
5	Size 5									
6	Size 6									
7	Size 7									
8	Size 8									
9	Size 9									
<b>Wetted parts material (chamber)</b>										
C	Carbon steel (standard)									
S	316/316L Stainless steel									
M	Monel									
A	Alloy 20									
H	Hastelloy C									
D	Duplex									
<b>Cover material</b>										
C	Carbon steel (standard)									
S	316/316L Stainless steel									
D	Duplex									
<b>Boiling material</b>										
C	STL A193 B7 / A194 2H Yello Zn Coated (standard)									
S	SST A193 B8M/A194 8M									
	NACE MR-01-75 and/or MR-0103									
X	None									
W	NACE wetted									
E	Environmental									

<b>Example:</b>	C	B	X	X	X	X	X	X	X
<b>End connection size</b>									
C	1/2" (Standard)								
F	1" (flange only)								
G	1-1/4" (flange only)								
H	1-1/2" (flange only)								
J	2" (flange only)								
<b>End connection type</b>									
B	NPT female (standard)								
D	Socketweld female								
N	Raised face SO								
P	Flat face SO								
R	RTJ SO								
S	Raised face SW								
T	Flat face SW								
U	RTJ SW								
V	Raised face WN								
W	Flat face WN								
Y	RTJ WN								
F	Vent and drain plugged								
G	Drain plugged								
H	Vent plugged								
J	Socketweld male								
<b>End connection pressure class</b>									
X	None								
1	P CL 150								
3	P CL 300								
6	P CL 600								
9	P CL 900								
F	P CL 1500								
T	P CL 2500								

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PART 4 - PAGE 9

PART 4 - PAGE 9

4	RHR	7	C	C	C	X	Example:	X	X	X	X	X	S	B	S	B	X	X	X	X
PART 2 - PAGE 7 C B X							Side connection size													
							X	None												
							C	1/2" (standard)												
							F	1" (flange only)												
							G	1-1/4" (flange only)												
							H	1-1/2" (flange only)												
							J	2" (flange only)												
							Side connection type													
							X	None												
							B	NPT female (standard)												
							D	Socketweld female												
							M	NPT male												
							N	Raised face SO												
							P	Flat face SO												
							R	RTJ SO												
							S	Raised face SW												
							T	Flat face SW												
							U	RTJ SW												
							V	Raised face WN												
							W	Flat face WN												
							Y	RTJ WN												
							L	Lap joint												
							Side connection pressure class													
							X	None												
							1	P CL 150												
							3	P CL 300												
							6	P CL 600												
							9	P CL 900												
							F	P CL 1500												
							T	P CL 2500												
							Side connection location													
							X	None												
							S	Right side connected (standard)												
							L	Left side connected												
							B	Back connected												
							F	Front connected												
							G	One bottom right												
							H	One bottom left												
							J	One top right												
							K	One top left												
							M	One bottom back												
							Connection dimension													
							X	None												
							00000	Inches (first 3 digits = number of whole inches, last 2 digits = fraction of an inch in hundredths)												

4	RHR	7	C	C	C	X	Example:	S	S	S	B	X	X	X
PART 2 - PAGE 7 C B X							Gasket material							
							S	Grafoil/SS insert (standard)						
							D	(ePTFE)						
							P	PCTFE (KEL-F)						
							Cusion material							
							S	Grafoil/SS insert						
							A	Garlock 5500						
							Paint specification							
							X	None						
							S	Standard						
							O	Offshore						
							Option 1							
							X	None						
							B	1 Welded support bracket						
							C	2 Welded support brackets						
							D	3 Welded support brackets						
							K	Belleville washers						
							Option 2							
							X	None						
							Option 3							
							X	None						
							B	Mica Shields V-4						
							C	PCTFE shields (KEL-F)						
							Option 4							
							X	None						
							N	Aluminosilicate glass						

# Penberthy RHR & THR Gages

## 7. Pressure / Temp Ratings

RHR/THR (PSI)		
Temperature		CS & 316SS
°F	°C	
100	38	5000
200	93	4685
300	149	4370
400	204	4055
500	260	3740
600	316	3425
For temperatures above 600°F (427°C) Aluminosilicate Glass must be used		
700	371	3110
800	427	2795

Saturated Steam Rating 1500 WSP

RHR/THR (BarG)		
Temperature		CS & 316SS
°F	°C	
100	38	344.7
200	93	323.0
300	149	301.3
400	204	279.6
500	260	257.9
600	316	236.1
For temperatures above 600°F (427°C) Aluminosilicate Glass must be used		
700	371	214.4
800	427	192.7

Saturated Steam Rating 1500 WSP

*TEST PRESSURE: All gauges are hydrostatically tested by Penberthy prior to shipment @ 1-1/2 times the design pressure rating at 100°F (38°C).*

## 8. Installation

Installation should only be undertaken by qualified, experienced personnel who are familiar with equipment of this type. They should have read and understood all of the instructions in this manual. The user should refer to relevant technical data sheets or product proposal to obtain dimensional information for the specific size and model liquid level gage.

Penberthy recommends that all liquid level gage installations be provided with gagecock sets equipped with a ball check shut-off. Gagecock sets are designed to isolate the gages from the pressure vessel when it becomes necessary to drain or service the gages. The ball check shut-off is designed to retard leakage of the contained fluid in the event of gage glass breakage. Ball checks are available for both positive and negative vessel pressures.

The number of different types of gage and gagecock installations is too great to detail adequately in an installation manual. It is, therefore, the user's responsibility to assure that knowledgeable installation personnel plan and carry out the installation in a safe manner.

The following procedures are some of the installation guidelines that should be employed:

**Piping strain** The gage should be mounted and connected so that it does not support any piping weight. Piping not supported properly, independent of the gage, may subject the gage to stresses that can cause leaks or glass breakage. Support brackets are available as an accessory.

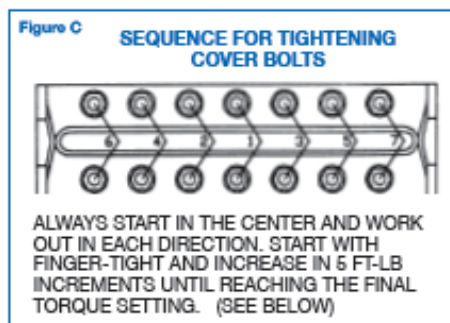
**Differential thermal expansion** High mechanical loads may be imposed on a gage by expanding and contracting pipes due to hot or cold service. Such mechanical loads on the gage must be minimized by the use of expansion loops in the system. Failure to allow for expansion or contraction can result in leaks or glass breakage.

**Mirror viewing** For added safety, a system of indirect viewing by means of mirrors should be installed to protect personnel from the hazards of possible gage failure.

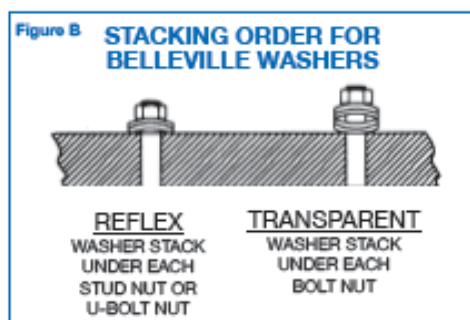
**Nut retorquing** Nut re-torque is vital to the operation of a liquid level gage because gaskets take permanent "set" under initial bolt loading at assembly. Tightening of nuts before installation to **80 FT-LBs (108 N-m)** is necessary to insure pressure retaining capabilities of a liquid level gage to specific design ratings.

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Tighten the nuts finger-tight, working from the middle set, alternating outward. Next, tighten with a torque wrench in the same sequence in 5 ft.-lb. (6.7 N-m) increments until the final torque value of **80 FT-LBs (108 N-m)**. With the torque wrench still set at the final value, make one final pass moving from left to right to confirm final torque value on all nuts. Moving from left to right will eliminate any crosstalk that may have occurred between bolt sets.



**Belleville washers (optional)** Belleville washers are used to reduce the need to retorque nuts. Model RHR gages require 2 washers per nut, model THR gages require 4 washers per nut (8 per bolt). Washers should be assembled as per the below



## 9. Operation

Before initializing liquid level gage operation, check that all installation procedures have been completed. Use only qualified experienced personell who are familiar with liquid level gage equipment and understand the implications of the instructions thoroughly. Check to determine that all connections are pressure tight. Ensure that nuts have been retorqued to **80 FT-LBs (108 N-m)**. Remove self stick caution tape from the glass and inspect to be sure that glass is clean and free of any damage such as cracks, scratches, pits, and chips.

### Hydrostatic test

#### **DANGER**

Liquid level gage installations should be brought into service slowly to avoid excessive shock or stress on the glass. Rapid pressurization or sudden changes in temperature may cause glass breakage. To avoid excessive thermal shock or mechanical stress on glass, the connecting gagecocks should be opened slightly, and the gage temperature and pressure allowed to slowly equalize. If the gagecocks are equipped with ball checks, the gagecocks must be opened all the way after the pressure and temperature have equalized to permit operation of the automatic ball checks in the event of failure. Failure to follow the recommended operating procedures can result in death, severe personal injury and/or property damage.

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Take all precautions necessary to handle the possibility of leakage during the test. Hydrostatically pressure test all installations to at least 100 psig (690 kPa) but less than the design pressure and correct any leakage before proceeding.

## 10. MAINTENANCE

### WARNING

Use only qualified, experienced personnel who are familiar with liquid level gage equipment and understand the implications of the related safety instructions thoroughly. DO NOT proceed with any maintenance unless the liquid level gage has been relieved of all pressure or vacuum, has been allowed to reach ambient temperature and has been drained or purged of all fluids. Failure to follow instructions can cause serious personal injury and property damage.

The rate at which components degrade is dependent upon a variety of conditions. Pressure, temperature and process media all influence the rate at which gage components deteriorate. Higher temperatures can accelerate the deterioration of gaskets, cushions, glass and metals. Acids and similar chemicals can accelerate the integrity of almost any material. Concentration of chemicals can accelerate the corrosion rate. Emerson cannot create a blanket maintenance schedule for every application.

The end user is the most familiar with the process media and conditions and must be responsible for creating a maintenance schedule. The user must create maintenance schedules, safety manuals and inspection details for each liquid level gage.

Realistic maintenance schedules can only be determined with full knowledge of the services and application situations involved. These will be based upon the user's own operating experience with their specific application.

If bolting, gasketing or glass on any section of a multi-section gage is disturbed, all sections must be checked for integrity and retorqued or repaired as necessary.

On all installations the following items should be evaluated regularly by the user for purposes of maintenance:

1. Glass, for cleanliness and signs of damage or wear.
2. Shields, if used, for signs of clouding, wear or deterioration.
3. Gage, for signs of leakage around gaskets or at connections.
4. Gage, for signs of internal or external corrosion.

### Maintenance procedures

Glass should be given regular and careful attention. Keep glass clean using a commercial glass cleaner and a soft cloth. Inspect the surface of the glass for any clouding, etching or scratching or physical damage such as bruises, checks or corrosion. Glass that is damaged is weakened and may break under pressure.

Shining a light at approximately a 45° angle will aid in detecting some of these conditions. Typically, damaged areas will glisten more brightly than the surrounding glass because the light is reflected.

Detection of any damage, problem areas or surface wear is sufficient evidence to take the liquid level gage out of service. DO NOT proceed with operation of the liquid level gage until the glass has been replaced with a glass replacement kit following the disassembly – reassembly instructions.

Shields showing any signs of clouding, wear or deterioration are an indication that the gage glass has been exposed, or could soon be exposed to the contained fluid. Take liquid level gage out of service immediately. DO NOT proceed with operation of the liquid level gage until the glass and shields have been replaced by following the disassembly-reassembly instructions.



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Gasket leaks must be repaired immediately. DO NOT proceed with operation of a liquid level gage until gaskets have been replaced.

Connection leaks at a flanged or threaded connection should be corrected by tightening the bolting at the connection or by taking the liquid level gage out of service and wrapping the connection threads with PTFE tape on all male pipe threads.

Corrosion may occur if the user has selected an improper material for the liquid level gage application. It is the responsibility of the user to choose a material of construction compatible with both the contained fluid and the surrounding environment. If internal or external corrosion is present, an investigation must be performed by the user immediately. It may be necessary to contact an authorized Penberthy distributor to better determine the origin of the corrosion.

## Troubleshooting

Problem: Glass becomes etched or clouded prematurely in service.

Cause: Fluid being handled is not compatible with the glass or shields.

Solution: Replace the glass and install shields which will not be affected by contained fluid.

Problem: Glass breaks continually in service despite careful attention to maintenance procedures.

Cause: Thermal shock, hydraulic shock, exceeding design ratings or combination of these.

Solution: Check entire system to determine possible sources of loads. Check application to determine actual operating conditions and contact an authorized Penberthy distributor on how to proceed.

## 11. REMOVAL – DISASSEMBLY – REASSEMBLY

### WARNING

Use only qualified, experienced personnel who are familiar with liquid level gage equipment and understand the implications of the tables and all the instructions thoroughly. DO NOT proceed with any maintenance unless the liquid level gage has been relieved of all pressure or vacuum, has been allowed to reach ambient temperature and has been drained or purged of all fluids. Failure to follow instructions can cause serious personal injury and property damage.

### Disassembly

Secure a workbench, equipped with a vise at one end, longer than the liquid level gage and sufficiently wide to lay out parts as they are removed. Attach and tighten a nipple to each end connection to serve as temporary means of supporting the liquid level gage during disassembly and reassembly.

1. Grip nipple on one end with vise and hold up the other end with a 2 x 4 or suitable prop
2. Hold gage firmly; loosen nuts starting at both ends of each section and then proceeding from both ends to the center of each section.
3. Nut loosening sequence.
  - Remove nuts, washer, belleville washers (if any) and nameplate.
  - Tap covers with rubber hammer as needed to loosen and remove.
  - For belleville washer assemblies: to remove covers, studs may need to be removed by laying the assembly on its side and knocking the stud/U-bolts through the cover with a hammer and punch.
  - Remove cushions, glass, shields (if any) and gaskets.
  - Tap liquid chamber or remaining covers as necessary with rubber hammer to break loose and remove remaining components.
  - Remove, destroy and dispose of all glass, cushions, gaskets and shields. Under no circumstances should these components be re-used or installed on a gage.

Note: If size of gage is smaller than shown, follow spiraling sequence from the ends until all bolting is loosened.

# Penberthy RHR & THR Gages

## WARNING

Once used, cushions, gaskets and shields are deformed permanently by compression and, if re-used, may cause leaks and high stress points resulting in glass breakage. Glass may contain hidden damage and internal stresses caused by previous usage. If re-used, the glass may break under pressure causing severe personal injury or property damage.

**Inspection of glass seating surfaces** Clean the glass seating surfaces on the liquid chamber and cover with a soft metal scraper (preferably brass) to remove all burrs, rust and remnants of the previous gaskets and cushions. Exercise extreme care to avoid gouging or scarring gasket and cushion seating surfaces. Use a known flat piece of metal the same approximate length as the glass or a new piece of glass and a thickness gage to check flatness of each glass seating surface on liquid chamber and under cover. Surface must be flat within 0.002 inch (0.05 mm).

## WARNING

Flatness of glass seating surfaces outside 0.002 inch (0.05 mm) tolerance specified is an indication that the gage has been overstressed through repeated exposure to mechanical, thermal or hydraulic shock during its previous service. Operation of a liquid level gage which has been overstressed will result in abnormal stresses on the glass which may cause glass to break.

**8.3 Reassembly** If all glass seating surfaces are found to be within the 0.002 inch (0.05 mm) tolerance described in the previous section, proceed to obtain new glass, gaskets, cushions and shields (if used) and proceed to reassemble as follows:

1. Clean threads on bolts and nuts to remove all paint, rust and scale. Apply a light coat of oil to the threads.
2. Insert studs through holes in half the covers, thread nuts flush with ends of studs and place covers on.
3. For reflex style and Belleville reflex style gages, grip nipple on one end of liquid chamber with vise and hold up the other end with a 2 x 4 or suitable prop. Lay out covers side by side with liquid chamber. Slide all U-bolts on chamber to their approximate location, using covers to space U-bolts.
4. For transparent Belleville style gages, insert studs through holes in half the covers, place four Belleville washers in series with pointed end toward the nut, thread nuts on stud and lay out covers on cut 1 x 4 pieces of wood along bench, side by side, with liquid chamber. Use chamber to space covers and line them up with vision slots.
5. Install one cushion inside each cover

## WARNING

Separate installation instructions are supplied with replacement glass. All instructions supplied with the glass must be followed, as there are precautions to be taken when handling gage glass. Among the precautions is avoidance of bumping or sliding glass against any surface and inspection of individual pieces. Failure to follow any of the replacement gage glass installation instructions could result in glass breakage with resulting sudden release of pressure, severe personal injury or property damage.

6. Install shields, if used, and gasket on glass being careful to keep components centered.
7. For transparent style gages, align studs to accept liquid chamber and slide liquid chamber into place being careful to keep components centered.
8. For reflex style gages, install covers in place while making sure alignment of components is maintained with vision slot. Install nameplate, washer and all nuts finger tight.
9. For reflex belleville style gages—install nameplate and seven belleville washers under each nut with pointed end toward the nut. Finger tighten nuts.
10. Using a torque wrench, tighten nuts in 5 ft-lb [7 Nm] increments, following the sequence in until the torque value **80 FT-LBs (108 N-m)** is reached. **Note:** depending on gage size there may be less bolting. Start at the center and follow “Z” pattern outward to the limit of bolting on a specific gage.
11. For transparent style gages, install gaskets and shields, if used, centered on vision slots.
12. Install covers in place being careful to maintain components alignment inside.
13. Install nameplate, washer and nuts to studs. Finger tighten nuts.

15. Using a torque wrench, tighten nuts in 5 ft-lb [7 Nm] increments, following the sequence until the torque value **80 FT-LBs (108 N-m)** is reached.

## 12. DISPOSAL AT END OF USEFUL LIFE

Penberthy gages are used in a variety of fluid applications. By following the appropriate federal and local regulations, the user must determine the extent of preparation and treatment the gage may incur before its disposal. A Material Safety Data Sheet (MSDS) may be required before disposal services accept certain components.

Metal, glass and polymers should be recycled whenever possible. Refer to order and applicable technical data sheets for materials of construction.