graham

Vacuum and Heat Transfer

BAROMETRIC CONDENSER

OPERATION, MAINTENANCE

AND

INSTALLATION MANUAL

Graham Corporation
20 Florence Avenue
Batavia, New York 14020

OMI-BARO-1097

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SECTION I - GENERAL INFORMATION

1.1 Introduction

Barometric condensers are utilized to desuperheat and condense the incoming vapors plus cool the exiting gases, while developing the lowest possible pressure.

1.2 Design Description

There are two principal types of condensers, namely counter flow and parallel flow. The counter flow condensers are constructed so that the vapors and the condensing fluid flow in opposite directions while the parallel flow condensers flow in the same direction (refer to Figure I).

The condensing fluid and condensed vapors are removed by either the use of a tailpipe or a pump. When a tailpipe is utilized, the unit is elevated to a sufficient height to permit drainage by gravity. When a pump is used, the system is called a low level barometric condenser. It should be noted that other items such as level control devices and valves are required in addition to the pump on the low level design (refer to Figure II).

1.3 Mechanical Description (Refer to Figure III)

Barometric condensers are constructed of cast iron, carbon steel, fiberglass reinforced plastic, Haveg, graphite and all weldable alloys. There are two (2) basic parts of a condenser: (1) the shell body, and (2) the spray device(s). The nozzle connections on units constructed of carbon steel and other weldable alloys may have weld ends rather than flanged and/or screwed. A bolted removable cover is supplied on the top of all units through size 24”. Shell internals and spray device(s) can be inspected by removing the top cover. A manhole is supplied on sizes 26” and larger. The spray devices are fastened internally by either a flanged connection or threaded ends.

SECTION II - INSTALLATION

2.1 Initial Inspection

Inspect for shipping damage to all protective covers. If damage is evident, inspect for contamination internally and replace protective covers if the unit is going to be stored. If the unit is damaged mechanically, *NOTIFY THE CARRIER IMMEDIATELY* and then contact Graham Corporation.

2.2 Installation

Sufficient clearance to remove the top cover with spray device(s) should be provided above the unit for sizes 24" and smaller to allow for inspecting the internals and the spray device(s). For sizes 26" and larger, a manhole is present on the side of shell for internal inspection.

There are two (2) supports supplied on units that are 41" diameter and smaller and four (4) supports on units 42" diameter and larger. A continuous ring may be supplied in lieu of supports on fabricated units and will be supplied on fiberglass reinforced plastic units. The size of the piping for the vapor inlet, vapor outlet, condensing fluid inlet and outlet should be carefully analyzed and designed so that there are no loads (forces & moments) reacting on the condenser.

The orientation of the piping is extremely important and reference should be made to Figures II and IV for guidelines. Referring to Figure II, the table lists recommended sealed tailpipe heights for the removal of water (as the condensing fluid) under all possible operating conditions likely to be encountered. <u>This is the minimum effective height!!</u> This minimum height is based entirely on the maximum recorded barometric pressure, regardless of the contemplated operating pressure. For fluids other than water, further adjustments must be made to the minimum height.

Refer to Sketch A of Figure IV: If the vapor inlet piping rises vertically upward from the process vessel and goes directly into the condenser with a 90 degree elbow, the condensing fluid may flow down this pipe. Therefore, a dam or series of elbows should be installed so this will not occur. CAUTION: The dam will cause a reduction in pipe flow area -- therefore, a larger pipe may be necessary.

Refer to Sketch B of Figure IV: The vapor inlet and outlet piping are vulnerable for vapors to condense in these lines and, therefore, loops should be avoided.

Refer to Sketch C of Figure IV: The tailpipe arrangement is very crucial and should not contain any horizontal runs. The ideal is straight down and the acceptable is 45-degree minimum off the horizontal, and the change in direction must be 5 pipe diameters or 4 feet minimum away from the water outlet flange and between all changes in direction.

Refer to Sketch D of Figure IV: The recommended tailpipe seal and clearance dimensions, from the tailpipe outlet to the bottom of the hotwell is shown. The size of the hotwell shall be such that the volume of the water measured from the bottom of the tailpipe to the point of overflow is at least equal to 1.5 times the volume of the minimum recommended height of the tailpipe; in no case should the seal height be less than 12".

SECTION III - OPERATION

3.1 Startup

Generally there are other pieces of equipment such as ejectors and/or liquid ring pumps upstream and/or downstream of the barometric condenser(s). Before any equipment upstream of the condenser(s) is operating, the condensing fluid must be flowing. For new installations, the inlet condensing fluid line should be flushed out to eliminate any weld spatter and chips from possibly plugging the spray device(s). A throttle valve should be installed near the inlet connection, as well as a compound pressure gauge for regulating the condensing fluid. Some installations will have a flow indicator or control device present which should be located between the throttle valve and barometric condensing fluid inlet. The condensing fluid flow should be regulated by the use of the flow indicator, observing the temperature rise of the condensing fluid, or regulating the inlet pressure on the compound pressure gauge. If this inlet pressure is unknown, check with the Graham Engineering Department for the required pressure. As a guideline, if the condenser is operating at an absolute pressure of 7 PSIA or less, a positive pressure of 1 to 5 PSIG on the compound pressure gauge, located at the condensing fluid inlet, will generally be adequate for startup purposes. Double-check with Graham for accurate data since higher than design flow could result in flooding of the condenser. Access to the inlet condensing fluid temperature should be available and a thermometer should also be properly located for measuring the outlet temperature. A thermometer should be located below the operating level in the tailpipe, in the hotwell, or in the condensing fluid outlet connection for the low level type barometric condenser. The temperature rise across the barometric is very helpful since it can aid in calculating the duty by the following formula:

$$\text{GPM} = \frac{\text{PPH} \times 1000}{(T_2 - T_1)500(C_p)\,(\text{S.G.})}$$

GPM = gallons per minute of condensing fluid
PPH = pounds per hour of steam condensed
T_2 = condensing fluid outlet temperature degree F
T_1 = condensing fluid inlet temperature degree F
C_p = specific heat
S.G. = specific gravity

Units of the low level design require a level in the bottom of the tank sufficient to satisfy the NPSH of the pump. Generally speaking, the height of the operating liquid level is 4 to 5 feet above the center line of the pump impeller. As a guideline, the tank should be filled so the level is halfway up in the gauge glass. The motor on the pump should be jogged to establish that the pump is rotating in the correct direction (if the rotation is wrong, reverse any two of the three motor leads and recheck). When the condensing fluid starts flowing, turn on the motor and observe the level controller and valve operation to make sure all are functioning properly. If the condensing fluid level rises out of sight in the gauge glass, decrease the condensing fluid quantity until the level is established. When the level is steady, check the flow rate to make sure the design flow is present. Check the instruction book included with the pump/motor for detailed instructions and review the pump curve for capacity.

3.2 Shutdown

Make sure all equipment upstream of the condenser has been turned off and then proceed to close the condensing fluid supply valve. For low level style barometric condensers, the power to the motor should be disconnected at the same time. If the equipment is to be shut off for an extended period of time, the unit should be thoroughly drained and protected against freezing, if necessary.

SECTION IV - TROUBLESHOOTING

4.1 General Information

Barometric condensers are fairly easy to analyze. The items that should be thoroughly checked are as follows:

A) Condensing fluid quantity
B) Condensing fluid inlet temperature
C) Partially plugged or worn spray devices
D) Leaky tailpipe
E) Insufficient tailpipe length or improper installation
F) Partially plugged vapor inlet

SECTION V - OPERATOR'S MAINTENANCE

Every 12 Months: Remove, clean and inspect strainers if present. Inspect spray devices and general internal appearance for wear or plugging.

SECTION VI - REPAIR AND REPLACEMENT ORDERS

When it is necessary to obtain spare parts, please address your communication to:

GRAHAM CORPORATION
20 Florence Avenue
Batavia, New York 14020

Telephone:	716 / 343-2216
Spare Parts:	800 / 828-8150
Fax:	716 / 343-1097
E-MAIL:	equipment@graham-mfg.com
WEBSITE:	http://www.graham-mfg.com

IMPORTANT - The following information should be given in order to identify the spare parts required:

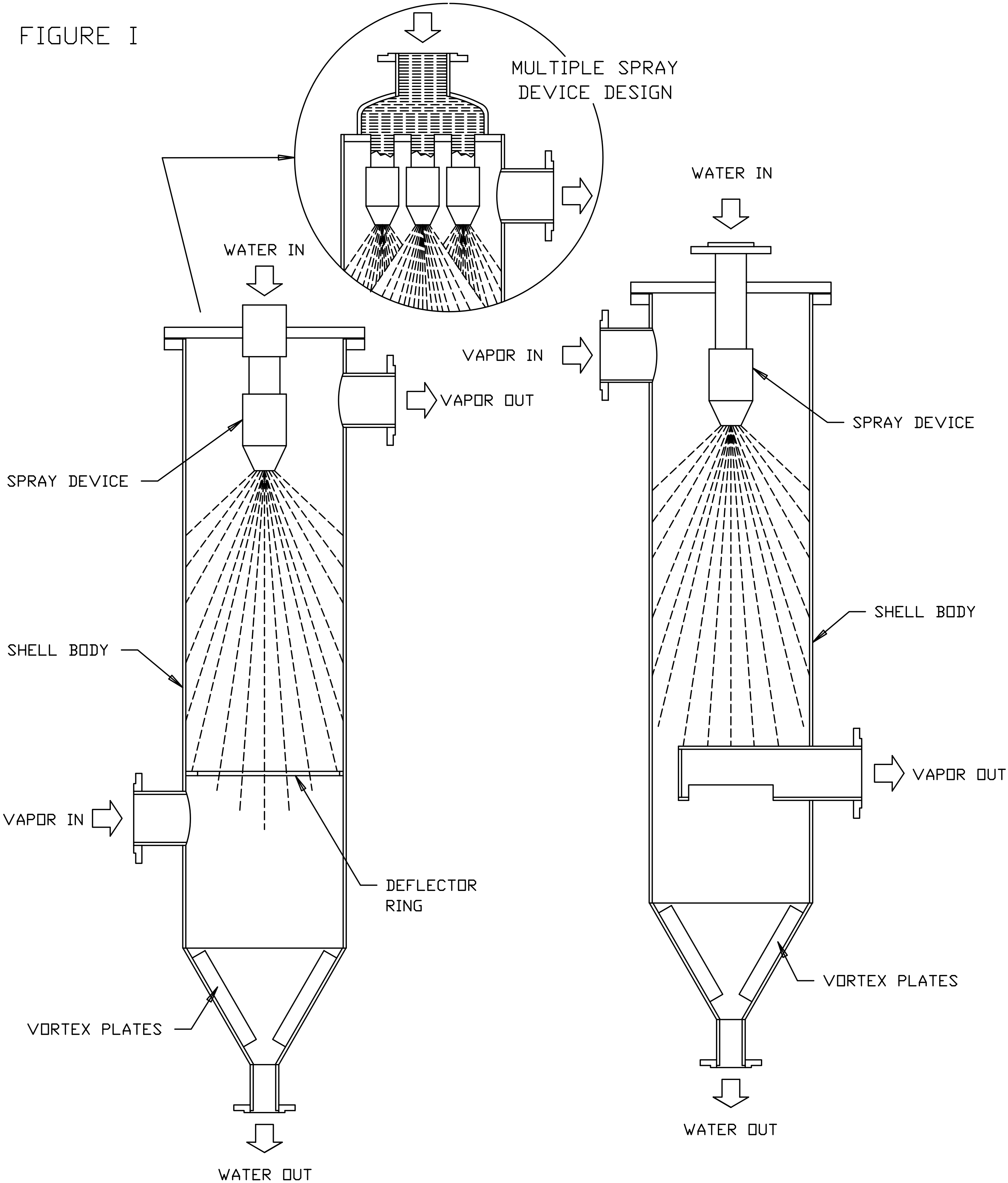
1. Serial number of unit (stamped on nameplate).

2. Name or description of part required.

3. Method of shipment (i.e. freight, express, etc.).

Graham Corporation presents the information in this manual as good engineering practice. We cannot be held responsible for any damage to equipment that may result from mal-operation nor for any personal injury should they occur during normal or abnormal operation.

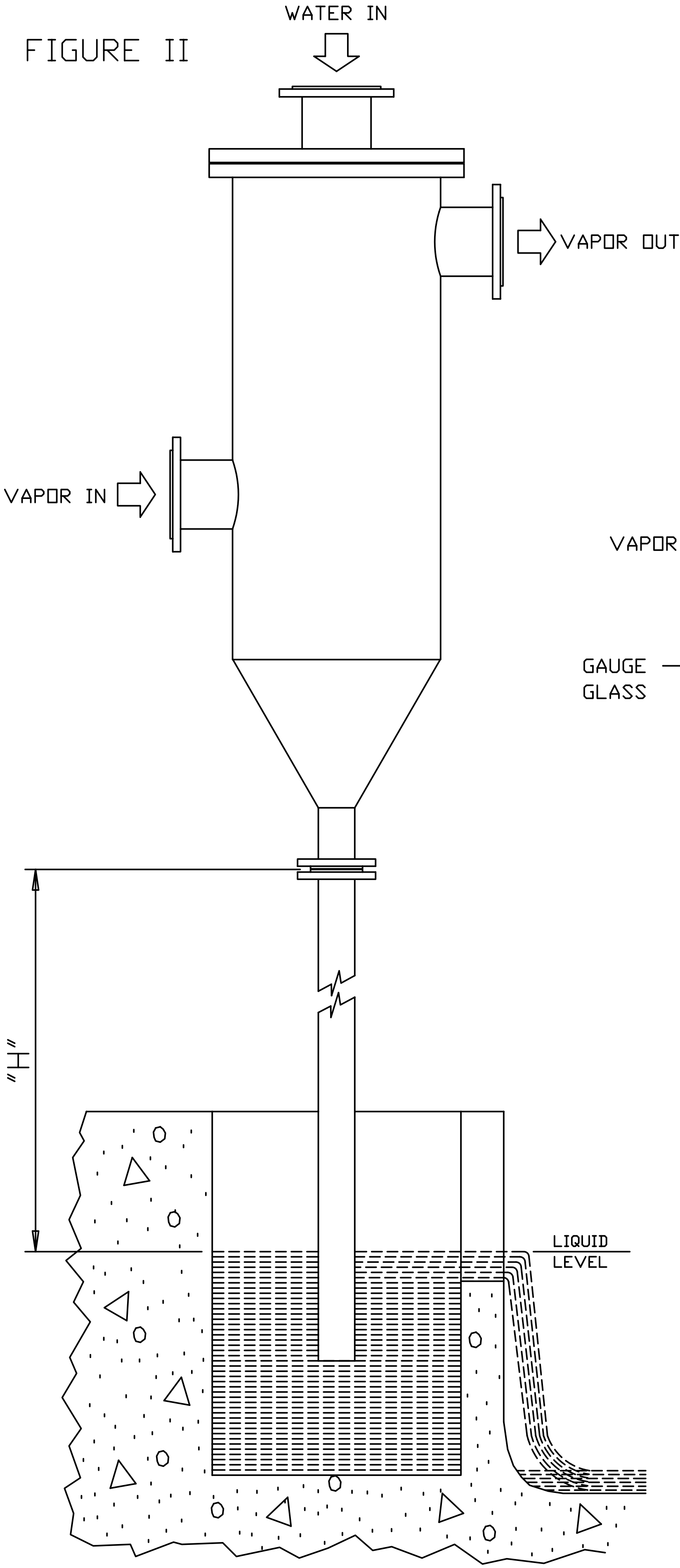
FIGURE I

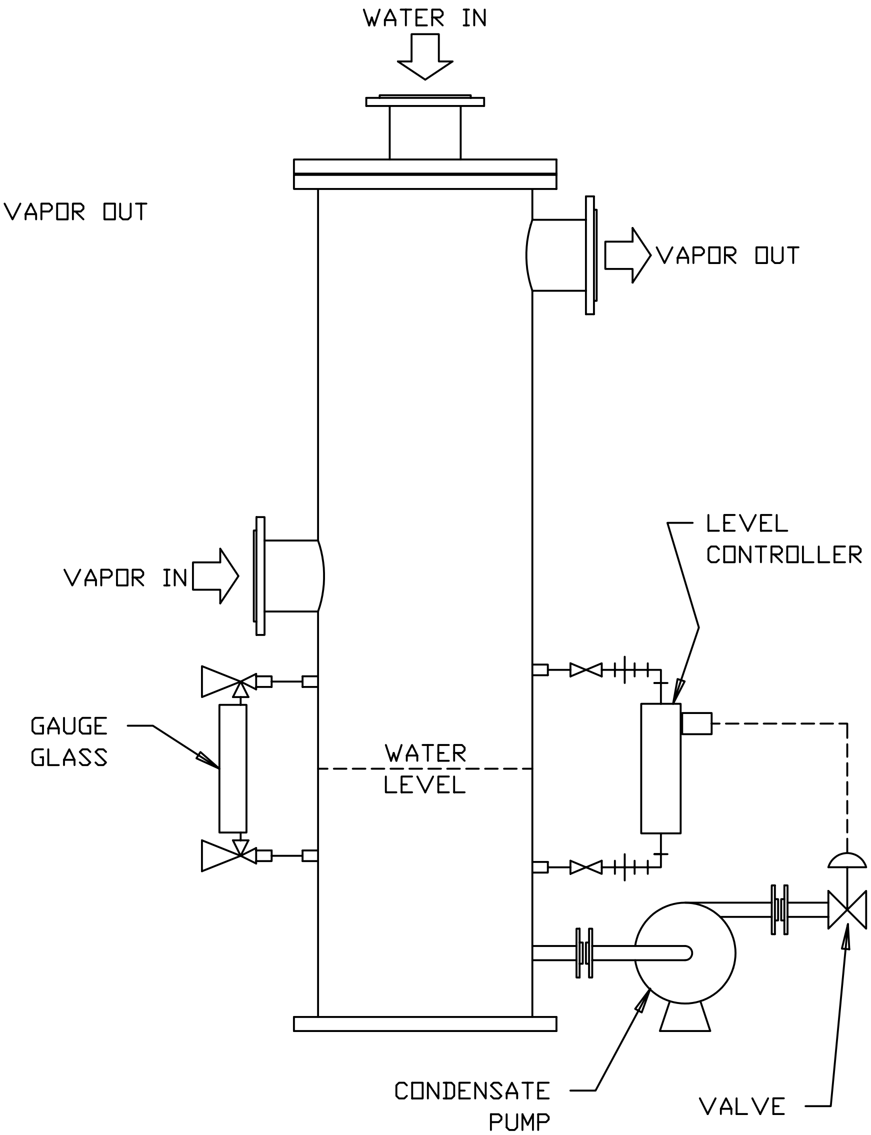


COUNTER FLOW
DESIGN

PARALLEL FLOW
DESIGN

FIGURE II



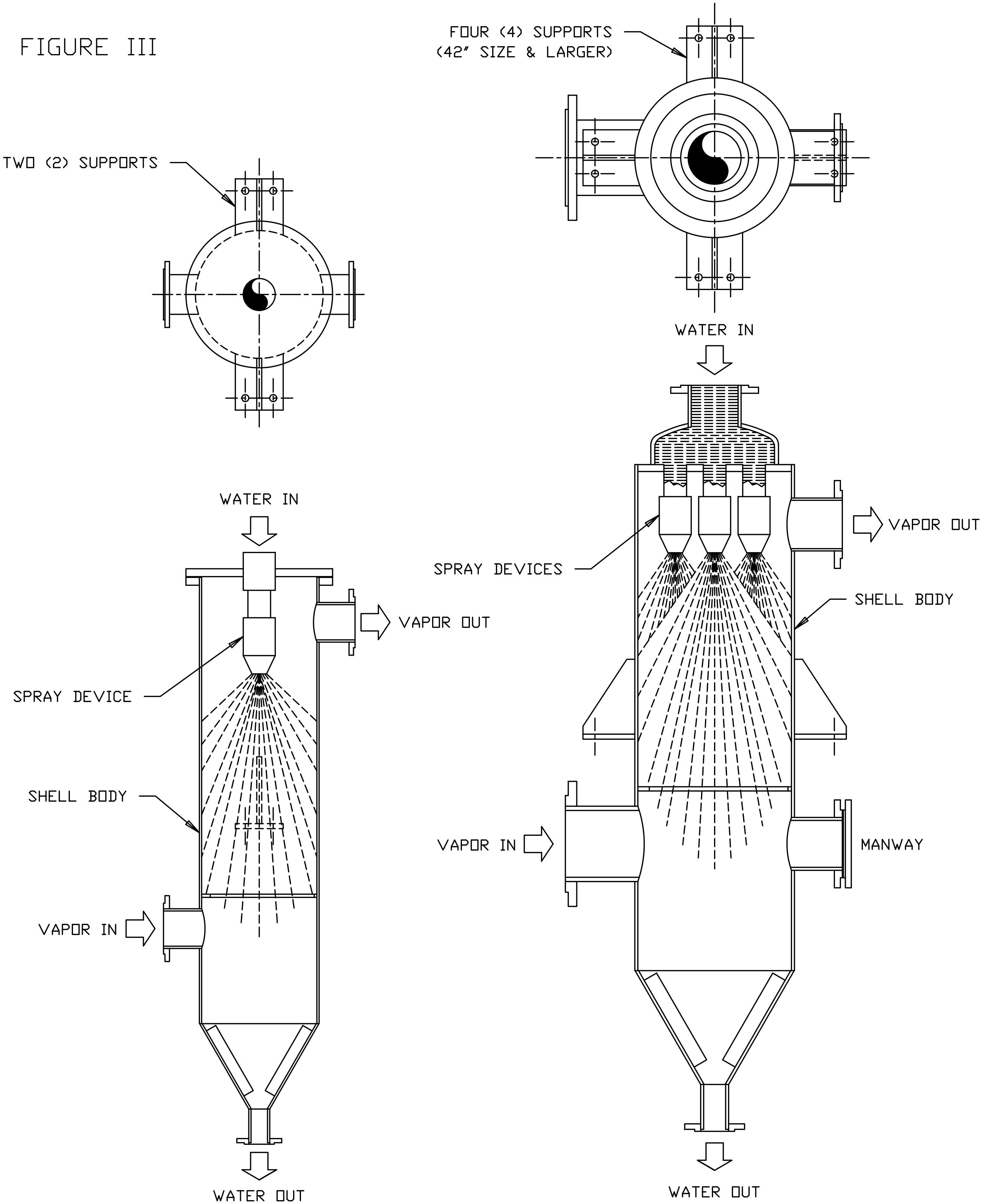


LOW LEVEL BAROMETRIC

RECOMMENDED MINIMUM EFFECTIVE
HEIGHT (H) OF TAILPIPE

MAXIMUM BAROMETRIC PRESSURE INCHES OF MERCURY @ 32°F	"H" HEIGHT IN FEET (WATER @ 32°F)
31	35.2
30	34.0
29	32.9
28	31.7
27	30.6
26	29.5
25	28.4
24	27.2
23	26.1

FIGURE III



24" SIZE & LARGER

26" SIZE & LARGER

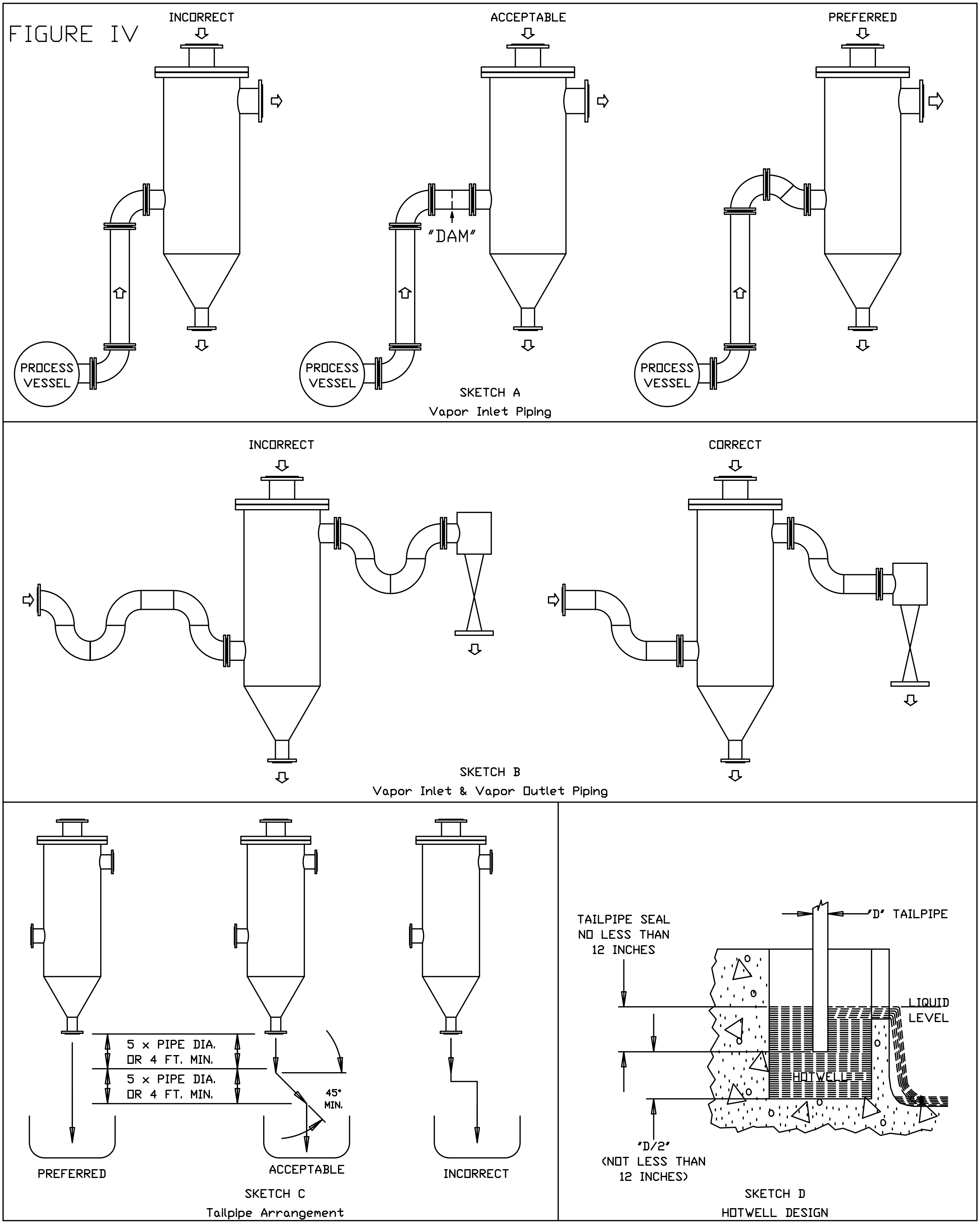


FIGURE IV
INCORRECT
ACCEPTABLE
PREFERRED
"DAM"
PROCESS VESSEL
PROCESS VESSEL
PROCESS VESSEL
SKETCH A
Vapor Inlet Piping
INCORRECT
CORRECT
SKETCH B
Vapor Inlet & Vapor Outlet Piping
5 x PIPE DIA. OR 4 FT. MIN.
5 x PIPE DIA. OR 4 FT. MIN.
45° MIN.
PREFERRED
ACCEPTABLE
INCORRECT
SKETCH C
Tailpipe Arrangement
TAILPIPE SEAL NO LESS THAN 12 INCHES
"D" TAILPIPE
LIQUID LEVEL
HOTWELL
"D/2" (NOT LESS THAN 12 INCHES)
SKETCH D
HOTWELL DESIGN