Specification for Oil and Gas Separators

API SPECIFICATION 12J
EIGHTH EDITION, OCTOBER 2008

EFFECTIVE DATE: APRIL 1, 2009

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Upstream Segment

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Specification for Oil and Gas Separators

1 Scope

1.1 General

This specification covers minimum requirements for the design, fabrication, and shop testing of oil-field type oil and gas separators and/or oil-gas-water separators used in the production of oil and/or gas, and usually located but not limited to some point on the producing flowline between the wellhead and pipeline. Separators covered by this specification may be vertical, spherical, or single or double barrel horizontal.

Unless otherwise agreed upon between the purchaser and the manufacturer, the jurisdiction of this specification terminates with the pressure vessel as defined in the Scope of Section VIII, Division 1 of the ASME *Boiler and Pressure Vessel Code*, hereinafter referred to as the ASME Code. Pressure vessels covered by this specification are normally classified as natural resource vessels by API 510, *Pressure Vessel Inspection Code*. Separators outside the scope of this specification include centrifugal separators, filter separators, and de-sanding separators.

1.2 Compliance

Any manufacturer producing equipment or materials represented as conforming with an API specification is responsible for complying with all the provisions of that specification. API does not represent, warrant or guarantee that such products do in fact conform to the applicable API standard or specification.

2 Definitions

The separation of gas and liquids primarily relies on physical differences in the phases. This section covers mechanical separation of liquids and gases. A separator vessel may be referred to as a knockout, trap, scrubber, flash chamber, or expansion vessel as well as the original term. This terminology is applied regardless of shape. Generally, the following definitions are regarded as basic.

2.1
corrosion
The destruction of a metal by chemical or electrochemical reaction with its environment (see Annex B).

2.2
free water knockout
A type of separator vessel used to separate free water from a flow stream of gas, oil, and water.

NOTE The gas and oil usually leave the vessel through the same outlet to be processed by other equipment. The water is removed for disposal.

2.3
maximum allowable working pressure
MAWP
The maximum pressure, permissible by the ASME Code, at the top of the separator in its normal operating position for a designated temperature.

2.4
operating pressure
The pressure in the vessel during normal operation, not to exceed the MAWP, and usually kept at a suitable level below the setting of the pressure relieving devices to prevent frequent opening (see Annex A).

2.5
scrubber

A type of separator which has been designed to handle flow streams with unusually high gas-to-liquid ratios, commonly used in conjunction with dehydrators, extraction plants, instruments, or compressors for protection from entrained liquids.

2.6
separator
A vessel used in the field to remove wellstream liquid(s) from gas components that may be either two-phase which remove the total liquid from the gas or three-phase which also remove free water from the hydrocarbon liquid.

2.7
total liquid knockout
A type of separator vessel used to remove the combined liquids from a gas stream.

3 Material

3.1 ASME Code

Separators furnished to this specification shall conform to the material requirements stipulated in the latest edition of the ASME Code.

3.2 Selection

Material selection for corrosive fluids should be selected based on a review of related API or NACE publications for materials that conform to 3.1. Consideration should be given to material selection as it relates to weight loss, sulphide stress cracking, chloride stress cracking, or other forms of corrosion. It is the responsibility of the user to determine what consideration for corrosion should be made to the vessel during its intended life (reference ASME Code, as applicable to corrosion). Corrosion guidelines are given in Annex B.

3.3 Corrosion Consideration

Corrosion consideration for separators furnished to this specification shall be for the pressure containing parts of the vessel only, and as can be identified as falling within the requirements of the applicable sections of the ASME Code. Corrosion considerations for vessel internals (non-pressure parts) is by mutual agreement between the purchaser and the manufacturer and not a part of this specification.

4 Design

4.1 Type, Size, Pressure and Temperature Ratings

Separators furnished to this specification may be vertical, horizontal, or spherical, and are available in sizes and MAWP ratings shown in Table 1, Table 2, and Table 3. The following tables are for nominal industry standards. Available sizes and working pressures may vary from the stated ratings. Other sizes, pressure, and temperature ratings may be furnished by agreement between purchaser and manufacturer.

4.2 Process Design and Sizing

Typical process design and sizing calculations are given in Annex C.

4.3 Design Checklist

A suggested checklist of separator design information is included in Annex E.

Table 1—Horizontal Separators Size and Working Pressure Ratings

Nominal Diameter in.	Maximum Allowable Working Pressure psig @ 130°F						
12 3/4	—	230	600	1,000	1,200	1,440	2,000
16	—	230	600	1,000	1,200	1,440	2,000
20	125	230	600	1,000	1,200	1,440	2,000
24	125	230	600	1,000	1,200	1,440	2,000
30	125	230	600	1,000	1,200	1,440	2,000
36	125	230	600	1,000	1,200	1,440	2,000
42	125	230	600	1,000	1,200	1,440	2,000
48	125	230	600	1,000	1,200	1,440	2,000
54	125	230	600	1,000	1,200	1,440	2,000
60	125	230	600	1,000	1,200	1,440	2,000

NOTE 1 Shell length is generally expanded in 2 1/2-ft increments measured from head seam to head seam and is typically 5 ft, 7 1/2 ft, or 10 ft. A minimum length-to-diameter ratio of 2.0 is normally used.

NOTE 2 Vessel diameter is generally expanded in 6-in. increments, measured either as outside diameter (OD) or inside diameter (ID). OD separators are normally furnished up to 24-in. diameter. Separators above this size may be either OD or ID vessels.

Table 2—Vertical Separators Size and Working Pressure Ratings

Nominal Diameter in.	Maximum Allowable Working Pressure psig @ 130°F						
16	—	230	600	1,000	1,200	1,440	2,000
20	125	230	600	1,000	1,200	1,440	2,000
24	125	230	600	1,000	1,200	1,440	2,000
30	125	230	600	1,000	1,200	1,440	2,000
36	125	230	600	1,000	1,200	1,440	2,000
42	125	230	600	1,000	1,200	1,440	2,000
48	125	230	600	1,000	1,200	1,440	2,000
54	125	230	600	1,000	1,200	1,440	2,000
60	125	230	600	1,000	1,200	1,440	2,000

NOTE 1 Shell length is generally expanded in 2 1/2-ft increments measured from head seam to head seam and is typically 5 ft, 7 1/2 ft, or 10 ft. A minimum length-to-diameter ratio of 2.0 is normally used.

NOTE 2 Vessel diameter is generally expanded in 6-in. increments, measured either as outside diameter (OD) or inside diameter (ID). OD separators are normally furnished up to 24-in. diameter. Separators above this size may be either OD or ID vessels.

4.4 Sample Calculation

Annex D gives an example calculation for separator sizing.

5 Fabrication, Testing, and Painting

5.1 Fabrication

Separators shall be shop constructed, tested, and stamped in accordance with the latest edition of ASME Code. Additional testing for internal or external leaks may be required by agreement between the purchaser and manufacturer.

Table 3—Spherical Separators Size and Working Pressure Ratings

Nominal Outside Diameter, in.	Maximum Allowable Working Pressure psig @ 130°F						
24	—	230	600	1,000	1,200	1,440	2,000
30	—	230	600	1,000	1,200	1,440	2,000
36	—	230	600	1,000	1,200	1,440	2,000
41	125	230	600	1,000	1,200	1,440	2,000
42	125	230	600	1,000	1,200	1,440	2,000
48	125	230	600	1,000	1,200	1,440	2,000
54	125	230	600	1,000	1,200	1,440	2,000
60	125	230	600	1,000	1,200	1,440	2,000

5.2 Painting

Before shipment, separators shall be cleaned of rust, grease, scale, and weld spatter, and externally coated with one application of a good grade of commercial metal primer. Internal coating and finish coating shall be applied if so agreed upon between the purchaser and manufacturer. Special access may be required to adequately apply internal coatings to smaller diameter vessels.

5.3 Internal Coating

Where internal coating is specified by the purchaser, all non-removable internal attachments shall be seal welded and prepared for coating in accordance with the purchaser's specifications. In the absence of purchaser's specifications, some acceptable practices are listed in Annex B. After coating, the vessel shall be stenciled in a conspicuous location "Internal Coating—Do Not Weld."

5.4 Preparation for Shipment

Prior to shipment, all foreign matter (including hydro-test water) shall be removed from the vessel, both internally and externally. All openings shall be protected with shipping covers or plugs.

6 Marking

6.1 API Nameplate

Separators furnished to this specification shall be identified by a nameplate of corrosion resistant material securely attached to a suitable bracket welded to the shell, or stamped on a steel nameplate seal welded to the shell. The nameplate shall bear the information in items 1 through 9 below, as shown in Figure 1.

1) Specification 12J.

2) Manufacturer's name.

3) Manufacturer's serial number.

4) Year built.

5) Weight, empty, in pounds.

6) Shell size, OD × length.

7) Maximum allowable working pressure, in pounds per square inch, at maximum design temperature, in degrees Fahrenheit. Also, minimum temperature if required by the ASME Code or specified by the purchaser.

8) Additional information required by state or other political subdivision regulations.

9) Additional markings desired by the manufacturer or requested by the purchaser are not prohibited.

Manufactured in Accordance with API Specification 12J

Manufacturer ______________________________

Serial Number ______________________________

Year Built ______________________________

Weight Empty ______________________________ lb

Shell Size ____________________ OD (in ft) × length (in ft)

Max Working Pressure ____________ psi at ________ °F

____

____

____

Figure 1—Separator Nameplate Format

6.2 ASME Code Nameplate

Separators furnished to this specification shall have a nameplate affixed to the vessel as required by the latest edition of the ASME Code. In lieu of a separate API nameplate and at the discretion of the manufacturer, the information required by 6.1 may be included below the ASME Code required marking on the ASME Code nameplate.

6.3 Stamping

Stamping directly on the separator shell may be injurious and should be avoided. See ASME Code for allowable stamping.

7 Inspection and Rejection

7.1 ASME Code Inspection

The authorized inspector required by the ASME Code shall make all inspections specifically required by the Code plus such other inspections believed necessary to certify that all vessels authorized to be stamped with the Code symbol meet all of the applicable requirements of the Code. The authorized inspector shall sign the Certificate of Inspection on the manufacturer's data report when the vessel, to the best of the inspector's knowledge and belief, is complete and in compliance with all the provisions of the Code.

7.2 Inspection Notice

Where additional inspection is required by the purchaser, the extent of such inspection should be stated on the purchase order. Where the inspector representing the purchaser desires to inspect separators purchased or witness any specification tests or evaluate the results of any nondestructive examinations, the manufacturer shall give reasonable notice of the time at which such inspections should be made.

7.3 Inspection by Purchaser

While work on the contract of the purchaser is being performed, the inspector representing the purchaser shall have free entry at all times to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford, without charge, all reasonable facilities to satisfy the inspector that the material is being manufactured in accordance with this specification. All inspections shall be made at the place of manufacture prior to shipment unless otherwise specified on the purchase order, and shall be so conducted as not to interfere unnecessarily with the manufacturer's operations.

7.4 Rejection

Material which shows injurious defects on initial inspection or subsequent to acceptance at manufacturer's works, or which proves defective when properly applied in service, may be rejected, and the manufacturer so notified. If tests that require the destruction of material are made at other than the place of manufacture, the purchaser shall pay for material complying with all of the provisions of this specification, but shall not pay for any material which fails to meet the specifications.

7.5 Compliance

The manufacturer shall be responsible for complying with all the provisions of this specification. The purchaser may make any investigation necessary to be assured of compliance by the manufacturer and may reject any material that does not comply with this specification.

Annex A
(informative)

Process Considerations

A.1 General

This annex provides a general discussion of the functional requirements of oil and gas separators and their controls as used in this specification.

A.2 Separator Components

The function of a separator is to provide removal of free gas from oil and/or water at a specific pressure and temperature. For efficient and stable operation over a wide range of conditions, a gas-liquid separator normally has the following features.

A.2.1 Primary Separation Section

This specification is for removing the bulk of the liquid in the inlet stream. Liquid slugs and large liquid particles are removed first to minimize gas turbulence and re-entrapment of liquid particles in preparation for the second step of separation. To do this, it is usually necessary to absorb the momentum and change the direction of flow by some form of inlet baffling.

A.2.2 Secondary Separation Section

The major separation principle in this section is gravity settling of liquid from the gas stream after its velocity has been reduced. The efficiency of this section depends on the gas and liquid properties, particle size and degree of gas turbulence. Some designs use internal baffling to reduce turbulence and to dissipate foam. The baffles may also act as droplet collectors.

A.2.3 Liquid Accumulator Section

The liquid(s) is (are) collected in this section. The liquid should have a minimum of disturbance from the flowing gas stream. Sufficient capacity is necessary to allow for surges and to provide the retention time necessary for efficient separation of gas breaking out of solution and separation of free water from oil in three-phase separators. A vortex breaker may be located over the liquid outlet nozzle(s) to prevent gas or oil entrapment with the bottom liquid.

A.2.4 Mist Extraction Section

The mist extractor of the coalescing section can be one of several designs (a series of vanes, woven wire mesh pad or a centrifugal device). The mist extractor removes from the gas stream the small droplets (normally down to 10 micron diameter) of liquid before the gas leaves the vessel. Liquid carryover is normally less than 0.1 gallon per MMSCF.

A.2.5 Process Controls

The operating pressure may be controlled by a weight loaded, spring loaded, or pilot operated gas back pressure valve. Where the gas is being delivered to a pipeline, the minimum separator pressure is usually set by the transmission or gathering system pressure. Separators should be equipped with one or more liquid level controls. Usually a liquid level control for the liquid accumulation section of two-phase separators activates a liquid dump valve to maintain the required liquid level. Two liquid level control systems are normally used for three-phase separators. Internal weirs and baffles are used in conjunction with these liquid level controls. Separators are equipped with gauge glasses or sight glasses to indicate one or two levels. A pressure gauge and thermometer well are usually installed on separators.

A.2.6 Relief Devices

All separators, regardless of size or pressure, shall be provided with pressure protective devices and set in accordance with ASME Code requirements. Multiple pressure relieving devices such as a pressure relief valve in conjunction with a rupture disk may be used to provide the necessary relieving capacity. The relief valve is normally set at the MAWP. The rupture disk is normally selected to relieve above the set pressure of the relief valve. The pressure relief devices need not be provided by the separator manufacturer, but over-pressure protection shall be provided prior to placing the separator in service. The purchaser should determine who has the responsibility to furnish relief devices.

A.2.7 Discharge Lines

Discharge lines from pressure relief devices should receive consideration on an individual basis. A detailed discussion is beyond the scope of this standard. Recommendations for discharge line consideration may be obtained from *Appendix M, Installation and Operation*, of the ASME Code as well as API 520 and API 521.

A.2.8 Other Controls and Accessories

When specified by the purchaser, separators may be equipped with other controls and accessories such as the following:

a) inlet shut-in valve;

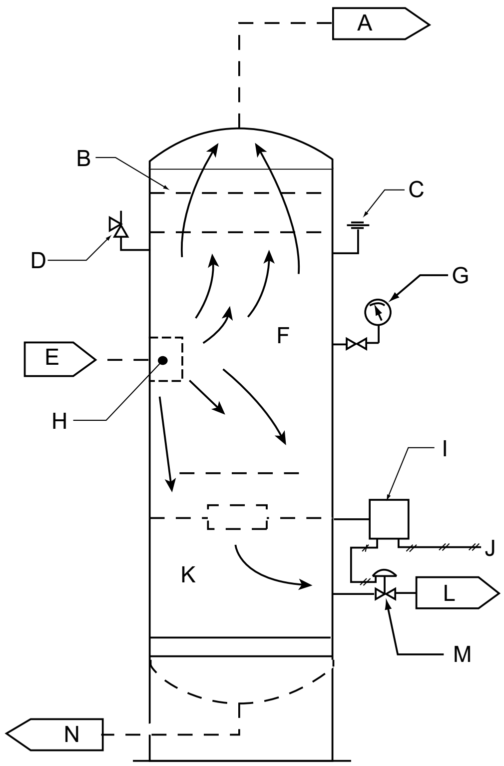
b) pressure sensor or control;

c) level sensor or control;

d) temperature sensor or control.

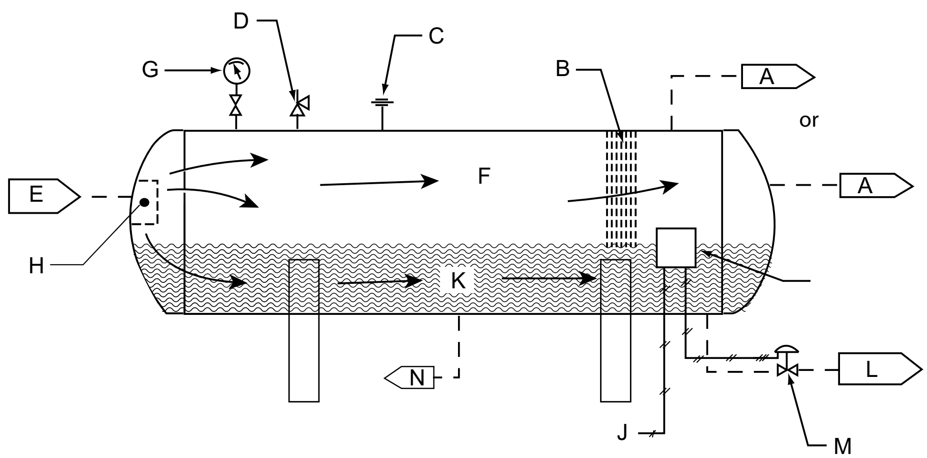
A.3 Separator Shapes

There are three different shapes of separators: vertical, horizontal, and spherical. The four main components are located differently in the various vessels. Figure A.1 and Figure A.2 give typical two-phase separator configurations for vertical, horizontal, and spherical separators.



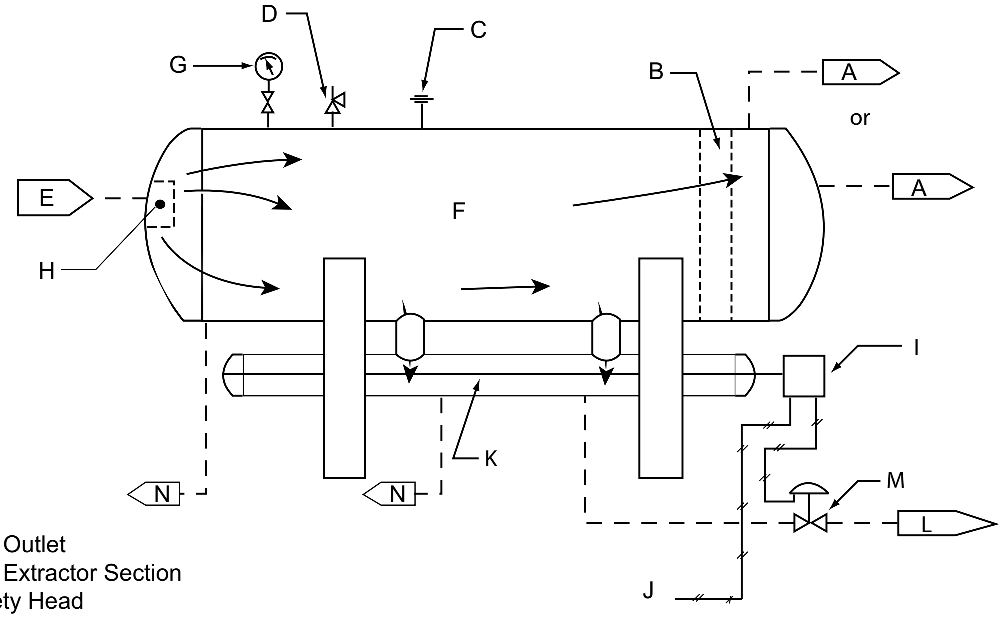
A. Gas Outlet
B. Mist Extractor Section
C. Safety Head
D. Relief Valve
E. Inlet
F. Secondary Separation Section
G. Pressure Gauge
H. Primary Separation Section
I. Liquid Level Control
J. Instrument Gas Supply
K. Liquid Collection Section
L. Liquid Outlet
M. Control Valve
N. Drain

Vertical Two-phase Separator



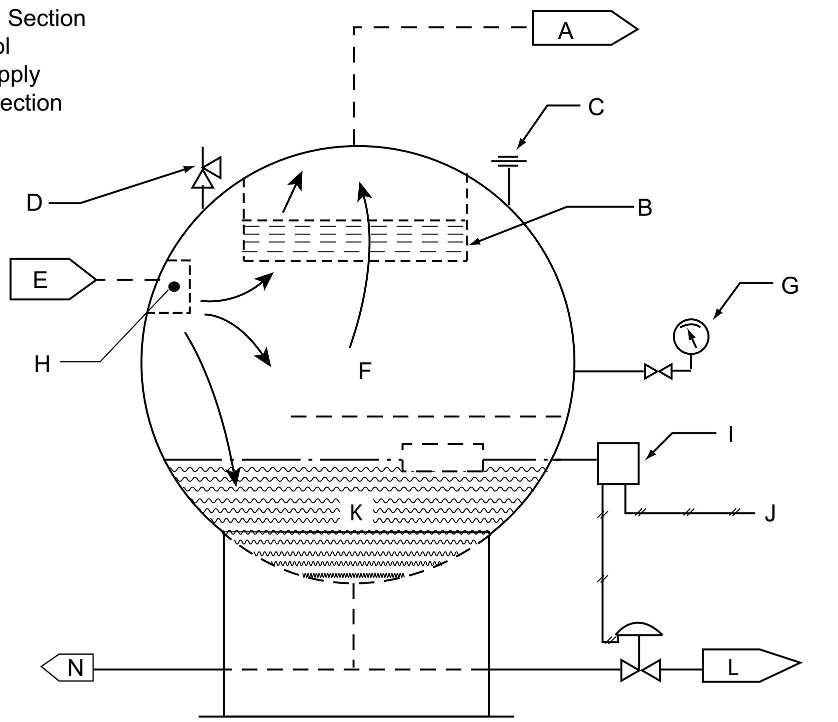
Horizontal Two-phase Separator

Figure A.1—Two-phase Separator Configurations



Horizontal Two-phase Double Barrel Separator

A. Gas Outlet
B. Mist Extractor Section
C. Safety Head
D. Relief Valve
E. Inlet
F. Secondary Separation Section
G. Pressure Gauge
H. Primary Separation Section
I. Liquid Level Control
J. Instrument Gas Supply
K. Liquid Collection Section
L. Liquid Outlet
M. Control Valve
N. Drain



Spherical Two-phase Seperator

Figure A.2—Two-phase Separator Configurations

Annex B
(informative)

Corrosion Guidelines

B.1 Considerations

The following guidelines are recommended for determining corrosion considerations for an applicable vessel.

Well streams that contain water as a liquid and any or all of the following gases are considered to be corrosive and are due consideration under these specifications (see API 14E, ASME Code, and NACE MR 0175):

a) oxygen—O_2;

b) carbon dioxide—CO_2;

c) hydrogen sulfide—H_2S.

The following guidelines are not mandatory but may be used to judge the extent of the corrosive environment, with respect to carbon steels.

a) Oxygen:

1) less than 0.005 ppm in natural brine—non-corrosive;

2) from 0.005 ppm to 0.025 ppm requires consideration;

3) greater than 0.025 ppm in natural brine—corrosive.

b) Carbon dioxide:

1) less than 600 ppm in natural brine—non-corrosive;

2) from 600 ppm to 1200 ppm requires consideration;

3) greater than 1200 ppm in natural brine—corrosive.

c) Hydrogen sulfide.

1) No lower limit of hydrogen sulfide has been identified as being non-corrosive. With hydrogen sulfide presence, the environment should be considered corrosive.

2) NACE MR 0175 (latest edition) should be used for all cases of hydrogen sulfide content for judgment of the possibility of sulfide stress cracking (SSC) and is extracted as follows: “Systems operating below 65 psia total pressure or below 0.05 psi H_2S partial pressure are outside the scope of this standard.”

Should alloy steel or stainless steel be used, other forms of corrosion should be considered such as, but not limited to, chloride stress cracking.

Some of the other factors that influence corrosion in a given vessel include: temperature, pressure, fluid velocities, metal stress and heat treatment, vessel surface condition, and time.

B.2 Corrosive Environment Practices

If the environment is judged as being subject to SSC from the criteria of NACE MR 0175 as stated in B.1.2 above, then all provisions of this NACE standard as apply to the vessel materials and construction shall be followed.

If the environment is judged as corrosive from any of the other criteria stated in B.1.2 above, the intent of this specification will be met provided any one or combination of the following practices are used.

a) An allowance for corrosion to the vessel parts may be made according to the ASME Code, *Appendix E*, *Suggested Good Practices Regarding Corrosion Allowances*.

b) Either sacrificial or impressed current anodes may be used, providing that the area of the corrosion attack can physically be protected by use of these anodes (see NACE RP 0575).

c) Corrosion effects may be controlled with holiday-free internal coatings on all exposed metal surfaces. NACE RP 0181 and NACE RP 0178 present guidelines and procedures for coating vessels such as oil and gas separators.

d) Corrosion effects may be disregarded provided they can be shown to a negligible or entirely absent on a historical basis. However, the system should be monitored periodically for possible new corrosion (see API 510).

e) Corrosion effects may be reasonably controlled with chemical inhibitor treatments.

Post weld heat treatment is recommended for carbon steel vessels for use in acid gas (containing hydrogen sulfide and/or carbon dioxide) service. Post weld heat treatment may be required by ASME Code regardless of corrosion considerations.

Annex C
(informative)

Design and Sizing Calculations

C.1 Sizing of Two-phase Oil-gas Separators

The following calculations are presented as a guide to the design and sizing of two-phase and three-phase separators. Sizing should be based on the maximum expected instantaneous rate.

C.1.1 Theory and Equation

Gas capacities of separators may be determined by a modification of Stokes' Law. When using Stokes' Law, the capacity is based on the principle of the minimum droplet size that will settle out of a moving gas stream at a given velocity. The maximum allowable superficial velocity of the gas at operating conditions is calculated by the following equation (see Annex D for separator sizing example calculation):

$$V_a = K\sqrt{\frac{d_L - d_G}{d_G}} \qquad \text{(C.1)}$$

where

V_a is the maximum allowable superficial velocity in ft/s through the secondary separation section;

d_L is the density of the liquid in lb/ft^3 at operating conditions;

d_G is the density of the gas in lb/ft^3 at operating conditions;

K is a constant, depending upon design and operating conditions.

Table C.1—K-factors for Determining Maximum Allowable Superficial Velocity

Type Separator	Height or Length L (ft)	Typical K-factor Range
Vertical	5 10	0.12 to 0.24 0.18 to 0.35
Horizontal	10 Other Lengths	0.40 to 0.50 0.40 to 0.50 × $(L/10)^{0.56}$
Spherical	All	0.2 to 0.35

The maximum allowable superficial velocity, calculated form the above factors, is for separators normally having a wire mesh mist extractor. This rate should allow all liquid droplets larger than 10 microns to settle out of the gas. The maximum allowable superficial velocity or other design criteria should be considered for other type mist extractor. Mist extractor manufacturer's recommended minimum distances upstream and downstream of the wire mesh between gas inlet and outlet nozzles should be provided for full utilization of the mist extractor.

C.1.2 Oil Capacity

The oil capacity of a separator is a function of retention time and gas-oil interface area. The basic requirement is to retain the oil long enough and provide sufficient interface area for entrained gas to break out of the oil. Separator liquid capacity is normally based on one minute retention time for non-foaming oils having a gravity of 35° API and above. A gravity lower that 35° API may require a greater retention time.

C.1.3 Foam

Foaming crudes offer a special problem in sizing separators. Foam is a mixture of gas dispersed in a liquid and having a density less than the liquid but greater than the gas. Greater interface area and longer retention time are needed to remove the gas from the liquid. Horizontal separators normally give the largest interface area. Retention times of as high as 15 minutes may be necessary. However, a retention time of 2 to 5 minutes is sufficient in most cases for the separators to handle foaming crudes. Where the well can be sampled in a test unit, a more accurate estimate of the required retention time can be determined. Defoaming separator designs often include a variety of proprietary internal configurations to improve capacity. These are beyond the scope of this specification.

C.1.4 Other Influences

In addition to the well stream properties, the gas capacity is influenced by the following:

a) operating temperature being above the cloud point of oil;

b) operating temperature being above hydrate point of gas;

c) foaming tendency of liquid;

d) uniformity of flow;

e) defoaming chemicals; if used.

C.1.5 Retention Time

The liquid capacity of a separator is primarily dependent upon the retention time of the liquid in the vessel. Good separation requires sufficient time to obtain an equilibrium condition between the liquid and gas phase at the temperature and pressure of separation. The liquid capacity of a separator or the settling volume required based on retention can be determined from the following equation:

$$W = \frac{1440(V)}{t} \text{ or } t \frac{1440(V)}{W} = \text{ or } V = \frac{W(t)}{1440} \tag{C.2}$$

where

W is the liquid capacity, bbl/day at flowing conditions;

V is the liquid settling volume, bbl;

t is the retention time, minutes.

Basic design criteria for liquid retention time in two-phase separators are generally as follows:

Oil Gravities	Minutes (Typical)
Above 35° API	1
20° – 30° API	1 to 2
10° – 20° API	2 to 4

The settling volumes may be used in the above equations to determine the liquid capacity of a particular vessel. For proper sizing, both the liquid capacity and gas capacity should be determined. It may be noted that on most high pressure gas distillate wells, the gas-oil ratio is high and the gas capacity of a separator is usually the controlling factor. However, the reverse may be true for low pressure separators used on wellstreams with low gas-oil ratios. The liquid discharge or dump valve on the separator should be sized based upon the pressure drop available, the liquid flow rate, and the liquid viscosity.

C.2 Sizing of Three-phase Gas-oil-water Separators

The basic principles of oil and gas separation have been covered under C.1. The following portion will cover the separation of free water and oil.

All of the basic separators (vertical, horizontal, spherical) may be used for three-phase separation. Regardless of shape, all three-phase vessels must meet the following requirements:

a) liquid must be separated from gas in a primary separating section;

b) gas velocity must be lowered to allow liquids to drop out;

c) gas must be scrubbed through an efficient mist extractor;

d) water and oil must be diverted to a turbulence-free section of the vessel;

e) liquids must be retained in the vessel long enough to allow separation;

f) the water-oil interface must be maintained;

g) water and oil must be removed from the vessel at their respective outlets.

Sizing a three-phase separator for water removal is mainly a function of retention time. Required retention time is related to the volume of the vessel, the amount of liquid to be handled, and the relative specific gravities of the water and oil. The effective retention volume in a vessel is that portion of the vessel in which the oil and water remain in contact with one another. As far as oil-water separation is concerned, once either substance leaves the primary liquid section, although it may remain in the vessel in a separate compartment, it cannot be considered as a part of the retention volume. There are two primary considerations in specifying retention time:

a) oil settling time to allow adequate water removal from oil;

b) water settling time to allow adequate removal of water.

The usual approach in design is to allow equal retention times for oil and water. This is accomplished with a wide range interface level controller or variable water weir. Basic design criteria for liquid retention time in three-phase separators are generally as follows:

Oil Gravities	**Minutes (Typical)**
Above 35° API	3 to 5
Below 35° API	
100 + °F	5 to 10
80 + °F	10 to 20
60 + °F	20 to 30

C.3 Separator Selection

The following procedure may be used when selecting a separator for a particular application.

a) Determine which shape fits the particular installation best considering space, mounting, and ease of access for maintenance. Both present and future operating conditions should be considered.

b) Determine whether unusual well stream conditions (foam, sand, etc.) would make the vessel selected difficult to operate or maintain.

c) Determine whether over-all economics is affected by the installation or portability of the shape selected.

d) Make certain that all design requirements such as heating coils for paraffin or hydrates and three-phasing for water removal have been considered and are compatible with the shape selected.

e) Consider possible liquid slugging of the separator.

Annex D
(normative)

Separator Sizing Example Calculation

Design Conditions:

Gas flow rate	25 MMSCFD
Oil flow rate	3,000 BPD
Operating pressure	800 psig
Operating temperature	80°F
Flowing gas density, d_G (for 20.3 mol. wt. gas)	3.40 lb/ft^3
Flowing oil density, d_L (for 40° API oil)	51.5 lb/ft^3
Separator type	Vertical, two-phase

Tentatively assume 10 ft shell height, 30% liquid full and use K value of 0.3 [see Table C.1 and Equation (C.1)].

The maximum allowable superficial velocity of the gas is:

$$V_a = K\sqrt{\frac{d_L - d_G}{d_G}} = 0.3\sqrt{\frac{51.5 - 3.4}{3.4}} = 1.128 \text{ ft/s}$$

$$\text{Actual volume flow rate of gas} = \frac{25{,}000{,}000 \text{ SCF/day} \times 20.3 \text{ lb/mol}}{379.5 \text{ SCF/mol} \times 86{,}400 \text{ s/day} \times 3.40 \text{ lb/ft}^3} = 4.552 \ \frac{\text{ft}^3}{\text{s}}$$

$$\text{Min. gas flow area} = \frac{4.552 \text{ ft}^3\text{/s}}{1.128 \text{ ft/s}} = 4.035 \text{ ft}^2$$

$$\text{Min. ID of separator} = \sqrt{\frac{4.035 \times 144}{0.7854}} = 27.2 \text{ in.}$$

Use 30-in. ID separator as next largest standard diameter. (Note that 30-in. OD might be preferable, but ID size is used here for simplicity of illustration.) Assume no less than 1-minute retention time for two-phase design with oil gravity exceeding 35° API [see C.1.7 and Equation (C.2)].

$$\text{Liquid volume, } V \text{ (excluding bottom head)} = \frac{(30)^2 \ 0.7854 \text{ in.}^2 \times 3 \text{ ft}}{144 \text{ in.}^2\text{ft}^2 \times 5.615 \text{ ft}^3\text{/bbl}} = 2.62 \text{ bbl}$$

The liquid capacity of the separator is:

$$W = \frac{1440(V)}{t} = \frac{1440 \times 2.62}{1.0} = 3{,}772 \text{ BPD}$$

Liquid capacity is satisfactory for design based on 30-in. ID × 10 ft vertical separator size.

The calculations on this page are merely examples for illustration purposes only. Each company should develop its own approach. They are not to be considered exclusive or exhaustive in nature. API makes no warranties, express or implied for reliance on or any omissions from the information contained in this document.

Annex E
(informative)

Separator Design Information

I. Operating Conditions

A. Liquid Volumes

1. Oil/Condensate ______________ bbl/day Gravity ___________ °API Viscosity ________ cp
2. Water ______________ bbl/day Sp. Gr. ___________ (Water = 1.0)

B. Oil/Condensate Characteristics

1. Foaming: Nil ___________ Moderate ___________ Severe ___________

2. Paraffin Problem: No _________ Yes _________ (if Yes, give cloud point) _________°F

3. Slug Flow: No _________ Yes _________ (if Yes, give details such as maximum liquid rate, slug volume, etc., or suggest surge factor.) ____

____

C. Gas ___________ MMSCFD Sp. Gr. _______________ (Air = 1.0)

D. Operating Temperature (°F) ____________ Max ____________ Min

E. Operating Pressure (psig) ____________ Max ____________ Min

F. H_2S Content ___________ Mole% CO_2 Content ___________ Mole%

G. Geographical Location ____

II. Design Requirements

A. Type ____________ Vertical ____________ Horizontal ____________ Spherical

Manufacturer's Recommendation ____

____________ Two-phase ____________ Three-phase

B. Design Pressure ____________ psig at Temperature ____________°F

C. Type Mist Extractor (Specify) ____

____

D. Liquid Retention Time ____

E. Corrosion Allowance _____________ (in.)

F. Corrosion Allowance for Non-pressure Internal Parts_____________ (in.)

G. NACE MR 0175 Required No ________ Yes ________

H. Special Stress Relieving No ________ Yes ________

Specify if Yes ____

____

I. API RP 14C Safety Systems Required: No ________ Yes ________

III. Coatings

A. External: Mfgr. Std ________ Other ________

Specify if Other ____

B. Internal (Specify) ____

C. Cathodic Protection (Specify) ____

____

IV. Special Instructions

A. Radiographic Inspection: ASME Code ________ Other ________

Specify if Other ____

____

____

____

B. Hydrostatic Test Pressure: ASME Code ________ Other ________

Specify if Other ____

C. Hardness Testing Requirements (Specify) ____

D. Lifting Lugs (Specify) ____

E. Skid Mounting (Specify) ____

F. Welding Requirement: ASME Code ________ Other ________

Specify if Other ____

G. Sand Removal System (Specify) ____

____

____

H. Other ____

____

____

Annex F
(informative)

Use of the API Monogram by Licensees

F.1 Scope

The API Monogram Program allows an API Licensee to apply the API Monogram to products. The API Monogram Program delivers significant value to the international oil and gas industry by linking the verification of an organization's quality management system with the demonstrated ability to meet specific product specification requirements. The use of the Monogram on products constitutes a representation and warranty by the Licensee to purchasers of the products that, on the date indicated, the products were produced in accordance with a verified quality management system and in accordance with an API product specification.

When used in conjunction with the requirements of the API License Agreement, API Q1, in its entirety, defines the requirements for those organizations who wish to voluntarily obtain an API License to provide API monogrammed products in accordance with an API product specification.

API Monogram Program Licenses are issued only after an on-site audit has verified that the Licensee conforms to the requirements described in API Q1 in total, and the requirements of an API product specification. Customers/users are requested to report to API all problems with API monogrammed products. The effectiveness of the API Monogram Program can be strengthened by customers/users reporting problems encountered with API monogrammed products. A nonconformance may be reported using the API Nonconformance Reporting System available at https://ncr.api.org. API solicits information on new product that is found to be nonconforming with API specified requirements, as well as field failures (or malfunctions), which are judged to be caused by either specification deficiencies or nonconformities with API specified requirements.

This annex sets forth the API Monogram Program requirements necessary for a supplier to consistently produce products in accordance with API specified requirements. For information on becoming an API Monogram Licensee, please contact API, Certification Programs, 1220 L Street, N. W., Washington, D.C. 20005 or call 202-962-4791 or by email at certification@api.org.

F.2 References

In addition to the referenced standards listed in Section 2 of this document, this annex references the following standard:

API Specification Q1

For Licensees under the Monogram Program, the latest version of this document shall be used. The requirements identified therein are mandatory.

F.3 API Monogram Program: Licensee Responsibilities

F.3.1 For all organizations desiring to acquire and maintain a license to use the API Monogram, conformance with the following shall be required at all times:

a) the quality management system requirements of API Q1;

b) the API Monogram Program requirements of API Q1, Annex A;

c) the requirements contained in the API product specification(s) for which the organization desires to be licensed; and

d) the requirements contained in the API Monogram Program License Agreement.

F.3.2 When an API-Licensed organization is providing an API monogrammed product, conformance with API specified requirements, described in API Q1, including Annex A, is required.

F.3.3 Each Licensee shall control the application of the API Monogram in accordance with the following.

a) Each Licensee shall develop and maintain an API Monogram Marking Procedure that documents the marking/ monogramming requirements specified by the API product specification to be used for application of the API Monogram by the Licensee. The marking procedure shall define the location(s) where the Licensee shall apply the API Monogram and require that the Licensee's License number and date of manufacture be marked on monogrammed products in conjunction with the API Monogram. At a minimum, the date of manufacture shall be two digits representing the month and two digits representing the year (e.g. 05-07 for May 2007) unless otherwise stipulated in the applicable API product specification. Where there are no API product specification marking requirements, the Licensee shall define the location(s) where this information is applied.

b) The API Monogram may be applied at any time appropriate during the production process but shall be removed in accordance with the Licensee’s API Monogram Marking Procedure if the product is subsequently found to be nonconforming with API specified requirements. Products that do not conform to API specified requirements shall not bear the API Monogram.

c) Only an API Licensee may apply the API Monogram and its License to API monogrammable products. For certain manufacturing processes or types of products, alternative Monogram marking procedures may be acceptable. The current API requirements for Monogram marking are detailed in the API Policy Document, *Monogram Marking Requirements*, available on the API Monogram Program website at http://www.api.org/certifications/monogram/.

d) The API Monogram shall be applied at the licensed facility.

e) The authority responsible for applying and removing the API Monogram shall be defined in the Licensee’s API *Monogram Marking Procedure*.

F.3.4 Records required by API product specifications shall be retained for a minimum of five years or for the period of time specified within the product specification if greater than five years. Records specified to demonstrate achievement of the effective operation of the quality system shall be maintained for a minimum of five years.

F.3.5 Any proposed change to the Licensee’s quality program to a degree requiring changes to the quality manual shall be submitted to API for acceptance prior to incorporation into the Licensee's quality program.

F.3.6 Licensee shall not use the API Monogram on letterheads or in any advertising (including company-sponsored web sites) without an express statement of fact describing the scope of Licensee’s authorization (License number). The Licensee should contact API for guidance on the use of the API Monogram other than on products.

F.4 Marking Requirements for Products

These marking requirements apply only to those API Licensees wishing to mark their products with the API Monogram.

F.4.1 Manufacturers shall mark equipment on the nameplate with the information identified in Section 6 of this specification, as a minimum, including “API Spec 12J.”

F.4.2 As a minimum, equipment should be marked with English (Imperial) units.

F.4.3 Nameplates shall be made of a corrosion-resistant material and shall be located as indication in the marking section of this specification. If the location is not identified, then F.3.3 a) of this annex shall apply.

F.4.4 Nameplates may be attached at the point of manufacture or, at the option of the manufacturer, at the time of field erection.

F.4.5 The API Monogram shall be marked on the nameplate, in addition to the marking requirements of this specification. The API Monogram License number shall not be used unless it is marked in conjunction with the API Monogram.

F.5 API Monogram Program: API Responsibilities

F.5.1 The API shall maintain records of reported problems encountered with API monogrammed products. documented cases of nonconformity with API specified requirements may be reason for an audit of the Licensee involved, (also known as audit for “cause”).

F.5.2 Documented cases of specification deficiencies shall be reported, without reference to Licensees, customers or users, to API Subcommittee 18 (Quality) and to the applicable API Standards Subcommittee for corrective actions.

Bibliography

[1] API Recommended Practice 14E, *Recommended Practice for Design and Installation of Offshore Production Platform Piping Systems*

[1] API 510, *Pressure Vessel Inspection Code: In-Service Inspection, Rating, Repair, and Alteration*

[2] API Recommended Practice 520, *Sizing, Selection, and Installation of Pressure-relieving Devices in Refineries*

[3] API Standard 521, *Guide for Pressure-relieving Systems and Depressuring Systems*

[4] NACE MR 0175 [1], S*ulfide Stress Corrosion Cracking Resistant Metallic Materials for Oil Field Equipment*

[5] NACE RP 0178, *Design, Fabrication, and Surface Finish of Metal Tanks and Vessels to be lined for Chemical Immersion Service*

[6] NACE RP 0181, *Liquid Applied Internal Protective Linings and Coatings for Oilfield Production Equipment*

[1] NACE International (formerly the National Association of Corrosion Engineers), 1440 South Creek Drive, Houston, Texas 77218-8340, www.nace.org.

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