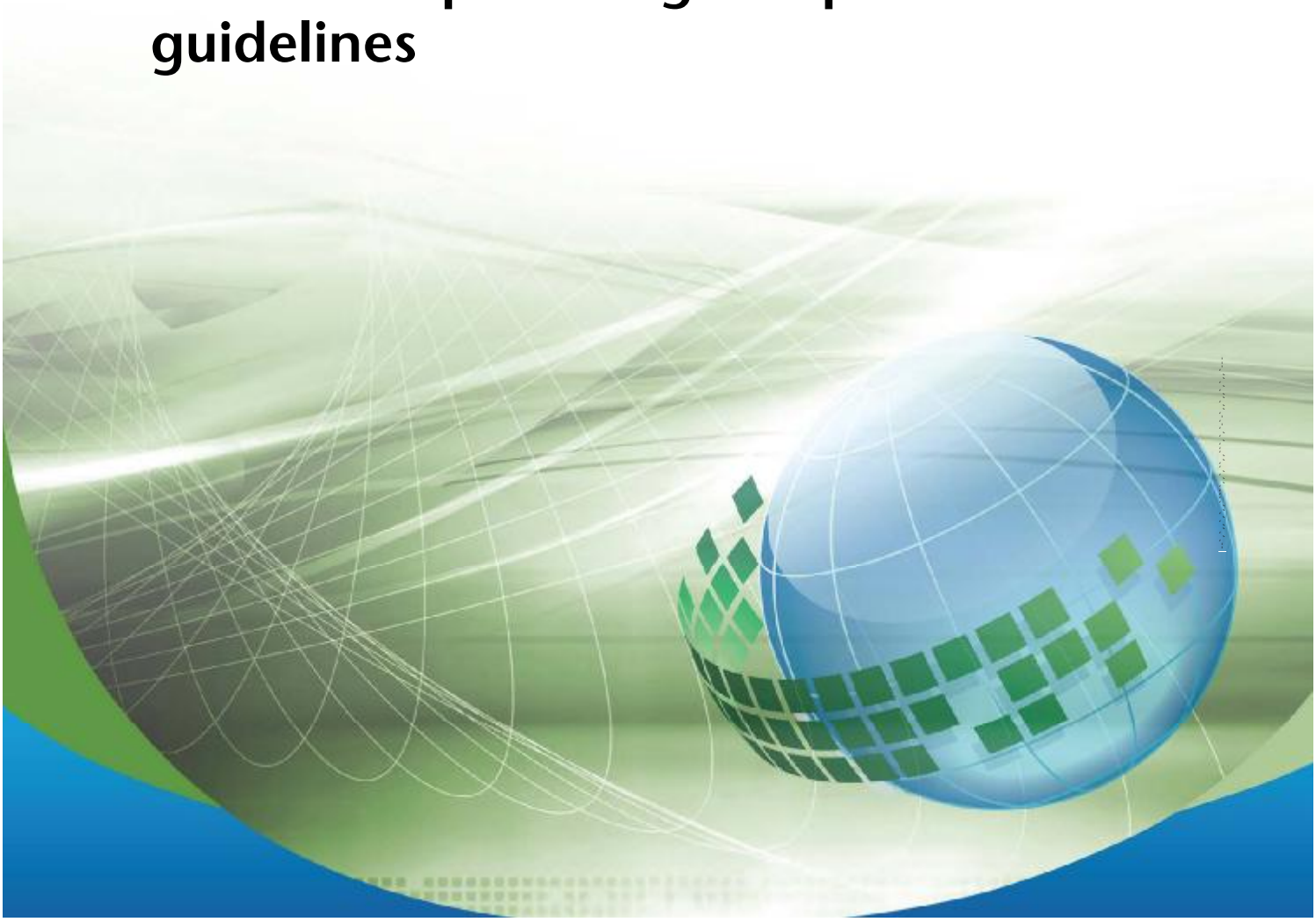
CSA Group

ANSI NGV 4.8-2012
CSA 12.8-2002
(reaffirmed 2013)

Standard for Natural gas vehicle fueling station reciprocating compressor guidelines



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AMERICAN NATIONAL STANDARD
ANSI NGV 4.8-2012

CSA 12.8-2002

Second Edition - 2012
This Standard is based on the Standard for
Natural gas vehicle fueling station
reciprocating compressor guidelines
ANSI NGV 4.8-2002 • CSA 12.8-2002

No changes from the 2002 edition were made to this document.

APPROVED

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American National Standards Institute, Inc.
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10036

Preface

The ultimate purpose for this document is that it constitute the performance standard for North America regarding fueling station reciprocating compressors applicable to dispensing natural gas to vehicles. Major funding in support of the consensus process for this Standard was provided by the Natural Gas Vehicle Coalition (NGVC), whose assistance is acknowledged with thanks.

This document is designated as being Guidelines because it presents the industry's minimum requirements for it's "best practices". It is also designated as being a Standard because of the consensus process by which it has been developed and approved. In the former instance the document has been labelled according to the type of information it contains and in the latter instance according to the levels of input, evaluation and acceptance of this information.

Portions of ANSI/NGV 4.8 • CSA 12.8 are taken from API 11P, Specification for Packaged Reciprocating Compressors for Oil and Gas Production Services, Second Edition, November, 1989 and reproduced with permission of the American Petroleum Institute (API), 1220 L Street, Northwest, Washington, D.C. 20005.

This proposed standard requires the purchaser to specify certain details. A bullet (•) in the margin indicates that information and/or a decision by the purchaser is required.

This publication represents a standard for safe operation, substantial and durable construction and performance testing of compressor packages containing reciprocating compressors for natural gas dispensing systems, within limitations given below and in the scope of this standard.

This standard is based on proven engineering principles, research and the combined expertise of gas utilities, manufacturers, users, and others having specialized experience.

Nothing in this standard is to be considered in any way as indicating a measure of quality beyond compliance with the provisions it contains. It is designed to allow compliance of products which may exceed that specified in the provisions herein. In its preparation, full recognition has been given to possibilities of improvement through ingenuity of design. This standard is subject to revision as further experience and investigation may show it is necessary and desirable.

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EFFECTIVE DATE: An organization using this standard for product evaluation as a part of its certification program will normally establish the date by which all products certified by that organization should comply with this standard.

Users of this Harmonized American National and Canadian Standards Association Standard are advised that the devices/products/activities within its scope may be subject to regulation at the Federal, state, provincial, or local levels. Users are strongly urged to investigate this possibility through appropriate channels. In the event of a conflict with this standard, the Federal, state, provincial or local regulations should be followed.

This standard does not apply to fuel system components that will be incorporated during original manufacture of motor vehicles which comply with Federal Motor Vehicle Safety Standards (FMVSS) or Canadian Motor Vehicle Safety Standards (CMVSS) for Natural Gas Powered Vehicles.

History Of Development Of ANSI NGV 4.8 • CSA 12.8

(This history is informative and is not part of the standard)

In 1988 a group of U.S. gas utilities formed the Natural Gas Vehicle (NGV) Coalition (the Coalition) to promote widespread use of compressed natural gas as a transport fuel. The Coalition organized committees to address technical, marketing and legislative issues which would affect the future expansion of a U.S. transportation industry fueled with natural gas.

The Coalition recognized that an important consideration in the successful commercialization of natural gas as a vehicle fuel was the issue of codes and standards pertaining to both fuel stations and vehicle fuel systems. The Coalition's Technology Committee was established to achieve the goal of an organized family of coordinated codes, standards and regulations addressing natural gas vehicles and fueling stations. To help achieve this goal, the Technology Committee established the Standards and Standardization Subcommittee.

During 1991, there was a growing need in the natural gas vehicle industry for guidelines pertaining to the safe assembly and operation of public compressed natural gas (CNG) dispensing equipment and related components which would fuel vehicles that operate on CNG. In response to this need the American Gas Association Laboratories (AGAL) developed A.G.A. Requirements for Compressed Natural Gas Dispensing Equipment for Vehicles, No. 2-92. AGAL also developed documents that would address related components of dispensing equipment, those are; A.G.A. Requirements for Hoses for Natural Gas Vehicles and Fuel Dispensers, No. 1-93; Manually Operated Valves for High Pressure Natural Gas, No. 2-93; Automatic, Pressure Operated Valves for High Pressure Natural Gas Service, No. 393; and Priority and Sequencing Equipment for Natural Gas Vehicle Fuelling, No. 4-93.

At the time of issuance, the aforementioned A.G.A. requirements were in compliance with NGV equipment and fueling stations specifications published by the National Fire Protection Association (NFPA) under its Standard for Compressed Natural Gas (CNG) Vehicular Fuel Systems, NFPA 52. The first edition of NFPA 52 was issued in 1984, and subsequently revised in 1988. The third edition of NFPA 52 was published in 1992, and incorporates many changes developed and recommended by the NGV Coalition's task groups.

In January of 1993, a joint meeting was held between the Coalition's Dispenser/Compressor/Inspection, and Measurement & Metering Task Groups, and the Canadian Gas Association Subcommittee's on Standards for Dispensing and Metering Devices, and for Compressors for NGV Dispensing Stations. During the coarse of the meeting the U.S. Task Groups and Canadian Subcommittee's agreed to initiate harmonization between the membership's, and for all specifications of applicable NGV dispensing equipment standards. The newly formed group was title the NGVC/CGA Joint Subcommittee on Standards for Dispensing Devices and Related Components.

In May 1994 the joint subcommittee agreed to designate the applicable standards with the following nomenclature.

- ANSI/IAS NGV 4.1-1999 • CSA 12.5-M99, NGV DISPENSING SYSTEMS;
- ANSI/IAS NGV 4.2-1999 • CSA 12.52-M99, HOSES FOR NATURAL GAS VEHICLES AND DISPENSING SYSTEMS;
- ANSI/IAS NGV 4.4-1999 • CSA 12.54-M99, BREAKAWAY DEVICES FOR NATURAL GAS DISPENSING HOSES AND SYSTEMS;
- ANSI/IAS NGV 4.6-1999 • CSA 12.56-M99, MANUALLY OPERATED VALVES FOR NATURAL GAS DISPENSING SYSTEMS;

- ANSI NGV 4.7- • CSA 12.57-, AUTOMATIC PRESSURE OPERATED VALVES -FOR NATURAL GAS DISPENSING SYSTEMS; AND
- ANSI/NGV 4.8-2002 • CSA 12.8-2002, NATURAL GAS FUELING STATION RECIPROCATING COMPRESSOR GUIDELINES.

The first edition of the harmonized ANSI/CSA Standard for Natural Gas Fueling Station Reciprocating Compressor Guidelines, was approved in the U.S. by the American National Standards Institute, Inc. on February 6, 2002, and in Canada by the CSA NGV Standards Steering Committee on Natural Gas Vehicles and Fuelling on December 18, 2000, and the Canadian Interprovincial Gas Advisory Council (IGAC) on November 23, 2000.

The following identifies the designation and the year of the harmonized standard:

ANSI NGV 4.8-2002 • CSA 12.8-2002

ANSI NGV 4.8-2012 • CSA 12.8-2002

This, the second edition, consists of the original standard's coverage found in the ANSI NGV 4.8-2002 • CSA 12.8-2002 standard. No changes were made to this document.

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Natural gas vehicle fueling station reciprocating compressor guidelines

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NOTE

This standard contains SI (Metric) equivalents to the yard/pound quantities, the purpose being to allow the standard to be used in SI (Metric) units. (Standard for use of the International System of Units (SI): The Modern Metric System, IEEE/ASTM SI I0 or Metric Practice Guide, CAN/CSA Z234.1 are used as a guide in making metric conversion from yard/pound quantities.) If a value for a measurement and an equivalent value in other units, the first stated is to be regarded as the requirement. The given equivalent value may be approximate. If a value for a measurement and an equivalent value in other units, are both specified as a quoted marking requirement, the first stated unit, or both shall be provided.

ANSI NGV 4.8-2012 • CSA 12.8-2002
Standard for natural gas vehicle fueling station reciprocating compressor guidelines

Part I: General

1.1 Scope

This standard describes the general requirements for compressor packages containing reciprocating compressors used in compressed natural gas fueling station service.

This standard applies to compressor designs referenced in Part 2 (Compressor). Coverage for other compressor designs can be provided at an appropriate time.

All references to psi throughout this document are to be considered gauge pressures unless otherwise specified.

If a value for measurement as given in this standard is followed by an equivalent value in other units, the first stated value is to be regarded as the specification. For Canadian applications see Exhibit B, "Items Unique to Canada."

Note: Hazardous situations can occur if S.I. fasteners are used with those which are not, which is mechanically feasible. S.I. elements can not be safely used with anything other than S.I.

Use of the word "Shall"

Where the word "shall" is used in this document it indicated a requirement (unless approved otherwise by the authority having jurisdiction); "should" indicates a recommendation or that which is advised but not mandatory; and "may" indicates an advisory or optional statement.

Use of Notes

Notes accompanying clauses do not include mandatory or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material that is not properly a part of the Standard. Notes to figures and tables are considered part of the figure or table and may be written as mandatory requirements; legends to figures are also considered part of the requirements of the figure.

1.2 Applications

Except as stated in this standard, compressor packages shall be designed, manufactured, and tested in accordance with the applicable requirements of the standards referenced. Unless otherwise indicated in this standard, the latest edition of any referenced standard/code shall be used.

1.3 Packager's Representation

The packager shall indicate the following parameters within the operations manual.

a. Suction pressure range;

b. Discharge pressure range;

c. Operating temperature range (ambient and suction gas);

d. Electrical requirements;

e. Outdoor or sheltered operation;

f. Type of cooling (liquid or air);

g. Driver data;

h. Rated flow rate at design inlet conditions;

i. Sound pressure level;*

j. Weight (gross and net);

k. Basic utility requirements (service); and

l. Packager nameplate data.

The packager shall warrant that the equipment meets the manufacturer's requirements or assume the responsibility as the manufacturer.

1.3.1 Design Assumptions.

Unless otherwise specified by the purchaser, the following criteria shall be used for design:

a. Ambient temperature = 100°F (38°C);

b. Site Elevation = 1500 ft (457 m);

c. Suction gas temperature = 60°F (15°C);

d. Intercooler gas outlet temperature = 120°F (49°C);

e. Aftercooler gas outlet temperature = 120°F (49°C);

f. Specific Gravity = 0.65;

g. "K" Value = 1.26; and

h. Parasitic Fan HP = 5% of engine bhp.

* Recommended method of test can be found in ARI 270, Sound Rating of Outdoor Unitary Equipment, or CAGI S5.1, Pneurop Test Code for the Measurement of Sound from Pneumatic Equipment.

NOTES: Caution should be exercised in applying air cooled heat exchangers because of their susceptibility to pulsation induced vibration in systems and structures. Mechanical natural frequencies and acoustic (organ-pipe) frequencies should not be coincident with pulsation frequencies generated by the compressor.

1.4 Compressor Package Performance Curves

When specified, compressor package performance curves shall cover the range of operating conditions indicated by the purchaser. Any limitations such as rod load, available driver horsepower, additional clearance required to meet the range of operating conditions, etc., shall be marked on the performance curves.

1.5 Package Arrangement

The arrangement of the package components shall be developed by the compressor packager to provide reasonable access for operation and maintenance.

1.6 Drawings

The packager shall furnish as-built plan and elevation drawings as well as piping and instrumentation (P&I) and electrical schematic drawings. Additional drawings may be specified by the purchaser.

1.7 Sound Pressure Level

Control of the sound pressure level of all equipment furnished shall be the joint effort of the purchaser and the packager. When specified, the equipment furnished by the packager shall conform to the maximum allowable sound pressure level required by the purchaser.

1.8 Electrical Location Classification

Electrical installations shall, as a minimum, be in accordance with the latest editions of NFPA 70, National Electrical Code, and NFPA 52, Compressed Natural Gas (CNG) Vehicular Fuel Systems or CSA B149.1, Natural Gas and Propane Installation Code, CSA B109, Natural Gas for Vehicles Installation Code, and CSA C22.1, Canadian Electrical Code Part I, as applicable.

1.9 Package Installation

The purchaser shall specify the site conditions. The packager shall stipulate these conditions on the "Packager's Representation" or other form as agreed to between packager and purchaser. The unit and its auxiliaries shall be suitable for operation in these specified conditions.

1.10 Torsional Analysis

The compressor packager shall assume responsibility for a torsionally sound system.

1.11 Definition Of Terms

See accompanying Exhibit C, NGV Glossary.

Part II: Compressor Package Caution Of Workmanship

The finished product shall exhibit and perform as to specifications stated relative to normal operating parameters. This shall include use of good manufacturing practices, procedures and general caution of workmanship to ensure safety, and performance for operating/servicing requirements. This shall include meeting existing established national manufacturing standards, and requirements for occupational health and safety.

2.1 General

The compressor package shall be designed for use with pipeline quality natural gas as defined in NFPA 52, Compressed Natural Gas (CNG) Vehicular Fuel Systems or CSA B149.1, Natural Gas and Propane Installation Code, as applicable and for the pressures and temperatures to which it may be subjected under packager-specified operating conditions. In cases where the compressor package is operating with gas that is not pipeline quality, it shall be noted on "Packager's Representation."

2.1.1

Quoted Capacity. The manufacturer or packager shall be responsible for providing evidence of name plate capacity.

2.2 Maximum Allowable Speeds

The maximum and minimum allowable compressor piston speed shall be specified by the manufacturer.

2.3 Maximum Allowable Discharge Temperature

The compressor shall be provided with sufficient compression stages and interstage cooling to limit the actual discharge temperature of each stage to a maximum of 350°F (177°C), unless a lower temperature is otherwise specified by manufacturer. This limit shall hold for all specified operating and load conditions. When specified, the compressor packager shall provide the purchaser with both the estimated actual and the calculated adiabatic discharge temperature rise.

2.3.1

Maximum Package Discharge Gas Temperature. Unless otherwise specified by the customer the gas temperature shall be a maximum of 20°F (11°C) above ambient.

Note: The purchaser is cautioned to verify that the downstream components meet the maximum temperature requirements.

2.4 Rod Loadings

2.4.1

Maximum Allowable Rod Load. The maximum rod load (gas or combined) shall not exceed the maximum allowable rod loading for the compressor or any rod load limitation specified by the manufacturer at any specified operating condition.

2.4.2

Piston Rod Load Reversal. Except for single acting pistons, with all specified operating load conditions, the axial component of the combined rod loading shall reverse enough to ensure uninterrupted lubrication for the crosshead pin and/or for the wrist pin during each complete turn of the crankshaft.

2.5 Compressor Cylinders

2.5.1 General.

2.5.1.1
Cylinder Maximum Allowable Working Pressure. The maximum allowable working pressure of the cylinder shall exceed the rated discharge pressure by at least 10 percent or 25 psi (172 kPa) whichever is greater.

2.5.2 Cylinder/Frame Appurtenances.

2.5.2.1
Cylinder Supports. Where applicable, the cylinder support shall be designed to avoid misalignment or excessive rod run-out during the warm-up period and at actual operating temperature. The cylinder support shall not be attached to the outboard cylinder head. The pulsation bottle, if furnished, shall not be used to support the compressor cylinder, unless approved by the compressor manufacturer. Compressor manufacturers should specify whether supports are needed.

2.5.2.2
Cylinder Bolting. Cylinder bolting shall be manufacturer's standard.

2.5.3
Cylinder Connections.

2.5.3.1
Gas Connections. Main inlet, outlet and clearance bottle gas connections shall either be flanges or faced bosses to accommodate a flange suitable for the working pressure of the cylinder as specified in Clause 2.5.1.1. The bolting of flanges or machined bosses shall conform to the dimensional requirements of ASME B16.1, Cast Iron Pipe Flanges and Flanged Fittings, ASME B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300, or ASME B16.5, Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys, as applicable. Special connections shall conform to the applicable API, ASME, or ANSI Specification. Connections not larger than 2 in (5.1 cm) nominal size, may be threaded.

2.6 Valves

2.6.1
Valve Designs. Compressors designed for natural gas service shall be equipped with valves which are designed for that service.

2.6.2
Valve Assemblies. The valve design shall be such that valve assemblies cannot be inadvertently interchanged.

2.6.3
Valve Guard and Bolting. The valve and cylinder designs shall be such that the valve guard or the assembly bolting (or both) cannot fall into the cylinder even if the valve assembly bolting breaks or unfastens.

2.7 Pistons, Piston Rods, And Piston Rings

2.7.1
Hollow Pistons. Hollow pistons (single or multi-piece) when used shall be self venting.

2.7.2
Piston Rods. Piston rods shall be manufacturer's standard.

2.7.3
Piston Rings. Piston rings shall be manufacturer's standard.

2.8 Crankshafts, Connecting Rods, Bearings & Crossheads

2.8.1
Crankshafts. Crankshafts shall be of the compressor manufacturer's standard material and design and shall be heat treated and machined on all working surfaces and fits. They shall be free of sharp corners. Drilled holes or changes in section shall be finished with radii and shall be polished. Forced lubrication passages in crankshafts shall be drilled.

2.8.2
Bearings. Bearings shall be compressor manufacturer's standard.

2.8.3
Connecting Rods. Connecting rods shall be of compressor manufacturer's standard material and design and may have a removable cap or be of single piece construction. They shall be free of any sharp corners. Forced lubrication passages shall be drilled.

2.8.4
Crossheads. Where applicable, crossheads shall be compressor manufacturer's standard material and design.

2.9 Distance Pieces

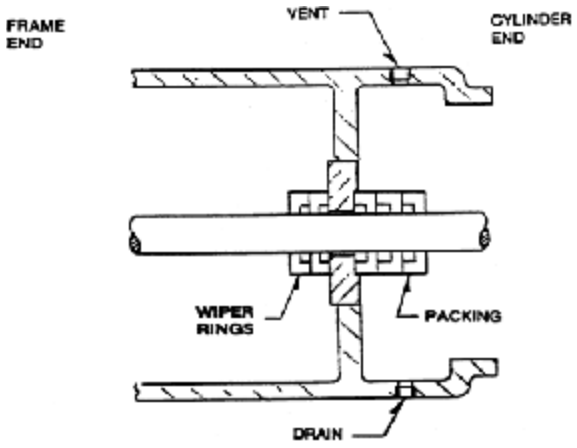
2.9.1
Design. Where applicable, if distance pieces are provided, they shall conform to Types "1," "2," or "3" (see diagrams) and shall be of manufacturer's standard design.

NOTES: Short, close-coupled, single compartment (type "1") and long, single compartment (Type "2") are utilized in the majority of oil and gas field applications. Type "1" is used where it is desired to keep overall width of the compressor to a minimum for ease of highway transportation of the package. Type "2" is used when physical separation of the pressure and wiper packing is desired. Type "3" provides double compartments for varying degrees of purging when required. Slinger rings may be added to Types "2" or "3" to prevent migration and mixing of oil between the crankcase and the compressor cylinders.

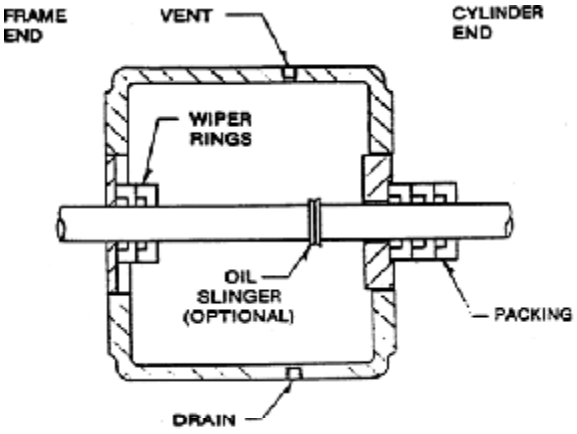
2.9.2
Openings. Where applicable, openings to permit servicing of the packing case shall be provided and shall have bolted access covers, a bottom drain connection, and a top vent connection. Refer to Clause 7.7 (Drain and Vent Piping) for drain and vent specifications.

2.9.3
Explosion Relief Door(s). Where applicable, and when specified by the purchaser, explosion relief door(s) shall be furnished on the compressor frame or distance piece(s).

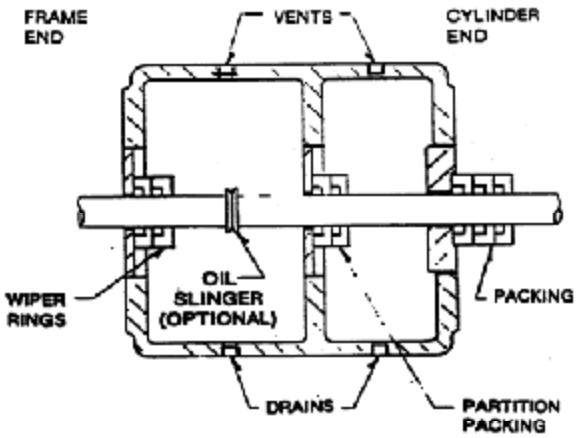
TYPE 1



TYPE 2



TYPE 3



2.10 Packing Cases And Pressure Packing [Where Applicable]

2.10.1
Type. Oil wiper, intermediate, and gas cylinder pressure packings shall be segmental rings with stainless steel garter springs.

2.10.2
Services. The pressure packing case shall be provided with a vent and a drain. Refer to Clause 7.7 (Drain and Vent Piping) for drain and vent specifications.

2.10.3
Wiper Packing. Crosshead wiper packing shall be provided to minimize oil leakage from the crankcase.

2.11 Compressor Frame Lubrication System

2.11.1
Frame Lubrication. The frame lubrication system may be splash or pressure lubricated.

2.11.2
Gauges and Connections. The frame shall have an oil level gauge and oil filling and drain connections.

2.11.3
Frame Oil Pump. Where applicable, the frame oil pump may be crankshaft driven either directly, through gears, chains, or belts.

2.11.4
Pressurized System. For pressurized systems the oil filtering components shall be the manufacturer's standard and may utilize automotive type spin-on filters or replaceable filter elements.

2.11.5
Oil Control. On oil lubricated compressors a compressor frame oil level or pressure control device, as applicable, shall be furnished by the compressor packager.

2.11.6
Lube Oil Temperature Control. Suitable lubrication oil heating and cooling systems shall be supplied, if required, to maintain lubrication oil temperatures according to the compressor manufacturer's recommendations.

2.12 Compressor Cylinder Lubrication

2.12.1
Cylinder Lubrication. Compressor cylinder lubrication, as required, shall be manufacturer's standard.

2.12.2
Flow Control or Oil Pressure. Where required, force-feed cylinder lubrication systems shall incorporate low oil pressure or flow control shutdown devices, as applicable.

2.13 Materials

2.13.1 General.

2.13.1.1
Materials of Construction. Materials selected for each compression stage shall be capable of withstanding applied pressure loads with a margin of safety equal to that required by Section II of the ASME Boiler and Pressure Vessel Code.

2.13.2 Repair

2.13.2.1
Casting Repair. Pressure containing gray iron or ductile iron castings shall not be repaired by peening, by burningin or by welding.

2.13.2.2
Repair by Plugs. Gray iron or ductile iron castings may be repaired by plugging within the limits specified in ASTM A395, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures. However, unless otherwise agreed upon by the purchaser and the compressor manufacturer, plugs shall not be used in the gas pressure containing wall sections, including the bore under the liner, if any. The drilled hole for a plug shall be subjected to a liquid penetrant examination to ensure that all defective material has been removed.

2.13.2.3
Repairs by Welding. All welding of steel cylinders shall be performed by operators and procedures qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code.

2.13.2.4
Repair Testing. The compressor manufacturer shall be responsible for the review of all repairs and repair welds to the compressor to ensure that they are properly heat treated and nondestructively examined for soundness and compliance with applicable qualified procedures.

2.14 Power Transmission

2.14.1
Gears. Gears shall be designed in accordance with the manufacturer's standard and shall be selected for the maximum continuous horsepower rating of the prime mover plus the coupling manufacturer's standard service factor for reciprocating compressor applications.

2.14.2
Couplings. Couplings shall be designed in accordance with the manufacturer's standard and shall be selected for the maximum continuous horsepower rating of the prime mover plus the coupling manufacturer's standard service factor for reciprocating compressor applications.

2.14.3
V-Belt Drives. V-Belt drives shall be designed in accordance with the manufacturer's standard.

2.14.4
Clutches. Clutches shall be designed in accordance with the manufacturer's standard.

Part III: Capacity Control

3.1 Method Of Capacity Control

Capacity control, if required, can be achieved by one or more of the following methods and must be designed in accordance with manufacturer's standard.

a. Speed Variation;

b. Clearance Pockets;

c. Bypass Systems;

d. Valve Removal or Unloading; and

e. Suction Pressure Control.

Part IV: Prime Mover

4.1 General

The type of prime mover (gas engine or electric motor) shall be specified by the purchaser. The prime mover shall be sized to meet the maximum specified operating conditions.

4.2 Natural Gas Engines

4.2.1
Code. Unless otherwise specified, the gas engine shall be installed in accordance with the applicable sections of NFPA 52, Compressed Natural Gas (CNG) Vehicular Fuel Systems or CSA B149.1, Natural Gas and Propane Installation Code, as applicable.

4.2.2
Rated Brake Horsepower. Unless otherwise specified by the purchaser, the gas engine shall be sized for the greatest horsepower required for any of the compressor operating conditions plus accessory horsepower, for the specific location, without exceeding the engine manufacturer's standard published rating criteria.

4.2.3
Operating Speed. The packager shall not apply an engine at an operating speed either greater or less than the manufacturer's recommended speed range.

4.2.4
Engine Starting and Ignition Systems. Electric, air or gas starting systems for the engine driver shall be specified by the purchaser.

4.2.4.1
Air or Gas Starting System. Unless otherwise specified, the packager's air or gas starting system shall include the following:

a. Manual block valve to isolate the system;

b. If required, a regulator to provide proper starting pressure. Purchaser shall specify source and minimum/maximum pressure of air or gas available for the starting system;

c. Safety relief valve. See Clause 7.8 (Relief Valves) for sizing, setting criteria, and venting;

d. Spring loaded (spring to close) quick opening valve;

e. Air or gas starter with lubricator and strainer, if applicable, and exhaust silencer in accordance with Clause 1.7 (Sound Pressure Level); and

f. The starter vent piping (sized for at least the same diameter as the starter exhaust connection) shall be piped to skid edge unless otherwise specified by the purchaser.

NOTES: The safe disposition of the starter vent gas must be considered in the installation and is the responsibility of the purchaser.

4.2.4.2
Electric Starting and Ignition Systems. Each spark-ignition engine located in a hazardous location shall be equipped with spark-protected electrical equipment.

a. Magnetos or distributors and coils shall be of the spark protected type with all leads positively attached. Ventilation openings in such devices shall be protected by a fire screen unless the device is purged, pressurized, or otherwise protected;

b. Ignition wire shall be positively attached at each end by use of the outer sheath or the insulation;

c. Spark plugs shall be fully shielded against flashover. Spark plugs either radio shielded or provided with insulating boots are acceptable;

d. Starter, generator, and associated electrical equipment, attached to engines, shall be of the spark protected type; and

e. Batteries, wiring, and electrical protective devices shall be protected against flashover and accidental shorting.

4.2.5

Air Intake System. The engine manufacturer's standard dry-type air filter, suitable for outdoor service, shall be provided. Unless adequately ventilated, air shall not be taken from inside enclosed buildings or package enclosure.

4.2.5.1

Minimum Design Requirements. The following features shall be considered in the design of an air intake system:

a. Piping and supports for remote mounted air filters shall be furnished by the purchaser unless otherwise specified;

b. Remote mounted air filters shall have internal surface corrosion protection of inlet piping;

c. Remote mounted air filters shall be placed so that ground dust or snow can not clog the filter;

d. All ducting, including air cleaner-to-manifold connections, must be air-tight to avoid the intake of unfiltered air; and

e. Restricted inlets, sharp or numerous bends, and undersized piping shall be avoided. Maximum pressure drop shall not exceed engine manufacturer's recommendation.

4.2.6

Exhaust System. An industrial spark arresting silencer shall be provided by the packager as a minimum.

4.2.6.1

Minimum Design Requirements. The following features shall be considered in the design of an exhaust system;

a. The exhaust system shall be properly anchored and supported, include all interconnecting piping, and direct the expansion of the piping involved away from the engine. If an expansion joint is required, it shall be stainless steel;

b. Exhaust piping shall not exceed the engine manufacturer's back pressure limitations; and

c. Provisions shall be made to prevent rain water from entering the system.

4.2.6.2

Insulation and Guarding. Insulation and/or guarding of hot metal surfaces shall be provided.

4.2.7
Engine Shutdowns. See Part 10 - Shutdowns, Alarms and Annunciators. Means shall be provided for manually stopping the engine.

4.2.8
Engine Emissions. Engine emissions requirements must be specified by the purchaser and/or meet local requirements.

4.2.8.1
Emission Control Device. If a catalytic converter or other external device is quoted to meet the air emissions requirements specified by the purchaser, the rated horsepower quoted shall reflect the effects, if any, of the additional back-pressure or heat loads placed on the driver by the device. Any special operational considerations, fuel composition, air:fuel ratio or lubrication specifications shall be clearly stated in the packager's quotation.

4.2.9
Engine Lubrication System. Engines shall be equipped with the engine manufacturer's standard lube oil system unless otherwise specified.

4.2.10
Fuel Gas Systems. Unless otherwise specified, the fuel system shall include:

a. A pressure-reducing regulator with internal relief and isolating valve;

b. Fuel system manual block valve;

c. Automatic valve in fuel system to shut off fuel to the engine when engine is shut down; and

d. Fuel filter/separator, if specified, shall be installed.

4.2.11
The fuel gas composition and pressure, if different than the gas to the compressor's inlet, shall be specified by the purchaser and the engine manufacturer shall be consulted for fuel treatment requirements and special precautions.

4.2.12
Instructions. Instructions for starting and stopping shall be supplied with each engine and, where feasible, shall be conspicuously posted on or near the equipment.

4.3 Electric Motors

4.3.1
Motor Description. The purchaser shall specify the available electrical services and type of motor starting (across the line, soft start, reduced voltage, etc.). The motor shall be listed or approved.

4.3.2
Motor Supplied Rated Brake Horsepower. The motor supplied shall be provided with a 1.15 service factor unless the actual compressor full load BHP is less than or equal to 85 percent of the motor rated BHP.

4.3.3
Motor Current Variations. The inertia of the rotating parts of the combined motor/compressor installation shall be sufficient to limit motor current variations to a value not exceeding 66 percent of the full load current in accordance with Paragraph 20.82 of NEMA MG1, Motors and Generators, for induction motors and Paragraph 21.84 of MG-1 for synchronous motors for all specified compressor operating conditions.

4.4 Guards

4.4.1
General. Flywheel, sheaves, belts, shafts, couplings and similar moving parts shall meet occupational safety and health requirements and have removable non-sparking guards.

4.4.2
Labeling. Suitable cautionary labeling is required (may include symbols) in accordance with local codes and standards.

Part V: Cooling System

5.1 Engine

An engine cooling system shall include the following features, as appropriate:

a. Engine cooling section(s) as required by the engine manufacturer for engine lube oil, engine turbocharger air aftercooler (if required) and engine jacket cooling;

b. Elevated deaerating type reservoir with gauge glass, vent line, coolant level switch, overflow, filling connection, and drain. Gauge glasses are not required on engine radiators;

c. Thermostatic coolant temperature control per engine manufacturer's recommendation; and

d. Plugged manual drain connections(s) to completely drain equipment and system.

5.2 Compressor

5.2.1
Circulated Coolant. When coolant cooled cylinders are furnished, a compressor cylinder jacket cooling system shall be provided either separate or integral with the engine cooling system to provide coolant to the compressor cylinders within the temperature limits recommended by the compressor manufacturer for the specified compression services. The cylinder cooling system piping shall be equipped with vents and low point drains. Manual valves to permit working on the compressor unit or auxiliary equipment without draining the engine cooler shall be furnished.

5.2.1.1
Cylinder Jacket System. When furnished, the cylinder jacket system must be designed to prevent leakage of gas into the coolant.

5.2.1.2
Sight Flow and Temperature Indicators. Sight flow and temperature indicators shall be furnished when specified by the purchaser.

5.2.2
Thermo-Siphon and Static Cooling. When applicable, the compressor cylinder jacket cooling system may be either static or thermo-siphon type where the compressor discharge temperatures are within the temperature limits recommended by the compressor manufacturer for the intended compressor cylinders and gas compression services.

5.2.3
Oil Cooling. When required, a compressor frame oil cooling system shall be provided in accordance with 2.11 (Compressor Frame Lubrication System).

5.2.4
Gas Cooling. Gas intercooling shall be provided as required and gas aftercooling shall be in accordance with 2.3.1.

5.3 Air Exchange Cooler Design Criteria

5.3.1

Properties. Physical and thermal properties of the fluids to be cooled shall be obtained from recognized sources, TEMA Standards or GPSA Data Books.

5.3.2

Glycol/Water. The coil sections intended for cooling engine and compressor cylinder jackets, if any, shall be designed to cool a fifty percent (50%) solution of ethylene glycol in water or other special solutions as required by the engine or compressor manufacturer at maximum design ambient temperature.

5.3.3

Pressure. The maximum allowable working pressure of gas sections shall be at least the maximum operation discharge pressure plus 50 psi (345 kPa) or 10 percent of the maximum operating discharge pressure, whichever is greater, at an assumed temperature of 350?F (177?C). The maximum allowable working pressure of the oil or coolant sections shall be in accordance with the ASME Boiler and Pressure Vessel Codes.

5.3.3.1

Code. Where applicable, an ASME Code stamp on the gas cooler sections shall be supplied.

5.4 Heat Rejection And Flow Rate

Heat transfer equipment for packaged compressor units shall be designed in accordance with manufacturer's standard and shall have a minimum 10 percent margin for corrosion and fouling.

Part VI: Pressure Vessels

6.1 General

6.1.1
Code. Pressure vessels handling compressed gas such as pulsation/volume bottles, vent recovery receiver, etc. shall be constructed in accordance with *ASME Boiler and Pressure Vessel Code*, Section VIII, (latest edition), or *CSA B51, Pressure Vessel and Pressure Piping Code*, as applicable.

6.1.2
Material. Pressure vessels shall be fabricated from pipe or rolled plate in accordance with material specifications contained in the ASME Boiler and Pressure Vessel Code, Section II.

6.1.3
Corrosion Allowance. Minimum corrosion allowance for pressure vessels shall be specified by the manufacturer and may be increased at the purchaser's discretion.

6.1.4
Flanges. Weldneck raised face flanges shall be used unless specified otherwise. Ring type joints or spiral wound metallic gaskets with centering ring shall be employed for ANSI Class 900 flanges or higher. Slip-on flanges, when used, shall be installed with full fillet welds and full internal fillets.

6.1.5
Connection Size. Connections up to and including 2 in (5.1 cm) diameter may be threaded. Only manufactured threadolets shall be used. For connections above 2 in (5.1 cm) nominal diameter, only welded connections shall be acceptable.

6.1.6
Small Connections. Connections $1^1/_2$ in (38.1 mm) in diameter and smaller shall be designed in accordance with Clause 7.2 (Gas Piping).

6.2 Pulsation/volume Bottles/recovery Systems

Pulsation/volume bottles and captive recovery systems shall be sized in accordance with manufacturer's recommendations.

Part VII: Piping And Appurtenances

7.1 General

7.1.1
Code. Gas piping (process, fuel, and starter) design, fabrication, inspection, and testing shall be in accordance with ANSI/ASME B31.3, Chemical Plants and Petroleum Refinery Piping or CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code, as applicable.

7.1.2
System. Piping systems shall include piping, isolating valves, control valves, pressure reducers, orifices, thermowell, pressure gauges, sight flow-indicators, and all related vents and drains. The compressor block is not considered part of the piping system. All components shall be rated for the maximum pressure and temperature to which they can be subjected under normal operating conditions.

7.1.3
Scope. The packager shall furnish all piping systems, including mounted appurtenances, for all equipment mounted on the package.

7.1.4
Drawings. When specified, the purchaser shall review the arrangement drawings of all piping and appurtenances (pulsation suppression devices, inter-coolers, after-coolers, separators, knockouts air intake filters, expansion joints, and vessels) immediately upstream or downstream of the compressor prior to fabrication.

7.2 Gas Piping

7.2.1
Threaded Connections. Threaded piping connections may be used on 2 inch and below nominal pipe size.

7.2.2
Connections. Connections $1^1/_2$ in (38 mm) and smaller shall be designed to minimize overhung weight and shall be braced back to the main pipe in at least two planes to avoid breakage due to vibration. Bracing shall be arranged to occupy minimum space.

7.2.3
Design. Design of piping systems shall achieve the following:

a. Proper support and protection to prevent damage from vibration or from shipment, operation and maintenance;

b. Proper flexibility and normal accessibility for operation, maintenance, and thorough cleaning;

c. Installation in a neat and orderly arrangement adapted to the contour of the machine and not obstructing access openings;

d. Complete drainage through low-points without piping disassembly;

e. Elimination of low points in the piping that could trap liquid;

f. Utilize pipe clamps on all gas piping and on all piping 2 in (50.8 mm) in diameter and larger; and

g. Supports should not be welded directly to gas piping.

7.2.4
Fabrication. Welding, fittings, flanges, and threaded connections shall be held to a minimum. Pipe bushings shall not be used to change diameter in a piping run. Break-out flanges or unions shall be included when packages need disassembly for transportation.

7.2.5
Threaded Joints. Pipe threads shall be taper threads in accordance with ASME B1.20.1, Pipe Threads, General Purpose, (Inch) or the following allowable thread forms:

a. Threaded Pipe. Pipe Threads, General Purpose (Inch) Revision and Redesignation of ASME/ANSI B2.1; and

b. Tube Fittings. ASME B1.20.1, Pipe Threads, General Purpose (Inch); ASME B1.20.3, Dryseal Pipe Threads, Inch or SAE HS-150/2000, Dryseal Pipe Threads; or British Standard BS 21, Pipe Threads for Tubes and Fittings Where Pressure-Tight Joints Are Made on the Threads - Metric Dimensions.

Only nationally recognized thread forms shall be used. Thread forms shall be designed for pressure tight joints. Pressurized connections that mate shall be of the same or compatible thread forms as allowed by their specific standard.

Close (fully threaded) nipples shall NOT be used.

7.2.6
Threaded Fittings. All threaded connections shall be suitable for the pressure to which they are subjected.

7.2.7
Flanged Joints. Flanges shall be in accordance with ANSI B16.5, Pipe Flanges and Flanged Fittings, Steel Nickle Alloy and Other Special Alloys. Weldneck raised face flanges shall be used unless specified otherwise. Ring type joints or spiral wound metallic gaskets with centering ring shall be employed for ANSI Class 900 flanges or higher. Slip-on flanges, when used, shall be installed with full fillet welds and full internal fillets.

7.2.8
Valves. Any valve suitable for natural gas service and of a material that meets ANSI/ASME B31.3, Chemical Plant and Petroleum Refinery Piping, requirements, shall be suitable.

7.2.9
Supports. Piping systems furnished by the packager shall be fabricated, installed in the shop, and properly supported.

7.2.10
Plugs. Tapped opening shall be plugged with solid steel, long-shank or hex-head plugs. Threads shall be coated with a non-locking pipe thread sealant. TFE tape shall not be applied to threads of plugs inserted into oil passages.

7.3 Frame Lubricating Oil Piping Requirements

7.3.1
Lube Oil Piping System. The packager shall supply a complete compressor lubricating oil piping system with its mounted appurtenances when applicable.

7.3.2
Material. Unless otherwise specified material shall be manufacturer's standard. Bends shall be used to minimize the number of fittings where possible.

7.4 Coolant Piping Requirements

7.4.1
Cleaning. During fabrication and assembly of the system each component and all piping and appurtenances shall be cleaned to remove foreign materials, corrosion products, and mill scale. After cleaning, open ends of piping and vessels shall be suitably covered to prevent contamination.

7.4.2
Coolant Piping. When coolant piping on liquid-cooled compressor cylinders is specified to be furnished by the packager, the packager shall supply a piping system for all equipment mounted on the skid. The piping shall be arranged to provide a single inlet connection on the bottom and a single outlet connection on the top for each coolant circuit operating at different inlet temperature levels and shall include a coolant control valve.

7.4.3
Coolant Vents and Drains. Coolant piping on liquid-cooled compressor cylinders shall be arranged so that air cannot be trapped. Where air traps cannot be avoided, venting equipment shall be provided. All low points shall have drains. All liquid-cooled compressor cylinders shall be equipped with valved coolant drains.

7.4.4
Coolant Piping Finish and Cleaning. When butt welds are necessary, such precautions as internal grinding of joints and use of gas tungsten arc welding for the first weld pass shall be taken to prevent weld splatter inside the lines. After fabrication lines shall be thoroughly cleaned.

7.5 Instrument Tubing Requirements

7.5.1
System. The packager shall supply all necessary tubing, valves, and fittings for all instruments and instrument panels.

7.5.2
Connections. Connections on equipment and piping for pressure instruments and test points shall conform to 7.2.4. A common connection for remotely mounted instruments measuring the same pressure may be used where convenient.

7.5.3
Tubing. Instrument and control tubing shall be 300 series stainless steel.

7.6 Filters, Separators And Pulsation Bottles

Filters and separators shall be sized for the maximum compressor gas throughput. The body design pressure shall not be less than the MAWP of the location at which it's installed. A drain valve shall be provided where applicable. Pulsation bottles shall be sized in accordance with manufacturer's recommendations.

7.7 Drain And Vent Piping

7.7.1
Drain and Vent Specifications. External drain and vent piping shall be of sufficient size and material for the application.

7.7.2
Common Distance Piece Vent Header. When specified by the purchaser, a common distance piece vent header terminating at the edge of the skid shall be furnished by the packager.

7.7.3
Common Distance Piece Drain Header. When specified by the purchaser, a common distance piece drain header terminating at the edge of the skid shall be furnished by the packager.

7.8 Relief Valves

7.8.1
Required Relief Valves. Relief valves must be located in each continuous system including but not limited to the compressor suction system, each interstage system and final discharge system.

7.8.2
Relief Valve Sizing. The packager shall furnish relief valves that are to be installed on equipment or in piping that the packager is supplying. Relief valve sizing shall be in accordance with API 520, Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries or ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 and be based upon the maximum quoted capacity of the unit, including accumulation, and shall take into consideration all possible types of equipment failure on the package. The purchaser must specify if additional suction relief valve capacity is required to protect the package for upset conditions other than the rated capacity. The packager shall determine the size and the set pressure of all relief valves related to the package. The packager's proposal shall list all relief valves and shall clearly indicate those to be furnished by the packager.

7.8.3
Relief Valve Setting. Relief valve setting shall take into consideration all possible types of equipment failure and the protection of the lowest pressure rated component in any continuous system. Relief valves shall be set to operate in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, CSA B51, Boiler Pressure Vessel, and Pressure Piping Code or CSA B108, NGV Refueling Stations Installation Code.

7.8.4
Venting. Relief valves shall vent in the following manner:

a. Relief valves shall be piped to the perimeter of the compressor package;

b. Vent lines shall be terminated in accordance with NFPA 52, Compressed Natural Gas (CNG) Vehicular Fuel Systems or CSA B108, NGV Refuelling Stations Installation Code; and

c. Relief valve vent lines may use a common header provided that the back pressure from the activation of one valve can not prevent the operation of any other valve.

Atmospheric vents shall have weep holes at the lowest point near the relief valve and shall discharge at a safe height above the package and away from the engine air intake. A suitable termination of the vent stack is required to prevent blockage.

NOTES: The effect of back pressure should be considered when selecting and sizing relief valves to discharge into a common vent header. Conventional relief valves should be specified with care as built-up back pressure may prevent low pressure valves relieving at a low enough pressure to protect the equipment.

7.9 Captive Recovery System

7.9.1
General. When required, a captive recovery system shall be designed to contain the maximum practical volume of gas released when the compressor unloads under normal operating conditions. The system shall include as a minimum a pressure vessel, pressure relief valve, controls, drain system, and associated piping.

7.9.2
Recovery Pressure Vessel. The pressure vessel shall be sized to prevent overpressurizing the pressure vessel under normal operating conditions. The pressure vessel shall be designed in accordance with 6.1 (General).

7.9.3
Pressure Relief Devices. The pressure vessel shall be equipped with one or more pressure relief devices in accordance with ASME Boiler and Pressure Vessel Code Section VIII.

7.9.4
Return. The piping system shall return the captured gas volume back to the compressor flow at the manufacturer/packager specified location and pressure.

7.9.5
Gas Recovery System Controls. Where required the system shall be equipped with controls to regulate the gas flow into and from the gas recovery system.

Part VIII: Electrical Systems

8.1 Codes

Unless otherwise specified by the purchaser, all electrical installations shall conform to the latest applicable electrical code. See Clause 1.8 (Electrical Location Classification).

8.2 Power Supply

When electrical equipment is to be supplied by the packager, electrical power supply data for motors, heaters, and instrumentation shall be specified by the purchaser.

8.3 Maintenance

To facilitate maintenance, clearances shall be provided for all energized components (such as terminal blocks and relays) on all equipment.

8.4 Conduits And Cable Runs

All wiring (including power and instrumentation leads) within limits of any package area shall be installed in accordance with the area classification in accordance with NFPA 52, Compressed Natural Gas (CNG) Vehicular Fuel System and CSA B149.1, Natural Gas and Propane Installation Code, and be properly supported to minimize vibration, and isolated or shielded to prevent interference between voltage levels. Conduits, may terminate (and in the case of temperature sensing elements shall terminate) with a flexible metallic conduit of sufficient length to permit access to the unit for maintenance without removal of the conduit. Wire type and size shall be selected in accordance with NFPA 70, National Electrical Code or CSA C22.1, Canadian Electrical Code, Part I.

Part IX: Instruments And Controls

9.1 General

Package control systems (start, shutdown, capacity, speed) may be pneumatic, hydraulic, electrical or electronic and may be automatically operated with a manual override. The purchaser shall specify the control signal, manual or automatic control system, the control range and sensitivity.

9.1.1
Codes and Standards. See Clause 1.8 (Electrical Location Classification.

9.1.2
Visibility and Accessibility. All controls and instruments shall be located and arranged for visibility and easy access by operators and for accessibility for tests and maintenance.

9.1.3
Instrumentation Mounting. All instrumentation shall be securely supported to eliminate vibration and undue force on instrument piping and to prevent damage during shipment, storage, operation, and maintenance.

9.1.4
Pneumatic Supply. Filtered and regulated, sweet, dry natural gas or dry, oil-free air shall be used as the medium to operate pneumatic instruments and controls unless otherwise specified by the purchaser. Purchaser shall state the available pressure and flow rate of a separate pneumatic supply. If natural gas is used, venting shall be in accordance with Clause 7.8.4.

9.2 Instrument And Control Panel

A panel shall be provided for the compressor package, suitable for the application.

9.2.1
Panel Mounting. Control and instrument panels may be remote mounted. Instrument panels mounted on the compressor system must be securely supported to minimize vibration, to prevent undue forces on piping, and to prevent damage during shipment, storage, operation, and maintenance. The mounting location shall not block access doors or covers that must be removed for inspection or maintenance.

9.2.2
Remote Panel Wiring. If separately mounted control panels are used, all connections shall be brought to one point on the skid with provision for ease of access. Interconnecting wiring shall be installed in conduits, enclosures or armored cable as specified by the packager. All leads and posts on terminal strips, switches and instruments shall be tagged for identification. Splicing of wiring inside conduits shall not be allowed.

9.2.3
Panel Instrument Tubing. Panel instrument tubing shall be 300 series stainless steel unless specified otherwise by the purchaser.

9.2.4
Maximum Operating Limits. All instrument and controls shall be designed to withstand 125 percent of the maximum anticipated operating temperature and pressure.

9.3 Instrumentation

Manufacturer's standard analog or digital instrumentation shall be utilized unless otherwise specified by the purchaser or required by code.

9.3.1

Pressure Measurement. Pressure measurement devices shall be suitable for natural gas applications.

Part X: Shutdowns, Alarms And Annunciators General Application

Unless otherwise specified the following criteria are applicable as the minimum requirements apart from additional considerations of liability or further concerns of the manufacturer or the certifying agency.

10.1 General

Shutdown or alarm systems may function hydraulically, pneumatically, electrically or in any combination unless otherwise specified by purchaser.

10.2 Annunciators

Each component which actuates shutdown of equipment or of the entire packaged unit shall also actuate an annunciating device to indicate first-out-cause of shutdown. Annunciators can be by-passed only for the purpose of a preset time lockout for use on certain shutdown devices during start-up and manual test.

10.2.1

Installation All switches shall be installed so that the normal vibration of the equipment can not cause the switch to falsely trip.

10.3 Required Shutdowns

Unless otherwise specified by the manufacturer, the following functions on the packaged unit, as a minimum, shall be equipped with devices to automatically shut the unit down.

a. Prime Mover:

Engine
High jacket water temperature (where applicable)
Low lubrication oil level
Low lubrication oil pressure
Overspeed
Engine coolant level
Motor
Motor overload

b. Compressor:

Low oil pressure or level
High-low suction pressure
High discharge temperature
High discharge pressure
Lubricator malfunction (if applicable)
High coolant temperature (if applicable)
Vibration

10.3.1

Purchaser's Selection. Where deemed necessary by a purchaser any of the following function devices may be added.

a. Prime Mover:

Engine
High auxiliary water temperature
Low jacket water temperature
Overcrank
Vibration
Motor
High stator winding temperature - larger than NEMA frame motors
Vibration

b. Compressor:

High interstage gas pressure(s) if 50 horse power or greater
High interstage temperature
Lubrication system failure
Vibration

c. Other:

Compressor coolant low flow
Coolant system failure
Cooler vibration
Coolant water level
Fan motor overload

10.4 Compressor Package Emergency Shutdown (ESD)

Packager shall provide provisions for emergency shutdown. Control circuits shall be arranged such that when an emergency shutdown device is activated, systems that shut down shall remain down until manually activated or reset after a safe situation is restored.

The ESD shall have a mushroom head button that is at a minimum $1\,^{3}/_{4}$ in (44.5 mm) in diameter. Emergency shutdown device shall be distinctly marked for easy recognition with a permanently affixed legible sign. The ESD shall cause the compressor prime mover to cease operation and shall shut off the gas supply to the compressor. Power to the control panel for shutdown annunciation may remain available.

The ESD shall be capable of interfacing with the ESD circuits for the dispenser and storage.

10.5 Shutdown/alarm Settings

Shutdown/alarm settings shall be the manufacturer's standard.

Part XI: Package Structure

11.1 General

A structure providing support to the compressor-prime mover unit, having no vertical members is referred to as a skid. A structure which serves in some fashion to enclose the unit is referred to as an enclosure. Both skids and enclosures shall be of sufficient strength for transportation and installation, and to transmit equipment generated forces and couples to a foundation. Structural materials susceptible to corrosion shall be protected by painting or other equivalent means.

11.2 Package Structure Design

11.2.1
Lifting. Package Structure shall have provision for winching and/or lifting.

11.2.2
Shims. Provisions for shims shall be made where alignment is critical. Shims shall be made of a corrosion resistant material.

11.2.3
Mechanical Equipment. The compressor and prime mover shall be mounted on full depth, load bearing structural members and secured by bolting, grouting or sole plate/rail mounting. Two plane horizontal jackscrews shall be provided on prime movers weighing in excess of 250 lb (113 kg). All bolts and nuts shall be accessible for maintenance using standard tooling.

11.2.4
Size. Package structure shall be of sufficient size to safely accommodate equipment.

11.2.5
Bracing. Load bearing components shall not be attached to unsupported floor plate.

11.3 Package Structure Construction Requirements

Structural steel skids shall be of welded construction. Abutting beams shall be welded on both sides. Splicing flanges of load bearing members is not acceptable. Contact between webs at perpendicular joints shall be a minimum of one-third of the depth of the smallest member.

11.4 Enclosure

11.4.1Materials. Materials used in enclosures shall not support combustion. The packager shall design the enclosure in accordance with customer requirements and/or local codes.

11.4.1
Ventilation. Ventilation must be provided to maintain the required operating environment.

11.4.2
Layout. Enclosures shall be designed for ease of maintenance and safety.

11.4.3
Venting. Deflagration venting shall be provided where required by code.

Note: For information on venting of explosions see "NFPA 68, Guide for the Venting of Deflagrations."

11.5 Walkways, Stairs And Platforms

Walkways, stairs and platforms shall be designed and built in accordance with occupational health and safety requirements.

Part XII: Paint And Painting

12.1 Surface Preparation

Surface preparation shall be to the manufacturer's standard unless otherwise specified by the purchaser.

12.2 Prime And Finish Coat

Primer coat and finish coat shall be to the packager's standard unless otherwise specified by the purchaser.

12.3 Application

Paint shall be applied in accordance with the paint manufacturer's specifications. The total dry film thickness of the primer and a finish coat should be 3 mils with the exception that aluminum paints may require a thinner coat.

12.4 Items Not To Be Painted

Stainless steel tubing and fittings, hoses, wire, nameplates, finish painted instruments, non-metallic products, rotating parts of machinery, finned tubes surfaces, v-belts, sheave grooves and temporary closures shall not be painted.

12.5 Air-cooled Exchanger

Siding and structure of the air-cooled exchanger may be hot-dipped galvanized in lieu of painting for use in a severely corrosive environment. Header may be galvanized or painted as specified by the purchaser.

Part XIII: Inspection, Testing And Preparation For Shipment

13.1 General

The vendor shall provide the purchaser with a list of the inspections, testing and preparation for shipment included in the supply. The purchaser may specify additional tests, inspections and shipment preparation.

13.1.1
Notice to Vendors. The packager shall be responsible for notifying affected vendors of the purchaser's inspection and testing requirements.

13.1.2
Purchaser Participation. The purchaser shall specify the extent of his participation in the inspection and testing program prior to any fabrication.

13.1.3
Witnessed. Witnessed means that a hold shall be applied to the production schedule and that the inspection or test shall be carried out with the purchaser or his representative in attendance. It usually implies a double test.

13.1.4
Observed. Observed means that the purchaser shall be notified of the timing of the inspection or test; however, the inspection or test shall be performed as scheduled, and if the purchaser or his representative is not present, the packager shall proceed to the next step.

13.1.5
Required Equipment. Equipment required for specified inspections or tests shall be provided by the packager.

13.2 Inspection

13.2.1
Historical Data. If required by the purchaser the packager shall keep the following data available for at least 3 years from date of shipment for examination by the purchaser or his representative upon request;

a. All necessary certification of material, such as mill test reports when required;

b. Purchase orders for serial numbered items on the bill of materials;

c. Results of quality-control tests, hydrostatic tests, mechanical run tests and other tests as specified by the purchaser; and

d. Weld procedures and welder qualifications.

13.2.2
Types of Inspection. The inspections shall be packager's standard unless additional requirements are specified by the purchaser.

13.2.3
Quality Control. When specified by the purchaser, the purchaser's representative shall have access to the packager's quality control program for review prior to the start of fabrication.

13.3 Testing

13.3.1
Pressure Tests.

13.3.1.1
Pressure Retaining Parts. The compressor package shall be tested with dry nitrogen, dry air, or natural gas at the compressors' maximum allowable pressure for a sufficient period of time to permit a complete examination of components under pressure. If the package is to be tested using air, the concurrence of the customer is to be obtained. Regardless of the media chosen for the pressure test, details of the test shall be mutually agreed upon between the purchaser and packager.

NOTES:
(a) When conducting tests using natural gas it is important that the system has been purged of air to preclude forming a combustible mixture.

(b) When conducting tests using air, it is important that conditions do not occur which are conducive to ignition of the cylinder lubricating oil during compression.

All piping and vessels shall be pressure tested in accordance with ANSI/ASME B31.3, Chemical Plants and Petroleum Refinery Piping, and/or the ASME code. All local code requirements should be observed as well.

All documentation/certification of these test results should be available upon request from the customer.

13.3.1.2
Test Period. Pressure tests should be held for as long as the applicable code requires or for at least sufficient time to determine the complete integrity of components under test.

13.4 Mechanical Running Tests

13.4.1
Compressor Package Units. All compressor packages shall be shop test run for a period not less than two hours at full load, using either commercially available nitrogen, natural gas, or dry air (with customer concurrence) to determine the following:

a. Prove mechanical operation of the unit;

b. Prove correct performance of coolers;

c. Prove correct power consumption of drivers;

d. Prove capacity of compressor package;

e. Prove performance of control system including shut-downs; and

f. Prove package to be leak tight at full operating pressure.

Regardless of the media chosen for the test run, details of the test shall be mutually agreed upon between the purchaser and packager. (If the shop test medium is not natural gas or if the site test conditions can not be simulated in the shop an alternative test acceptable to the purchaser shall be performed.)

All test data should be made available to the purchaser upon request.

13.4.2
Field Verification Tests. When specified by the purchaser additional tests may be performed after installation of equipment at the purchaser's location, with all services and vent lines provided.

13.5 Preparation For Shipment

13.5.1
Preparation. Equipment shall be suitably prepared for the type of shipment or storage as specified by the purchaser. If a storage period is specified, the purchaser shall consult with the packager regarding recommended procedures to be followed. Proper storage of the unit is the responsibility of the purchaser.

13.5.2
Crating. When specified by the purchaser, the equipment shall be crated for shipment. Lifting, load-out, and handling instruction shall be securely attached to the exterior of the largest package in a well-marked weatherproof container. When specified by the purchaser, all special lifting devices and rigging shall be supplied with the unit. Upright position, lifting points, weight, and dimensions shall be clearly marked on each package.

13.5.3
Prior to Shipment. Preparation for shipment shall be made after all testing and inspection of equipment has been accomplished, and approved by the purchaser if required. The preparation shall include that specified in 13.5.3.1 through 13.5.3.4 as a minimum.

13.5.3.1
Exterior Surfaces. Exterior surfaces not finish painted, except for machined surfaces, shall be given at least one coat of the packager's standard primer. Machined exterior surfaces shall be coated with a rust preventative.

13.5.3.2
Flanged Openings. Flanged openings shall be provided with metal or wood closures.

13.5.3.3
Threaded Openings. Threaded openings shall be provided with metallic or non-metallic closures.

13.5.3.4
Bevelled Openings. Openings that have been bevelled for welding shall be provided with closures designed to prevent entrance of foreign materials and damage to the bevel.

13.5.3.5
Data Book. Two copies of the packager's operation and maintenance manual shall be provided with the package.

13.5.3.6

Loose Parts. Component parts, loose parts, and spare parts associated with a specific major item of equipment shall be separately crated for shipment, and shall not be mixed with similar parts associated with another major item of equipment. For example, parts for the compressor shall not be mixed in the same crate with similar parts for the prime mover.

13.5.3.7

Temporary Closures and Plugs. Temporary closures and plugs must be identified by tagging or bright color coding.

Part XIV: Marking

14.1 General

In Canada, all installation and marking provisions must be in a form that is easily understood in both the English and French languages, see Exhibit B, Items Unique to One Country (Canada).

14.2 Material

Name plates and rotation arrows shall be of the manufacturer's standard material (aluminum, stainless steel or monel) and permanently attached.

14.3 Package Name Plate

14.3.1

The packager's nameplate shall include:

a. Packager's name;

b. Serial number;

c. Capacity at Standard Temperature and Pressure (STP);

d. Electrical classification rating;

e. Operating RPM;

f. Operating horsepower;

g. Operating temperature range;

h. Date or date code;

i. Voltage, phase, frequency, amperage;

j. Suction and discharge pressure; and

k. Packager's address and phone number.

14.3.2

The compressor manufacturer's name plate shall include:

a. Compressor manufacturer's name;

b. Serial number;

c. Compressor model and type;

d. Minimum and maximum suction pressure;

e. Minimum and maximum discharge pressure;

f. Minimum and maximum RPM's;

g. Date code; and

h. Manufacturer's address and phone number.

The name plate shall be securely affixed in a conspicuous place on the compressor system.

14.4 Engine Name Plate

Name plates on engine drivers shall be the engine manufacturer's standard.

14.5 Motor Name Plate

Name plates on motor drivers shall include the motor manufacturer's name, serial number, model, rated bhp, rated rpm, service factor (if any), temperature rise of coils, voltage and full load amperage or as indicated in NEMA MG-1, Motors and Generators.

14.6 Cooler Name Plate

Name plates on coolers shall include the cooler manufacturer's name, serial number and model.

14.6.1

Cooler Section Name Plate. Each gas, oil or water cooling section name plate shall include the maximum allowable working pressure, hydrostatic test pressure, ASME code stamp unless not required, serial number and number of passes.

14.7 Electrical Panel Nameplates

Applicable nameplates shall include the packager's name with address and telephone number, date or date code, serial number, voltage, phase, frequency, amps, electrical rating and classification, and operating range.

Exhibit A
Reference Publications

AIR-CONDITIONING AND REFRIGERATION INSTITUTE
4301 N. Fairfax Drive, Suite 425, Arlington VA, U.S. 22203.

ARI 270-95, Sound Rating of Outdoor Unitary Equipment

AMERICAN PETROLEUM INSTITUTE
1220 L Street, NW, Washington DC, U.S. 20005

ANSI/API 11P 01-Nov-1989, Specification for Packaged Reciprocating Compressors for Oil and Gas Production Services, Second Edition

API 520-1 01-Jan-2000, Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries

AMERICAN SOCIETY OF MECHANICAL ENGINEERS
United Engineering Center, 345 East 47th Street, New York, New York, U.S. 10017

ASME BPV Code (01-Jul-1998), Boiler and Pressure Vessel Code

ASME SEC II (01-July-2001), Boiler and Pressure Vessel Code, Material Specification

ASME SEC VIII (01-July-2001), Boiler and Pressure Vessel Code, Rules for Construction of Pressure Vessels

ASME SEC IX (01-July-2001), Boiler and Pressure Vessel Code, Welding and Brazing Qualifications

ASME B1.20.1-1983 (R1992), Pipe Threads, General Purpose, (Inch)

ASME B1.20.3-1976 (R1991), Dryseal Pipe Threads, Inch

ASME B16.1-1998, Cast Iron Pipe Flanges and Flanged Fittings,

ASME B16.5-1996, Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys

ASME B16.42-1998, Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300

ANSI/ASME B16.3-1987, and Addenda B16.3a-1988, and B16.3b-1988, Malleable-Iron Threaded Fittings

AMERICAN SOCIETY FOR TESTING AND MATERIALS
1916 Race Street, Philadelphia, PA, U.S. 19103

ASTM A395/A395M-99 (10-Dec-1999), Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures

BRITISH STANDARDS INSTITUTE
389 Chiswick High Road, London, England W4 4AL

BS 21 (30-Sep-1985), Pipe Threads for Tubes and Fittings Where Pressure-Tight Joints are Made on the Threads - Metric Dimensions

CANADIAN GENERAL STANDARDS BOARD
222 Queens Street, 4th Floor, Suite 1402, Ottawa, Ontario, Canada, A1A 1G6

CGSB 3.513 DRAFT, Natural Gas for Vehicles

CSA AMERICA, INC.
8501 East Pleasant Valley Road, Cleveland, Ohio, U.S. 44131

ANSI/AGA NGV3.1-1995 • CGA NGV 3.1-1995 (R1999), Fuel System Components for Natural Gas Powered Vehicles

CANADIAN STANDARDS ASSOCIATION
178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3

CGA NGV 3.1-1995 • ANSI/AGA NGV3.1-1995 (R1999), Fuel System Components for Natural Gas Powered Vehicles

CSA B51-97, Pressure Vessel and Pressure Piping Code

CSA B108-99, NGV Refueling Stations Installation Code

CSA B109-00, Natural Gas for Vehicles Installation Code

CSA B149.1-00, Natural Gas and Propane Installation Code

CSA C22.1-98, Canadian Electrical Code Part I

COMPRESSED AIR AND GAS INSTITUTE
1300 Sumner Avenue, Cleveland, Ohio, U.S. 44115

CAGI S5.1-1971, Pneurop Test Code for the Measurement of Sound from Pneumatic Equipment

NATIONAL FIRE PROTECTION ASSOCIATION
1 Batterymarch Park, P.O. Box 9101, Quincy, Massachusetts, U.S. 02269

NFPA 52-1998, Compressed Natural Gas (CNG) Vehicular Fuel Systems

NFPA 70-1999, National Electrical Code

SOCIETY OF AUTOMOTIVE ENGINEERS
400 Commonwealth Drive, Warrendale, Pennsylvania, U.S. 15096

SAE J1616, Recommended Practice for Compressed Natural Gas Vehicle Fuel

Exhibit B
Items Unique Canada

Units of measurement required on printed instructions and markings shall include the SI (metric) values as a minimum.

Voltage of a circuit means the greatest root-mean-square (effective) voltage between any two conductors of the circuit concerned.

Extra-low voltage means any voltage up to and including 30 V.

Low voltage means any voltage from 31 to 750 V inclusive.

High voltage means any voltage above 750 V.

All installation and marking provisions specified in this document are required to be in a form easily understood in both English and French.

The following make reference to specific instructions and/or markings and are listed below in both the English and French languages.

In Canada only the P30 system is allowed for dispensing natural gas to the general public for use as a vehicle fuel.	Au Canada, seul le système P30 est permis pour la distribution au public du gaz naturel utilisé comme carburant pour véhicules.
WARNING - Disconnect electrical power and vent gas per manufacturer's instructions before servicing filter.	Avertissement. Couper l'alimentation électrique et évacuer le gaz selon les instructions du fabricant avant d'entreprendre le dépannage du filtre.
For use with natural gas only.	Utiliser avec du gaz naturel uniquement.
For installation in Canada a Canadian Registration Number is required and is issued by the local Boiler and Pressure Vessel Regulatory Authority.	Pour les installations au Canada, un numéro d'enregistration canadien (C.R.N.) est requis et est émis par le service local d'inspection de la fabrication des chaudières et appareils sous pression.
A dispenser shall only be installed with a listed or approved overfill protection system.	Un distributrice ne peut être installée qu'avec un système de protection contre le trop plein homologué ou approuvé.
CSA-B108 National Standard of Canada Natural Gas Fuelling Stations Installation Code	CSA-B108 Norme Nationale du Canada Centres de Ravitaillement de GNV Code d'Installation

Exhibit C
NGV Glossary

This Glossary constitutes a general appendix to each of the bi-national standards in the series designated as the ANSI NGV 4.x / CSA 12.x harmonized North American standards applicable to the utilization of natural gas as a vehicle fuel.

ACCESSORY: A part capable of performing an independent function(s) and contributing to the operations of the equipment that it serves.

AIR:

Dry Air: Air with a moisture content such that the dew point of the air at the required test pressure is at least 10°C (20°F) below the ambient test temperature.

APPROVED: Acceptable to the authority having jurisdiction.

APPROVED STANDARD: A standard which is acceptable to the authority having jurisdiction.

APPROVAL: Approved by, or approval of, the Regulatory Authority.

AUTHORITY HAVING JURISDICTION: The organization, office or individual responsible for approving equipment, an installation or a procedure.

AUTOMATIC VALVE: See VALVE.

BLEED VENTING: The expiration or inspiration of air or gas from, or to, one side of a diaphragm of any accessory, component, or equipment such as a valve, pressure regulator, or switch.

BREAKAWAY DEVICE:

Dispenser breakaway device: A component installed immediately upstream of the dispenser to shut off gas flow in the event of the dispenser being sheared from its mounting support.

Hose breakaway device: A component installed downstream of the dispenser outlet connection to protect the dispenser assembly from damage by vehicles driving away while still connected to the dispenser nozzle.

BUFFER: See CONTAINER.

CERTIFICATION AGENCY: An impartial body possessing the necessary competence and reliability to operate a certification system and in which the interests of all parties concerned with the functioning of the system are represented.

CERTIFIED: (With respect to any accessory, component, equipment, or manufacturer's installation instructions) investigated and identified by a nationally recognized testing and certification agency as conforming to recognized standards or requirements or accepted test reports.

CERTIFICATION SYSTEM: A system having its own rules of procedure and management for certification facilities, products, services or systems to specific standards or other recognized documents.

COMBINED ROD LOADING: The combined rod loading is the algebraic sum of gas load and inertia force. Gas load is the force resulting from differential gas pressure acting on the piston differential area. Inertia force is that force resulting from the acceleration of the reciprocating mass. The inertia force with respect to the cross head pin is the summation of all reciprocating masses (piston and rod assembly, and crosshead assembly including pin) times their acceleration.

COMPRESSOR: A device consisting of equipment specifically designed to increase the gas pressure in a container.

COMPRESSOR PACKAGE: The compressor package should include but not be limited to all necessary equipment from the inlet connection to the discharge connection.

CONNECTOR: Tubing or hose with a fitting at each end for connecting equipment with piping or tubing.

CONTAINER:

Buffer Container: A container or group of containers with a total water capacity not exceeding 200 liters capacity that is used at a slow fill refuelling station to prevent the compressor from short cycling.

CROSSHEAD: A reciprocating component similar to a piston used to connect the piston rod to the connecting rod. It is not used for compression. The crosshead is located between the connecting rod and the piston rod on each crankshaft throw. Its purpose is to dampen out the rocking motions and side thrusts from the connecting rod, and convert it into a reciprocating motion. This reciprocating motion is then transferred to the pistons, via the piston rod.

CROSSHEAD TYPE COMPRESSOR: A positive displacement reciprocating compressor in which piston and crossheads are separate elements. These two elements are linked by a piston rod located in a distance piece equipped with a gas seal. Shaft rotation is translated into piston reciprocating motion, via the connecting rod. This type of compressor can be horizontal or vertical straightline, L, or have an angle arrangement of the cylinders.

CYLINDER: (With respect to natural gas ground storage) a container which complies with the requirements of the CTC or DOT for storage and transportation of compressed natural gas.

DATA BOOK: The data book is a book containing the manufacturer's instructions, parts lists, data sheets, "as-built" plan and elevation package drawings, "as-built" and other pertinent data.

DESIGN POINT: The design point is the point at which the packager certifies that the quoted capacity and power consumption is met.

DEW POINT TEMPERATURE: The temperature, referenced to a specific pressure, at which water vapor or other vapor phase components begin to condense.

DISPENSER: A device intended to transfer compressed natural gas..

DISPENSER BREAKAWAY DEVICE: A component installed immediately upstream of the dispenser to shut off gas flow in the event of the dispenser being sheared from it's mounting support.

DISTANCE PIECES: The distance piece is installed between the compressor cylinders and crosshead housing (frame) on each crankshaft throw, to provide a separation between these two components. This helps to prevent uncontrolled oil splash from the frame entering the cylinders, and blow by gas from the cylinders entering the frame. It is usually equipped with vents and drains.

DOUBLE ACTING PISTON: A piston where compression takes place on both of the two piston strokes per revolution.

ESD: Emergency shut down switch.

ENCLOSURE: A structure that protects equipment from the environment or provides noise attenuation.

FAST-CLOSING VALVE: See VALVE.

FAST FILL: See STATION.

FILL PRESSURE: The pressure attained at the actual time of filling. Fill pressure varies according to the gas temperature in the container which is dependent on the changing parameters and the ambient conditions.

FITTING: An item in a piping or tubing system that is used as a connector, such as an elbow, return bend, tee, union, bushing, coupling, cross, or nipple, but not including such functioning items as a valve or pressure regulator.

FLEXIBLE METALLIC HOSE: An all-metallic flexible gas conduit.

FUELLING STATION: A facility for the dispensing of natural gas and includes all stationary equipment and associated components downstream from the inlet of a compressor manual shut-off valve.

GGE: See GASOLINE GALLON EQUIVALENT.

GASOLINE GALLON EQUIVALENT (GGE): 1 GGE is 123.55 scf of mean natural gas.

(USA) 1 GGE equals 5.660 lbs. of Natural Gas.

(Canada) 1 kilogram NG equals 1.5 liters of gasoline.

HOSE: A flexible conduit.

HOT METAL SURFACES: For purposes of insulation requirements, hot metal surfaces shall be defined as surfaces with temperatures of 140°F (60°C) or greater.

HOUSING: A section of the system that encloses, and is intended to protect, operating parts, control mechanisms, or other components, that need not be accessible during normal operation.

HYDROSTATIC PRESSURE: Pressure caused by an incompressible fluid.

HYDROSTATIC TEST: The pressure to which a component is taken during acceptance testing.

INSTALLER: Any individual, firm, corporation, or company which either in person or through a representative, is engaged in the installation, replacement, repair, or servicing of gas piping, venting systems, appliances, components, accessories, or equipment, and who is experienced and/or trained in such work and has complied with the requirements of the authority having jurisdiction.

KIOSK: A structure having an area of less than 100 square feet (9.24 m^2) located on a remote dispenser island which provides shelter and contains the necessary equipment to permit a person to perform their duties and is not considered a building.

LISTED: Equipment or materials included in a list published by an organization acceptable to the authority having jurisdiction and concerned with product evaluation that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or materials meets appropriate standards or has been tested and found suitable for use in a specified manner.

LUBRICATION:

Non-Lube: No oil is forced into the compression cylinders. The sealing components such as piston rings and packings are normally non-metallic. Design measures are taken to limit migration of oil from the crankcase to the cylinders.

Normal Lube: The cylinders are lubricated by either of the following common methods.

(i) Splash lubrication via splashed oil from the crankcase into the process gas compression cylinders. The rates of lubrication are normally controlled by piston ring configuration;

or

(ii) Force fed lubrication via a separate oil injection system which injects a metered amount of oil to sealing areas of the compression cylinders and packings (if applicable).

Oil free: Compressors are fitted with extra-long distance pieces which allows oil slingers to be fitted to the piston rods and that no part of the piston rod can transfer oil into an area in contact with any part of the piston rod which enters the compression chamber or gas packing area.

(See also "oil free", after "oil carryover.")

Oil less: The compressor runs with no oil whatsoever in the crankcase or compression cylinders. This design is normally utilized in the smaller range of CNG compressors such as vehicle fueling appliances.

LUBRICATED PLUG TYPE VALVE: See Valve.

MANUFACTURER: The person or organization responsible for the design, fabrication and testing of the equipment and components.

MAXIMUM ALLOWABLE OPERATING ROD LOAD: The maximum allowable operating rod load (manufacturer's published rating calculated by manufacturer's standard methods) is the highest force that a manufacturer will permit for continuous operation.

MAXIMUM ALLOWABLE SPEED: Maximum allowable speed in revolutions per minute is the highest speed at which the manufacturer's design will permit continuous operation.

MAXIMUM ALLOWABLE TEMPERATURE: Maximum allowable temperature is the maximum temperature for which the manufacturer has designed the equipment (or any part to which the term is referred) when handling the specified fluid at the specified pressure.

MAXIMUM ALLOWABLE WORKING PRESSURE: The maximum pressure to which a component is designed to be subjected when handling the specified fluid at the maximum specified temperature.

MINIMUM ALLOWABLE SPEED: Minimum allowable speed in revolutions per minute is the lowest speed at which the manufacturer's design will permit continuous operation.

NGV: (Per ANSI/AGA NGV 3.1) natural gas for vehicles having a quality and chemical composition as defined by the Standard CGSB 3.513, Natural Gas for Vehicles, which is dispensed at the appropriate container pressure as set out by the authority having jurisdiction or in the absence of a regulation, in accordance with CGA Standard CSA B108, NGV Refuelling Stations Installation Code, or SAE J1616, Recommended Practice for Compressed Natural Gas Vehicle Fuel.

(In the USA the term NGV is frequently applied to the natural gas vehicle i.e. the mobile unit itself rather than the fuel.)

Natural Gas stored in gaseous state to be used as engine fuel for a highway vehicle.

NORMAL OPERATING POINT: The normal operating point is the point at which the packager certifies that the quoted capacity and power consumption is met.

NOZZLE:

Type 1: A nozzle for use with dispensing hoses that may remain fully pressurized at dispenser shutdown. The nozzle shall be equipped with an integral valve or valves incorporating an operating mechanism which first stops the supply of gas and safely vents the trapped gas before allowing the disconnection of the nozzle from the receptacle. The operating mechanism shall ensure the vent

valve is in the open position before the release mechanism can be operated and the gas located between the nozzle shut-off valve and the receptacle check valve is safely vented prior to nozzle disconnection.

Type 2: A nozzle for use with dispensing hoses that remain fully pressurized at dispenser shutdown. A three-way valve connected to the inlet of the nozzle is required to safely vent trapped gas prior to nozzle disconnection. With a Type 2 nozzle the vent valve operating mechanism is external to the nozzle.

Type 3: A nozzle for use with dispensing hoses which are automatically depressurized [517 kPa (75 psi) and below] at dispenser shutdown.

Class A: This class specifies high frequency use, with a cycle life of 100,000 cycles.

Class B: This class specifies low frequency use, with a cycle life of 20,000 cycles.

OIL CARRYOVER: The amount of oil to be detected or calculated at the discharge of the compressor package at normal conditions, specified in ppm.

OIL FREE: "Oil Free" compressors come in two basic designs.

(i) The compressor runs with no oil whatsoever in the crankcase or compression cylinders. This design is normally utilized in the smaller range of CNG compressors such as vehicle fueling appliances.

(ii) Compressors are fitted with extra-long distance pieces which allows oil slingers to be fitted to the piston rods and that no part of the piston rod can transfer oil into an area in contact with any part of the piston rod which enters the compression chamber or gas packing area.

ONE TIME USE DEVICE: A device that must be replaced after it has been used for its intended purpose.

OVERCRANK: A fault which will cause the compressor to shut down or go into fault mode if several unsuccessful attempts are made to start the engine or if prolonged cranking time occurs, applicable only to engine driven compressors.

OXYGEN CONCENTRATION: Provided the water dew-point temperature of the gas is maintained, it is not necessary to impose an oxygen concentration limit for corrosion purposes. At no time shall the oxygen level produce a mixture within the flammability limits of the fuel.

PISTON ROD: The piston rod is a round rod, secured to the crosshead, to which the pistons are attached. The round rod facilitates the use of pressure packings and oil wipers.

PISTON SPEED: This is the product of the crankshaft revolutions per minute multiplied by two times the stroke length, usually expressed in feet per minute (meters/second).

PRESSURE: Expressed as psi or kPa or bar.

High pressure: In the NGV context, 4 bar (60 psi) or greater.

Service Pressure: The settled pressure at a uniform gas temperature of 20°C (70°F). This pressure may be 2400, 3000 or 3600 psi.

Test Pressure: The pressure to which a component or equipment is taken during testing.

PRESSURE PACKINGS AND OIL WIPERS: Packings and wipers are installed at opposite ends of the distance piece. Packings help to seal the cylinders, and minimize the amount of gas escaping from the cylinders. Oil wipers help to prevent oil migrating up the piston rod from the frame. Combination packings, combining both of the above in one assembly, are sometimes used to reduce the overall width of the compressor.

PRESSURE RELIEF DEVICE (PRD): A one-time use device, triggered by excessive temperature and/or pressure, which vents gas to protect the cylinder from rupture.

PRESSURE RELIEF VALVE: A device which prevents a pre-determined upstream pressure from being exceeded.

PURGE: To replace the existing fluid (gaseous or liquid) in piping, tubing, equipment, or a container, with a desired fluid.

RATED DISCHARGE CONDITIONS: Rated discharge pressure and temperature are the highest required to meet the conditions specified by the purchaser for the intended service.

RATED POWER: Rated power is the highest power required for any of the specified operating conditions.

REQUIRED CAPACITY: Required capacity is the capacity specified by the purchaser to meet process conditions.

RESISTIVE TEMPERATURE DEVICE (RTD): An electrical conductor that experiences a change in resistance which can be measured using a Wheatstone-bridge circuit. A thermistor is such a device commonly used to measure temperature changes.

REVOLUTIONS PER MINUTE (RPM): The speed at which the compressor or prime mover is rotating.

ROD REVERSAL: Rod reversal is a change in direction of force in the piston rod loading (tension to compression, or vice-versa), which results in a load reversal at the crosshead pin during each revolution. The duration of rod reversal is usually expressed in degrees of crankcase rotation.

ROOM TEMPERATURE: Except as otherwise stated, testing at room temperature will be conducted between 15°C (59°F) minimum and 30°C (86°F) maximum.

SAFETY CIRCUIT: A circuit or portion thereof involving one or more safety controls.

SAFETY LIMIT CONTROL: A safety control intended to prevent an unsafe condition of temperature, pressure, or liquid level.

SAFETY SHUT-OFF VALVE: See VALVE.

SERVICE TEMPERATURE RANGE: The temperature range the cylinders will be subjected to in normal service.

SHALL AND SHOULD: The word “shall” is to be understood as mandatory, and the word “should” as non-mandatory, advisory or recommended.

SINGLE ACTING PISTON: A piston where compression takes place on only one of the two piston strokes per revolution.

STANDARD CUBIC FEET PER MINUTE OR MILLION STANDARD CUBIC FEET PER DAY: Standard cubic feet per minute (SCFM) or million standard cubic feet per day (MMSCFD) refers to the capacity at 14.7 pounds per square inch absolute and 60 degrees Fahrenheit (101.325 kPa and 15°C).

STANDARD PRESSURE: In the U.S. is defined as 14.696 pounds per square inch absolute (psia); in Canada is defined as an absolute pressure equal to 101.325 kilopascals (kPa).

STANDARD TEMPERATURE: In the U.S. is defined as 60 degrees Fahrenheit; In Canada is defined as 15 degrees Celsius.

STATION:

Fast fill station: A fuelling station where an individual vehicle fill flow-rate is greater than 200 SCFM.

Fuelling Station: A facility for the dispensing of natural gas and includes all stationary equipment and associated components downstream from the inlet of a compressor manual shutoff valve.

TEMPERATURE, ROOM: Except as otherwise stated, testing at room temperature will be conducted between 15°C (59°F) minimum and 30°C (86°F) maximum.

TOOLS, SPECIAL: Those tools which are not available on the open retail market.

TRUNK (PISTON) TYPE COMPRESSOR: A positive displacement reciprocating compressor which has no separation between the cylinder(s) and frame (crankcase) and where the piston and crosshead are combined into one element. Shaft rotation is translated into piston reciprocating motion via the connecting rod. There is no piston rod. This type of compressor can be straight-line, angle (Y, V, or W) or radial configured.

VALVE: A device by which the flow of a fluid may be started, stopped, or regulated, by a movable part which opens or obstructs passage.

Automatic: A self actuated or remotely actuated device consisting essentially of a valve and operator.

Back check: A valve which allows gas to flow in only one direction.

(i) **Type A:** A valve which is used as a normal part of the equipment or system operation.

(ii) **Type B:** A valve which is used to shut off gas flow, in the event of an emergency (ie: gas leak, fire, etc.), or to shut off gas flow to a component or components for the purpose of service, maintenance or replacement.

Pressure relief: A device which prevents a pre-determined upstream pressure from being exceeded.

VEHICLE REFUELLING APPLIANCE (VRA): A natural gas compressor package not containing storage, having a flowrate not in excess of 0.3 cubic meters per minute (10 CFM) [corrected to standard conditions of 101.325 kPa at 15°C (30 inches Hg and 60°F)] and intended for unattended refuelling of vehicles having a properly installed containment system.

VENTILATION: (With respect to the space in which any equipment or appliance is installed) the removal of inside air, leaked or spilled products of combustion, exhaust or flue gases from that space to outside the space, and the replacement of same by air from outside that space.

VRA: See VEHICLE REFUELLING APPLIANCE.

ZONES:

Zone 0: An area in which an explosive gas atmosphere is present continuously or for long periods.

Zone 1: An area in which an explosive gas atmosphere is likely to occur in normal operation.

Zone 2: An area in which an explosive gas atmosphere is not likely to occur in normal operation and, if it does occur, is likely to do so only infrequently and will exist for a short period only.

STANDARDS PROPOSAL FORM

FAX OR MAIL TO:

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8501 East Pleasant Valley Road,
Cleveland, Ohio, U.S. 44131
Fax: (216) 520-8979

or

CSA Group
5060 Spectrum Way, Suite 100,
Mississauga, Ontario, Canada L4W 5N6
Fax: (416) 747-2473

DATE: _____ NAME: _____

ADDRESS: _____

TELEPHONE NUMBER: ( ) _____

REPRESENTING (Please indicate organization, company or self):

1. a) Title of Standard: _____

   b) Section/Paragraph Number and Title: _____

2. Proposal Recommends: (check one) ☐ New Text ☐ Revised Text ☐ Deleted Text

3. Proposal (Include proposed wording change(s)* or identification of wording to be deleted. If proposed wording change(s) is not original, provide source.):

4. Statement of Rationale for Proposal:

5. ☐ This proposal is original material.

   ☐ This proposal is not original material, its source (if known) is as follows:

   _____

* (Note: Proposed wording and original material is considered to be the submitter's own idea based on, or as a result of, his/her own experience, thought or research, and to the best of his/her knowledge is not copied from another source.)

I hereby assign to CSA and CSA America Inc., all worldwide right, title, and interest in and to the proposed change(s) or original material listed above, including, but not limited to, the copyrights thereon and all subsidiary rights, including rights of publication in any and all media, therein.

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PLEASE USE SEPARATE FORM FOR EACH PROPOSAL.

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