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Guidance on Industry Standard for Natural Gas Engines

GIS 34-306

BP GROUP
ENGINEERING TECHNICAL PRACTICES

Foreword

This is the first issue of Engineering Technical Practice (ETP) BP GIS 34-305. This Guidance on Industry Standard (GIS) is based on parts of heritage documents from the merged BP companies as follows:

British Petroleum

GS 134-8 Requirements for the Protection of Diesel Engines Operating in Zone 2 Hazardous Areas.

Amoco

A RE-ENG-HS-G Rotating Equipment—Engines—High Speed Gas and Diesel—Guide.
A RE-ENG-HS-P Rotating Equipment—Engines—High Speed Gas and Diesel—
Procurement Specification.

Gulf of Mexico Deepwater (GOMDW)

1400-20-ME-SP-2050 High Speed Diesel and Gas Engines.

PTA

PTA RE-ENG-HS-G Rotating Equipment—Engines—High Speed Gas and Diesel—Guide.
PTA RE-ENG-HS-P Rotating Equipment—Engines—High Speed Gas and Diesel—
Procurement Specification.

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1. Scope

This GIS provides guidance on industry standard for the design, materials, fabrication, inspection, testing, documentation, and preparation for shipment of gas engines fuelled by natural gas, such as butane or propane. Dual fuel (natural gas and diesel) engines are not included in this GIS.

2. Normative references

The following normative documents contain requirements that, through reference in this text, constitute requirements of this technical practice. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this technical practice are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

BP

GIS 06-601	Guidance on Industry Standard for Painting.
GIS 14-011	Guidance on Industry Standard for Noise Control.
GIS 34-503	Guidance on Industry Standard for API 671 Special Purpose Couplings.

American Bureau of Shipping (ABS)

ABS Publication 6	Rules For Building and Classing Mobile Offshore Drilling Units (MODUs).
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American Gear Manufacturers Association (AGMA)

AGMA 9000-C90	Flexible Couplings, Potential Unbalance Classification.
AGMA 9002-A	Bores and Keyways for Flexible Couplings (Inch Series).

American Society of Mechanical Engineers (ASME)

ASME B31.3	Process Piping.
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British Standards (BS)

BSI BS 2050	Electrical resistance of conducting and anti-static products made from flexible polymeric material.
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Codes of Federal Regulations (CFR)

46 CFR 111.01-19	Inclination of the Vessel.
46 CFR 182.440	Independent Fuel Tanks.

3. Symbols and abbreviations

For the purpose of this GIS, the following symbols and abbreviations apply:

bhp	Brake horsepower.
BMEP	Brake mean effective pressure.
LHV	Low heating value.



TBN Total base number.

4. Technical requirements

- a. Technical requirements for separable high speed natural gas engines (600 rpm or higher) are based on engine manufacturer standard design. This GIS provides additional requirements.

This GIS encourages standard package in which all auxiliary systems (except main cooler) are engine mounted. Reliable and compatible auxiliary systems are usually provided by Vendor and are not specified in detail.

- b. Equipment noise levels shall comply with GIS 14-011.
- c. Design and mechanical construction of engines, accessories, and auxiliary system components shall have minimum of 16 000 hours of field operating service.
- d. Unless specified otherwise, engines shall be rated for continuous service.
- e. Engines rated for continuous service shall be designed to operate in excess of 8 000 hr/yr with uninterrupted periods of 1 000 hr, minimum, excluding oil filters, air filters, and spark plugs.

Continuous and intermittent performance classifications are commonly used by BP. The following are general criteria for each:

- *Continuous duty engines operate at least 8 000 hr/yr and operate for uninterrupted periods of 1 000 hours or more, excluding normal maintenance of oil filter, air filters, and spark plugs.*
- *Intermittent duty engines operate less than 1 500 hr/yr and operate at rated kW (bhp) for 4 hours in any 24 hour period, then operate at or below continuous kW (bhp) rating, excluding normal maintenance of oil filter, air filters, and spark plugs.*

- f. Current turnkey overhaul cost shall be provided as follows:

1. Major and minor overhauls shall be included.
2. Parts and labour shall be listed separately.

5. Performance

5.1. Standard conditions and fuel heating values

The following standard conditions shall be used for engine rating:

- a. Standard conditions are 29°C (85°F) and barometric pressure of 0,9949 bar (29,38 in of mercury).
- b. Standard water vapour pressure is 0,0129 bar (0,38 in of mercury), which corresponds to 50% relative humidity and dry barometric pressure of 0,9820 bar (29,0 in of mercury) at sea level.
- c. Standard fuel gas shall be 90% methane, minimum, and have low heating value (LHV) of 34,3 MJ/m³ (920 Btu/ft³).

Three sets of operating conditions for specifying and evaluating a gas engine are:

- *Standard conditions in accordance with this GIS.*
- *Standard conditions as defined by Vendor.*
- *Site conditions where engine will be installed.*



Paragraphs 5.1.a through 5.1.c specify operating conditions and require Vendor to calculate (horse)power for proposed engine for these conditions. This requirement establishes common base for engine (horse)power evaluation, whereas Vendor standard conditions vary and cannot be used to make meaningful comparisons.

Site conditions normally differ from BP specified standard conditions. Site conditions should be defined and entered on data sheet because they affect engine rated (horse)power.

Site conditions have significant effect on selection of engines and auxiliary systems. If selecting engines and air coolers, maximum ambient temperature should be highest temperature that is exceeded only 3% of the time. Critical concerns are rated ambient temperature and emission control.

Most Vendors do not guarantee site performance because of variance in conditions. However, they do guarantee test stand performance corrected to site conditions by agreed upon derating criteria. Typical (horse)power derating criteria for naturally aspirated engines are:

- *Derate 1% for each 5,6°C above 29°C (10°F above 85°F).*
- *Derate 3,5% for each 300 m (1 000 ft) of elevation above 150 m (500 ft).*
- *Derate supercharged or turbocharged engines in accordance with Vendor criteria.*

Values for ambient temperature and barometric pressure become less significant if intake air is compressed by supercharger or turbocharger because superchargers and turbochargers increase inlet air pressure and temperature. Net pressure and temperature increase depend on Vendor design. Therefore, (horse)power corrections for supercharged or turbocharged engines should be made by Vendor.

Superchargers or turbochargers increase air/fuel mixture density, which results in higher (horse)power rating for a given engine. Turbocharger efficiency decreases at low speeds. Therefore, supercharger designs should be chosen for applications with wide speed variations. Compared to naturally aspirated engine, turbocharging increases power output by 25% to 40%, with slight decrease in fuel consumption.

Allowable kW (bhp) should be 90% of rated kW (bhp) at standard conditions. This derating should be applied to all engines regardless of service. This derating allows for variations in test tolerances (typically $\pm 5\%$), site fuel quality, off design conditions, and normal wear. This is necessary because Vendor (horse)power rating does not consider test tolerances or site specific variations.

Operating an engine for extended periods above continuous rated speed increases wear and maintenance. Speed versus power limitations in this GIS are based on successful field operating experience that results in acceptable maintenance levels.

[EDS Note: Recommend moving all commentary following 5.1.c to the GP.]

5.2. Performance correction

5.2.1. Standard to site conditions

(Horse)power corrections for temperature and altitude from standard conditions to site conditions shall be as follows:

- a. For naturally aspirated engines, 2,5% for each 5,6°C (10°F) above 29°C (85°F) and 3,5% for each 300 m 1 000 ft in excess of 460 m 1 500 ft above sea level.
- b. For supercharged or turbocharged engines, Vendor standard correction for site temperature and barometric pressure shall apply.

