

GENERAL SPECIFICATION

HVAC

GS EP HVA 100

HVAC Basis of Design

10	10/2012	Updating
09	01/2012	Updating
08	01/2011	Updating of defined words, formulae, heat dissipation from equipment
07	10/2009	Updating
00	10/2002	First issue
Rev.	Date	Purpose of the revision

Owning entity: DEV/TEC	Managing entity: DEV/TEC/MTH
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General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 2 of 51

Contents

1. Scope	4
2. Reference documents.....	4
3. Notes Regarding ATEX Directives	8
4. Equipment Certified in Accordance with ATEX Directives.....	9
5. <i>REFRIGERANT</i> Choice for <i>HVAC</i> Systems.....	10
6. Remarks Regarding the Use of Direct Expansion Refrigeration Systems	10
7. Fixed Data.....	11
7.1 Temperature of a Metal Surface Exposed to Direct Sunlight	11
7.2 Indoor Conditions (Temperature / Humidity).....	11
7.3 Seasonal Energy Efficiency Ratio (SEER)	17
7.4 U-Values	19
7.5 Heat Gains.....	20
7.6 Heater Capacity Calculations	23
7.7 Overpressure Inside Rooms.....	23
7.8 Air Flow Rates.....	27
7.9 Air Velocity.....	32
7.10 Tropicalisation.....	33
7.11 Hazardous Area Classification	33
7.12 Sound Pressure Levels	33
7.13 Over-Design.....	35
7.14 Equipment Minimum Performances	35
7.15 Specific Algorithms	35
8. Project Data to be Completed by Engineering	40
8.1 Location	41
8.2 Building Types	41
8.3 Segregation of HVAC Equipment.....	41
8.4 External Conditions	43
8.5 Additional Requirements for External Conditions	46



General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 3 of 51

8.6	Calculated U-Values	47
8.7	Utility Data	47
8.8	Heat Gains from Equipment	50
9.	Other References	51

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 4 of 51

1. Scope

The present specification defines the reference documents and the data which shall be used as basis of design for *HVAC* systems.

The data listed in section 7 "Fixed data" are applicable to all projects.

The data listed in section 8 "Project data to be completed by Engineering" are specific to each project and shall be indicated and / or calculated by *HVAC ENGINEERING*.

The words and expressions in CAPITAL characters and *italic* are defined inside the general specification **GS EP HVA 801**.

When other words require a definition only to be used in the present document, then the definition is given in a dedicated paragraph of the present document and the defined word, when used, is marked in small and *italic* letters.

In case of the Basic Engineering is part of a design competition where the competitor has to produced a quoted offer, the competitor shall require the *HVAC* Basis of design document approval by COMPANY HVAC SPECIALIST. In case the above procedure is not respected by the competitor, this last one shall support the consequences (financial, technical and schedule) of a basis of design change during the detailed engineering phase.

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

Equipment and installations shall be in accordance with (in order of precedence):

1. The country local regulations where equipment and/or installations shall be operated
2. Total General Specifications as listed in **GS EP HVA 000**
3. The International Standards
4. The French Regulation (when Country local regulation does not exist).

International System of Units (SI) shall be used, whatever the document (drawing, data sheet, documentation...).

Notes:

- in case of either a local regulation, or a project position is in opposition with the principle and / or the philosophy usually applied by COMPANY, the assistance of the *HVAC SPECIALIST* shall be requested by the *HVAC ENGINEERING*, in order to define the principle / philosophy which has to be applied;
- in case of discrepancy among documents, the more stringent requirements shall apply;
- the *HVAC VENDOR* or *CONTRACTOR* may propose proven improvements to the reference documents but shall obtain written approval of the COMPANY prior to implementation;

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 5 of 51

- an International Standard is a good "engineering practice" which shall be recognised and taken into consideration by *VENDOR*, *SUPPLIER*, *MANUFACTURER* and/or *CONTRACTOR*. If required, the translation of the standards shall be included into *HVAC* scope;
- the latest revision of Standards, codes, regulations and the published errata if any shall be used and applied by *VENDOR*, *SUPPLIER*, *MANUFACTURER* and *CONTRACTOR*.

Some documents listed hereafter are issued from the French Government and are applicable to the basic engineering, detailed engineering and construction. *ENGINEERING*, *CONTRACTOR* are in charge to translate or to entrust the translation to specialist.

When a requirement is mentioned in a General Specification, it prevails over the requirement on same topic as indicated in Standards, Codes, Other documents and Professional documents.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
ADC	Air Diffusion Council (All documents in accordance with equipment or part of <i>HVAC</i> installation designed)
AFI	American Filtering Institute (All documents in accordance with equipment or part of <i>HVAC</i> installation designed)
AGA	American Gas Association (All documents in accordance with equipment or part of <i>HVAC</i> installation designed)
AICVF Codes	Association des Ingénieurs de Chauffage, Ventilation Français (All codes in accordance with equipment or part of <i>HVAC</i> installation designed)
AMCA	Air Moving and Conditioning Institute (All documents in accordance with equipment or part of <i>HVAC</i> installation designed)
ARI	Air Conditioning and Refrigeration Institute (All documents in accordance with equipment or part of <i>HVAC</i> installation designed)
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers (All documents in accordance with equipment or part of <i>HVAC</i> installation designed)
Circulaire DGS n° 97/311	Circulaire de la direction générale de la santé 97/311 (French document)
Directive 1999/92/EC, referred to a ATEX 118 / 137	Directive of the European parliament and the council on minimum requirements for improving the safety and health protection of workers potentially at risk from explosives atmospheres

HVAC Basis of Design

Rev.: 10

Effective date: 10/2012

Page: 6 of 51

Reference	Title
Directive 2004/108/EC dated 15 December 2004	Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC with EEA relevance
Directive 2006/42/EC dated 17 May 2006	Directive 2006/42/EC of the European parliament and of the council on machinery, and amending Directive 95/16/EC
Directive 2006/95 dated 12 December 2006	Directive 2006/95/EC of the European Parliament and of the Council of 12 December 2006 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits
Directive 2009/125/CE	Directive 2009/125/EC of the European Parliament and of the Council of the 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products
Directive 94/9/EC, referred to a ATEX 100a / 95	Directive of the European parliament and the council on the approximation of the laws of the member states concerning equipment and protective systems intended for use in potentially explosives atmospheres
Directive 97/23/EC dated 29 May 1997	Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment
Directive 98/37/EC dated 27 June 1988	Directive 98/37/EC of the European Parliament and of the Council of 22 June 1998 on the approximation of the laws of the Member States relating to machinery
EN 12100 (Parts 1; 2)	Safety of machinery - Basic concepts, general principles for design - Parts 1; 2
EN 13831	Closed expansion vessels with built in diaphragm for installation in water systems
EN 60204-1	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
IEC 60079-14	Explosive atmospheres - Part 14: Electrical installations design, selection and erection
IEC 60335-1	Household and similar electrical appliances - Safety - Part 1: General requirements
IEC 60529	Degrees of protection provided by enclosures
IEC 61131-2	Programmable controllers - Part 2: Equipment requirements and tests
ISO 9614-1	Acoustics - Determination of sound power levels of noise sources using sound intensity
NF C15-100	Low voltage electrical installations

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 7 of 51

Reference	Title
Order in Council n°2007-1133 dated 24-07-2007	Décret n° 2007-1133 du 24 juillet 2007 relatif aux dispositions réglementaires du code du sport
Order in Council n°2008-244 dated 7-03-2008	Décret n°2008-244 du 7-03-2008 Article 9
Regulation No 327/2011	Commission Regulation (EU) No327/2011 of 30 March 2011 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for fans driven by motors with an electric input power between 125 W and 500 kW
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association. (All documents in accordance with equipment or part of HVAC installation designed)
UTE C63-100	Low-voltage switchgear and controlgear for industrial use. Switching devices. Code of practice for the construction of appliances and their enclosures designed for operation in specific environments. Relevant tests

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
GS EP HVA 000	List of HVAC specifications
GS EP HVA 301	HVAC plant room
GS EP HVA 801	Terminology, definitions, abbreviations

GS PVV

The following Company General Specifications mainly related to design and sizing of Process equipment, **shall not be used** for design and sizing of HVAC equipment:

GS EP PVV 202: Standard drawings for accessories and equipment of vessels

GS EP PVV 211: Design and fabrication of pressure vessels according to ASME VIII

GS EP PVV 212: Design and fabrication of pressure vessels according to BSI PD 5500

GS EP PVV 312: Design and fabrication of metallic vertical storage tanks

GS EP PVV 402: Standards for exchangers accessories and equipment

GS EP PVV 411: Shell and tube heat exchangers

GS EP PVV 412: Plate and frame heat exchangers

¹ The second phase of art. 3 shall be applied on 1/01/2013 instead of 1/01/2015 as mentioned in the Regulation – COMPANY requirement

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 8 of 51

GS EP PVV 414: Double pipe heat exchangers

GS EP PVV 415: Design and fabrication of air cooler

GS EP PVV 441: Procedure for shop hydraulic tests of shell and tube heat exchangers

GS EP PVV 611: Welding of pressure containing piping and equipment

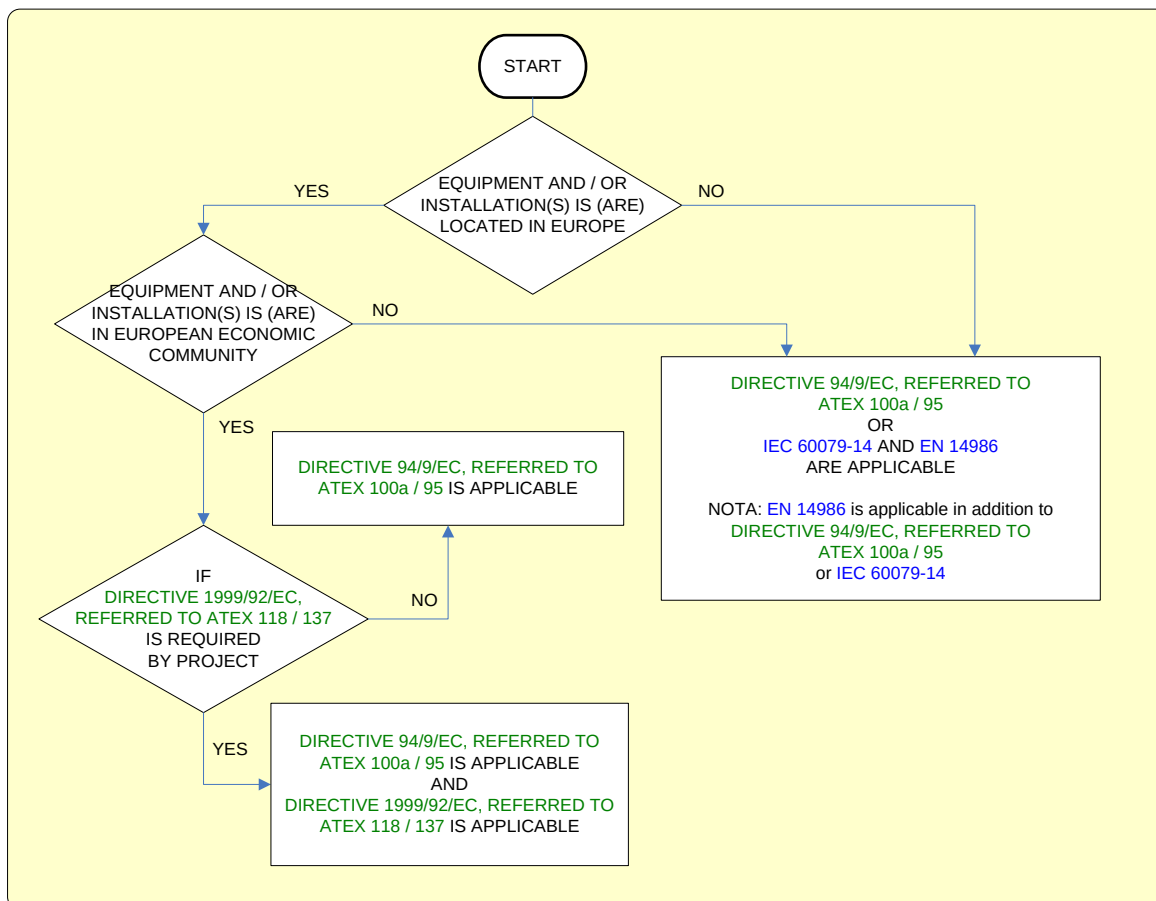
3. Notes Regarding ATEX Directives

ATEX Directives, as referred above, are applicable to *HVAC* equipment, without derogation. Unless otherwise stipulated in General Specifications, the certification of *HVAC* equipment has to be issued from a Notified Body agreed by COMPANY. The self-certification or certification by another Company than agreed Notified Body is rejected by COMPANY.

When equipment and / or components of a *SYSTEM* can produce an explosion risk, the whole *SYSTEM* (and not only components located in hazardous area) shall be designed taking into account ATEX Directives.

It means that *CONTRACTOR* is in charge to obtain a global certification of installed equipment, indicating that design and construction are in full accordance with requirements mentioned in ATEX Directives.

Both ATEX Directives shall be applicable for all the Company facilities located within the European Union (EU countries) and also outside the EU (whatever the location of Design, Construction and Installation).



4. Equipment Certified in Accordance with ATEX Directives

When ATEX Directives are applicable to equipment, requirements indicated in the General Specifications (whatever the discipline) shall be taken into account by the *MANUFACTURER* and by *HVAC CONTRACTOR*. A certificate shall be delivered, for each equipment by equipment *MANUFACTURER* taking into account the operating conditions and environment of that equipment.

The certificate shall be issued for equipment leaving the factory. Whatever the reason of equipment dismantling, (transportation, handling, installation, reparation ...), the re-assembly of unit shall be realized by the equipment *MANUFACTURER*. It is *HVAC CONTRACTOR*'s responsibility to purchase the re-assembly of unit to the equipment *MANUFACTURER* (mandatory). It is *HVAC CONTRACTOR*'s responsibility to indicate to *MANUFACTURER* that equipment shall be dismantled.

Installation of dismantled equipment shall be supervised by the equipment *MANUFACTURER*. It is *MANUFACTURER*'s responsibility to inform *COMPANY* when the above installation requirement is not respected.

Equipment inspection procedure by Notifying Body and by *MANUFACTURER*, in Factory and / or on site, shall be in full accordance with IEC 60079-14.

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 10 of 51

5. REFRIGERANT Choice for HVAC Systems

CFC and HCFC use is strictly forbidden in refrigerating equipment (air conditioning, cold room, freezer room...), whatever the location of construction, of installation, of operation of equipment and even if these *REFRIGERANTS* are not excluded by local law where the refrigerating equipment is built, installed, operated.

Preferred and accepted *REFRIGERANTS* are:

Application	Accepted <i>REFRIGERANT</i>
Chilled water production	R134a, R410A
Split system (RS4, RS6)	R134a, R410A
Split system with direct expansion in <i>AHU</i> (RS9, RS10, RS12, RS14, RS15)	R134a, R410A
Positive cold rooms	R134a
Negative cold rooms	R404A

However, depending on specific operating conditions and / or refrigerating capacity, R407C may also be used with *HVAC SPECIALIST* agreement.

Note: *REFRIGERANT* gas detection shall be installed in each room housing a part of the refrigerating system.

6. Remarks Regarding the Use of Direct Expansion Refrigeration Systems

Remark 1: DX system (direct expansion of *REFRIGERANT* in a finned tube cooling coil – air cooling) for *HVAC* can be used, on condition that:

- the total cooling capacity (sensible and latent capacity) does not exceed 250 kW;
- the *OUTDOOR AIR* quantity of *HVAC* system does not exceed 25% of the *SUPPLY AIR* of *HVAC* system;
- a water cooled condenser is installed;
- the *REFRIGERANT* shall supply a maximum of two evaporators (duty and stand-by units);
- the mass of *REFRIGERANT* does not exceed the mass of *REFRIGERANT* which is contained in a *CHILLED WATER UNIT* having an equivalent total refrigerating capacity.

Remark 2: DX split units (RS4, RS6) can be installed for bedrooms and offices only if:

- the total cooling capacity of all split units for a building does not exceed 15 kW (sensible and latent capacity);
- the total number of split units installed for a building does not exceed ten (10) units.

Remark 3: Split systems installed for crane cabin in offshore installations shall be ATEX certified, when located in or out of hazardous area.

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 11 of 51

7. Fixed Data

The *HVAC* documents (General Specifications, Particular Specification etc.) requirements may be more stringent than those dictated by the Regulations.

Sometimes requirements from Regulations are recalled in the *HVAC* documents.

Although some derogation to the Regulations, raised by *HVAC CONTRACTOR*, may be accepted by Notified Body, the *COMPANY* requirements shall apply. Such authorized derogations shall not prevail on *COMPANY* requirements as stated in the *HVAC* documents.

In the following sections, data refer sometimes to the occupation of the rooms. The number of occupants has to be considered as per the basis of design given in the present specification, except when the occupation is defined in the project specification. In this case, the occupation indicated in the project documentation (Pre-project, Basic Engineering...) prevails over the present General Specification and Derogation request to the present General Specification is not required.

7.1 Temperature of a Metal Surface Exposed to Direct Sunlight

A metal surface exposed to direct sunlight shall be considered at 80°Celsius. This value shall be used for thermal insulation calculation for all applications.

7.2 Indoor Conditions (Temperature / Humidity)

7.2.1 Indoor Conditions During Winter

The following temperatures shall be considered:

- The “Winter temperature design point” is the temperature value to take into account for calculations (Heat losses calculations),
- The “Winter temperature tolerance” is the acceptable difference between the “Winter temperature design Point” and the measured room temperature, when outside temperature is in accordance with the assumption for outside winter temperature.

Room	Winter temperature <i>DESIGN POINT</i> (°Celsius)	Winter temperature tolerance (°Celsius)
Ablution room	22	± 1
Air lock	16	± 1
Bakery	22	± 1
Battery room	16	± 1
Bed room (Hot climate) ²	22	± 1
Bed room (Cold climate) ³	20	± 1

² Refer to Project specification

³ Refer to Project specification

HVAC Basis of Design

Rev.: 10

Effective date: 10/2012

Page: 12 of 51

Room	Winter temperature <i>DESIGN POINT</i> (°Celsius)	Winter temperature tolerance (°Celsius)
Changing room / lockers room	22	± 1
Coffee or tea room	20	± 1
Cold rooms plant room	16	± 1
Control room	22	± 1
Corridors	20	-1 / +2
Diesel oil purifier room	16	± 1.5
Dining room	22	± 1
Dish wash	22	± 1
Dryer room	18	± 1.5
Electrical room	19	± 1
Electrical room for pumps & HPU (Hydraulic Power Unit)	19	± 1
Fire control station	16	± 1
General service cooling water	16	± 1
Generator enclosure for Emergency diesel generator, Essential diesel generator, Main power generator	10 (maximum of 40°C when the generator is running)	± 2
Generator technical room	19	± 2
Generator room for Emergency diesel generator, Essential diesel generator, Main power generator	19 °C when the generator is not running (maximum of 40°C when the generator is running)	± 2
Grocery / dry goods store	18	± 1.5
HPU (Hydraulic Power Unit)	16	± 1.5
<i>HVAC PLANT ROOM</i>	16	± 1,5
Inert gas room	16	± 1
Instrument room	19	± 1
Kitchen	22	± 1
Laboratory	20	± 1
Laundry	18	± 1.5

HVAC Basis of Design

Rev.: 10

Effective date: 10/2012

Page: 13 of 51

Room	Winter temperature <i>DESIGN POINT</i> (°Celsius)	Winter temperature tolerance (°Celsius)
Library	21	± 1
Marine store	16	± 1
Meeting room, conference room	21	± 1
Mortuary	8	± 1
Muster room, secondary muster room	19	± 1
Office	21	± 1
Photocopy room	21	± 1
Prayer room	20	± 1
Pump room	16	± 1.5
Radio room	21	± 1
Recreation room	22	± 1
Sewage treatment room	16	± 1.5
Shaft, riser	5	0 / + NC
Showers ⁴	24	± 1
Sick bay, first aid, infirmary	24	± 0.5
Sport room	18	± 1
Staircase (enclosed)	20	-1 / +2
Storage	16	± 1
Storage (non perishable foods)	14	-1 / +0
Telecom room	19	± 1
Transformer room	7	± 2
Toilets (except cabins)	20	± 1
TV room	22	± 1

⁴ Room given access to showers shall be maintained at 24°C

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 14 of 51

Room	Winter temperature <i>DESIGN POINT</i> (°Celsius)	Winter temperature tolerance (°Celsius)
Vegetables preparation	16	± 1
Waste room / garbage	2 ⁵	± 1
Water maker (fresh water) room	16	± 1
Workshop	18	± 1.5

Note: NA = Not Applicable, NC = Not Controlled

A *RELATIVE HUMIDITY* at least equal to 30% shall be maintained in all areas and the necessary equipment shall be designed and supplied by the *HVAC CONTRACTOR*.

If ATEX is applicable, a special risk assessment shall be carried out and the above values should be modified (refer to COMPANY instructions).

For winterisation purpose of oil and gas process equipment located inside a closed space, the minimum temperature to be maintained in that space shall be +5°C. For other equipment or for functions indicated within above table, the values of this above table shall be applied.

7.2.2 Indoor Conditions During Summer

The conditions listed hereafter should be adequate for all equipment (*HVAC* equipment or all other equipment located in the rooms) even if sensitive to temperature or relative humidity. The *HVAC CONTRACTOR* shall check the recommendations from the various equipment *MANUFACTURERS* and use the more stringent requirements for design.

The following conditions shall be considered:

- The “Summer temperature *DESIGN POINT*” is the temperature to take into account for calculations. These temperatures are the maximum indoor temperature acceptable in summer period. It means that inside temperature in rooms can be lower than indicated values but this temperature shall be higher than “Winter temperature design point”.
- The “*RELATIVE HUMIDITY*” is the humidity which shall be achieved at any temperature within the setting range.
- The “Summer temperature tolerance” is the acceptable difference between the selected setting and the actual room temperature.

Room	Summer temperature <i>DESIGN POINT</i> (°Celsius)	<i>RELATIVE HUMIDITY</i> (%)	Summer temperature tolerance (°Celsius)
Ablution room	24	40 to 65	± 1
Air lock	24	NC	± 1

⁵ Whatever the outside temperature

HVAC Basis of Design

Rev.: 10

Effective date: 10/2012

Page: 15 of 51

Room	Summer temperature DESIGN POINT (°Celsius)	RELATIVE HUMIDITY (%)	Summer temperature tolerance (°Celsius)
Bakery	24	NC	± 1
Battery room	24	40 to 60	± 1
Bed room	24	40 to 60	± 1
Changing room	24	40 to 65	± 1
Coffee or tea room	24	40 to 60	± 1
Control room	24	40 to 60	-1 / +0
Cold rooms plant room	26	30 to 50	± 1.5
Corridors	24	NC	± 1
Diesel oil purifier room	35	20 to 75	± 2
Dining room	24	40 to 60	± 1
Dish wash	24	NC	± 1
Dryer room	24	NC	± 1.5
Electrical room	26	40 to 60	-1 / +0
Electrical room for pumps & HPU (Hydraulic Power Unit)	26	40 to 60	-1 / +0
Fire control station	24	40 to 60	± 1
General service cooling water	35	20 to 75	± 2
Generator enclosure for Emergency diesel generator, Essential diesel generator, Main power generator	26°C when generator is not running 40°C when generator is running	NC	+ 2
Generator technical room	24	40 to 65	± 1
Generator room for Emergency diesel generator, Essential diesel generator, Main power generator	26°C when generator is not running 40°C when generator is running	NC	+ 2
Grocery / dry goods store	18	55 to 65	± 1.5

HVAC Basis of Design

Rev.: 10

Effective date: 10/2012

Page: 16 of 51

Room	Summer temperature <i>DESIGN POINT</i> (°Celsius)	<i>RELATIVE HUMIDITY</i> (%)	Summer temperature tolerance (°Celsius)
HPU (Hydraulic Power Unit)	35	20 to 75	± 2
<i>HVAC PLANT ROOM</i>	24	40 to 60	± 1.5
Inert gas room	35	20 to 75	± 2
Instrument room	26	40 to 60	-1 / +0
Kitchen	24	40 to 70	± 1
Laboratory	20	50 to 65	± 1
Laundry	24	NC	± 1.5
Library	24	40 to 60	± 1
Lockers room	24	40 to 65	± 1.5
Marine store	26	30 to 50	± 3
Meeting room, conference room	20	40 to 60	± 1.5
Mortuary	8	60 to 90	± 1
Muster room, secondary muster room	22	40 to 60	± 1.5
Office	See hereafter	40 to 60	± 1
Photocopy room	24	40 to 60	± 1
Prayer room	22	40 to 60	± 2
Pumps room	35	20 to 75	± 2
Sport room ⁶	22	40 to 65	± 1
Radio room	22	40 to 60	± 1
Recreation room	24	40 to 60	± 1
Sewage treatment room	35	20 to 75	± 2
Shaft, riser	+5°C minimum	NC	NA
Showers ⁷	24	NC	± 1

⁶ For squash room, design point: 17°C / 40 to 65%

⁷ Room given access to showers shall be maintained at 24°C

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 17 of 51

Room	Summer temperature <i>DESIGN POINT</i> (°Celsius)	<i>RELATIVE HUMIDITY</i> (%)	Summer temperature tolerance (°Celsius)
Sick bay, first aid, infirmary	24	40 to 60	± 0.5
Staircase (enclosed)	24	NC	± 1
Storage (non perishable foods)	14	40 to 60	-1 / +0
Storage	26	30 to 50	± 3
Telecom room	24	40 to 60	-1 / +0
Toilets	24	NC	± 1.5
Transformer room	30	25 to 60	± 2
TV room	24	40 to 60	± 1
Vegetables preparation	14	NC	NA
Waste room / garbage	2	60 to 90	± 1
Water maker (fresh water) room	24	40 to 65	± 1
Workshop	24	40 to 60	± 1.5

Note: NA = Not Applicable, NC = Not Considered

For office and equivalent room, care shall be taken by *CONTRACTOR* to provide equipment ensuring an evolution of temperature according to the following formula:

$$T_{int} = \frac{T_{ext} - 4}{2} + 10$$

Where: T_{int} = setting point temperature in ° Celsius

T_{ext} = outside air temperature in ° Celsius

Result of this calculation shall be limited to a minimum of 21°C and a maximum of 24°C.

For winterisation purpose of oil and gas process equipment located inside a closed space, the maximum temperature to be maintained in that space shall be 35°C, except for transformer rooms where temperature shall be limited to 30°C. For other equipment or for functions indicated within above table (except for transformer rooms), the values of this table shall be applied.

7.3 Seasonal Energy Efficiency Ratio (SEER)

A seasonal Energy Efficiency Ratio (SEER) shall be calculated by *ENGINEERING*, according to the local meteorological data base.

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 18 of 51

The calculation method of A, B, C, D coefficients used for $SEER$ calculation (refer to chilled water unit General Specification) is indicated hereafter:

The fluid (outside air, sea water or fresh water) depends on season. For each Project, the following values shall be calculated:

ETC_{Max} = Maximum fluid entering temperature on condenser (nominal Project conditions) - Refer to "General design data" paragraph of "Chilled Water Unit(s) - General Specification"

ETC_{Min} = Minimum fluid entering temperature on condenser (nominal Project conditions) - Refer to "General design data" paragraph of "Chilled Water Unit(s) - General Specification"

$$\Delta T = ETC_{Max} - ETC_{Min}$$

Four temperature ranges shall be defined according to the hereafter table:

Range	ΔT
Range 4	Maximum fluid entering temperature on condenser (nominal Project conditions) to $ETC_{Min} + 0,75 \cdot (ETC_{Max} - ETC_{Min})$
Range 3	$ETC_{Min} + 0,75 \cdot (ETC_{Max} - ETC_{Min})$ to $ETC_{Min} + 0,50 \cdot (ETC_{Max} - ETC_{Min})$
Range 2	$ETC_{Min} + 0,50 \cdot (ETC_{Max} - ETC_{Min})$ to
Range 1	$ETC_{Min} + 0,25 \cdot (ETC_{Max} - ETC_{Min})$ to Minimum fluid entering temperature on condenser (nominal Project conditions)

For each above range (Range 1 to Range 4), the number of days for which the average fluid entering temperature to condenser is reached, shall be calculated.

The number of days, per period, will represent a percentage of year will defines the value for each coefficient A, B, C, D .

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 19 of 51

The calculation steps shall be summarized by *ENGINEERING* in the following table:

Range	Fluid average entering temperature on condenser (°C)		Number of days per year	Percentage per year
	From	To		
Range 4				$D =$
Range 3				$C =$
Range 2				$B =$
Range 1				$A =$

Coefficients A, B, C, D shall be used as per "*CHILLED WATER UNIT(s)* - General Specification".

For each project and for each type of chilled water unit, the minimum *SEER* for unit selection shall be requested by *ENGINEERING* to COMPANY. This (these) value(s) shall be indicated by *ENGINEERING* in the present paragraph.

7.4 U-Values

The U-values shall be calculated by *CONTRACTOR*, from architectural data. The convection and radiation factors shall be calculated taking into account the actual values of wind and colors. *WALLs* shall be designed to prevent condensation on surface and / or in *WALLs* materials.

In case the calculated U-values are higher than the reference U-values, insulation efficiency shall be improved in order to reach the reference U-values. The improvement shall be defined in accordance with COMPANY Architecture Specialist (additional insulation or change of material).

In case the calculated U-values are lower than the reference U-value, Reference U-value shall be considered for *HVAC* calculation notes.

<i>WALLs</i>	Reference U-value in $W/m^2/°C$
External walls	0.6
Roof	0.6
Floor	0.6
Doors	3.5
Windows	2.7
Partitions / internal walls	2.2

The above limits are applicable to offshore installations.

For onshore installations, local regulation shall be used, but, condensation risk inside *WALLs* shall be worked out. In absence of local regulation, the French regulation shall be used.

HVAC Basis of Design

Rev.: 10

Effective date: 10/2012

Page: 20 of 51

7.5 Heat Gains

7.5.1 Heat Gains from Persons

In case of the occupancy of rooms is not defined by the Project, the following number of persons inside the rooms has to be considered (occupancy defined by the Project prevails over the following values):

Room	Number of persons inside rooms	Activity type
Ablution room	1 person / 3 m ² of floor	Light work
Air lock	0	
Bakery	2	Light work
Battery room	2	Light work
Bed room	Number of bed	Seated
Coffee or tea room	1 person / m ² of floor	Sedentary work
Conference room	1 person / m ² of floor	Seated
Control room	4	Sedentary work
Corridors	0	
Dining room	Number of seats	Seated
Dryer room	1	Heavy work
Electrical room	2	Light work
Grocery / dry goods store	0	
<i>HVAC PLANT ROOM</i>	2	Heavy work
Instrument room	2	Light work
Kitchen	3	Light work
Laboratory room	2	Sedentary work
Laundry	3	Heavy work
Library	1 person / 3 m ² of floor	Sedentary work
Lockers room	0	
Meeting room	1 person / 3 m ² of floor	Seated
Mortuary	2	Sedentary work
Muster room, secondary muster room	1 person / m ² of floor	Heavy work
Office	1 person / 7 m ² of floor	Office work

HVAC Basis of Design

Rev.: 10

Effective date: 10/2012

Page: 21 of 51

Room	Number of persons inside rooms	Activity type
Photocopy room	1	Light work
Prayer room	1 person / 0,8 m ² of floor	Seated
Radio room	1	Seated
Recreation room	1 person / m ² of floor	Sedentary work
Showers	1 per shower	Light work
Sick bay	2	Seated
Sport room	1 person / 3 m ² of floor	Heavy work
Store	0	
Telecom room	1	Seated
Toilets	0	
TV room	1 person / m ² of floor	Seated
Vegetables preparation	1	Heavy work
Waste room / garbage	0	
Workshop	2	Heavy work

Sensible and latent heat gains shall be taken into account in accordance with the following values, for cooling loads calculation:

	28°C		27°C		26°C		24°C		21°C	
Activity type	Sens.	Lat.	Sens.	Lat.	Sens.	Lat.	Sens.	Lat.	Sens.	Lat.
Seated	51	51	57	45	61	41	67	35	75	27
Office work	52	79	58	73	63	69	71	60	82	49
Sedentary work	56	106	64	97	71	90	82	79	94	67
Light work	56	164	64	155	72	147	86	133	107	113
Heavy work	131	292	138	288	142	282	153	270	176	247

(Values in Watts)

Heating loads calculation (winter period) shall not take into account the heat gains from persons.

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 22 of 51

7.5.2 Heat Gains from Lighting

The following values shall be taken into account for cooling loads calculations (assuming fluorescent type of lighting), during Basic Engineering phase:

Room	Ratio (W/m ²)
Corridor	12
Control room, meeting room	18
Bedroom and other occupied rooms, dining room, electrical room, kitchen, bakery, showers baths, toilets	15
Machinery	12
Shaft, riser	6 W/m ³
Store, waste, mortuary, prayer room	12
Stairs	18
Technical room	15
Other	15
Conference room	18

Heat dissipations, issued from lighting equipment *MANUFACTURER* and lighting studies shall be considered during Detailed Engineering phase.

Heating loads calculation (winter period) shall not take into account the heat gains from lighting.

7.5.3 Heat Gains from Equipment

The heat gains from equipment shall be defined according to the heat dissipations provided by equipment *MANUFACTURER*.

- For technical rooms (electrical rooms, instrument rooms, telecom rooms, etc.), laundry, galley/kitchen area, machinery room and copy room, 50% of heat gains from equipment shall be taken into account for heating loads calculations (winter period).
- For other rooms, heat gains from equipment shall not be taken into account for heating loads calculations (winter period).

For computer in office, 300 W minimum per unit shall be considered. For computer in bedroom, 70W per unit shall be considered. For printer 500 W minimum per unit shall be considered.

7.5.4 Heat Gains from Solar Radiation

Heating loads calculation (winter period) shall not take into account the heat gains from solar radiation.

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 23 of 51

7.6 Heater Capacity Calculations

The heater capacity shall be designed based on winter conditions. It means that the heaters capacities, called ϕ , shall be designed in accordance with the following formula:

$$\phi = \phi_1 + \phi_2$$

Where:

- ϕ_1 is the thermal needs for air reheating from *SUPPLY AIR* temperature to "Winter temperature design point"
- ϕ_2 is the thermal needs to balance the heat losses (taking into account 50% of heat gains from equipment in technical rooms (electrical rooms, instrument rooms, telecom rooms, etc.), laundry, galley/kitchen area, machinery room and copy room).

7.7 Overpressure Inside Rooms

The overpressure target is to avoid gas transfer from a polluted or non safe area to another area where:

- Equipment is not designed for explosive atmospheres
- Pollutant could have an effect on health or wellbeing of the occupants.

The overpressure has to be provided for each room which can be exposed to one of both of the above cases. The protection of a room or a group of rooms regarding a pollutant can be made by means of a pressure barrier in order to avoid the pollutant entrance.

In case of a corridor serving several rooms and adjacent to a polluted area, the following design has to be implemented:

- When the polluted (or potentially polluted) space can be continuously maintained at a lower pressure than the pressure of the corridor, an air lock is not required between the corridor and the polluted (or potentially polluted) space.
- When the polluted (or potentially polluted) space cannot be continuously maintained at a lower pressure than the pressure of the corridor, an air lock shall be installed between the corridor and the polluted (or potentially polluted) space.

For a room having an emergency access door to a polluted (or potentially polluted) space, an air lock is not required if this room has less than 3 doors to other non pressurized spaces. This room shall be pressurized with positive pressure regarding the polluted (or potentially polluted) space.

Unless otherwise specified, the reference pressure shall be the ambient pressure outside of the building without wind.

The leakage air flow rates (through walls, roofs, floors, windows) shall be calculated by *CONTRACTOR*, taken into account architectural data.

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 24 of 51

At the design stage (basic engineering), and in order to anticipate ageing, the following values shall be considered. For an air at 24°C and 50% RH, the maximum leakage flow rates through the doors, in m³/h, (including the leakage between the door and the fixed frame) shall be:

Type of door	Differential Pressure (Pa)				
	10	20	30	40	50
Simple leaf 2.1x0.8m	99	140	171	198	221
Simple leaf 2.1x0.9m	103	146	179	207	231
Simple leaf 2.1x1.0m	108	153	187	216	241
Simple leaf 2.1x1.1m	112	159	195	225	251
Double leaf 2.1x1.4m	157	268	328	379	423
Double leaf 2.1x1.6m	166	281	344	397	444
Double leaf 2.1x1.8m	175	293	359	415	464
Double leaf 2.1x2.0m	184	306	375	453	484

During detailed engineering, the above values shall be taken into account for calculation. The leakage air flow rates from doors *MANUFACTURER* and test report shall be attached to the leakage air flow rates calculation note.

Notes: During the detailed engineering, the *CONTRACTOR* in charge of doors purchasing and installation, shall guarantee *HVAC Engineering* and *COMPANY*, that leakage air flow rates, measured during commissioning will be lower than 20% of values indicated within above table.

The leakage air flow rates, indicated by the doors *MANUFACTURER*, shall be transmitted to *COMPANY*. These rates cannot exceed 10% of the values indicated in the above table. An installation specification has to be provided by the doors *MANUFACTURER* to guarantee the above rate.

During *COMMISSIONING* and start-up of the plant, only 20% of the leakage rates (indicated in the above table) will be accepted. These leakages rate may be lowered due to more stringent requirements from Architecture or Safety disciplines.

For *WALLs*, infiltration surface of 10⁻⁵ m²/m² of *WALL* shall be used for calculations.

Pressurization values to be obtained inside rooms are indicated hereafter. These values are indicative and depend on overpressure philosophy, rooms arrangement, etc, thus they have to be discussed with and approved by COMPANY SPECIALIST during Basic Engineering. During quotation and/or endorsement phase, a modification of layout can have an impact on pressurization values set in the rooms. The bidder shall include the necessary updating in technical review and quotation.

During detailed engineering phase, a modification of layout can have an impact on pressurization values set in the rooms. The *CONTRACTOR* shall include the necessary updating in *HVAC* studies.

The following values for differential pressure between rooms and outside are given as a guide. They can be modified by *HVAC ENGINEERING* with *Company HVAC SPECIALIST* agreement

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 25 of 51

(without derogation request). The values indicated hereafter are applicable for non-surrounded rooms. In case of surrounded rooms, the values of table have to be modified in order to maintain the differential pressure between

- rooms, in order to avoid transfer of pollutants between these rooms
- between rooms and outside.

The final value shall be defined considering safety as the first criteria.

Room	Differential pressure between room and outside, in Pascal
Ablution room	30
Air lock	50
Bakery	30
Battery room	30
Bed room	30
Coffee or tea room	30
Control room	30
Corridors (with air lock)	NC
Corridors (without air lock)	50
Dining room	30
Dryer room	30
Electrical room	30
Grocery / dry goods dry	30
<i>HVAC PLANT ROOM</i>	30
Instrument room	30
Kitchen	30
Laboratory room	30
Laundry	30
Library room ⁸	30
Lockers room	30
Meeting room, conference room	30
Mortuary	30
Muster room, secondary muster room	50

⁸ Not applicable for building type "Laboratory".

HVAC Basis of Design

Rev.: 10

Effective date: 10/2012

Page: 26 of 51

Room	Differential pressure between room and outside, in Pascal
Office	30
Photocopy room	30
Prayer room	30
Radio room	30
Recreation room	30
Showers baths	30
Sick bay, first aid, infirmary	30
Smoking room	At least 10 Pa less than the pressure of the adjacent rooms
Sport room	30
Staircase (with air lock)	NC in normal case 50 in case of fire in surrounding room(s)
Staircase (without air lock)	50
Store	30
Telecom room	30
Toilets	30
TV room	30
Vegetables preparation	30
Waste room / garbage	Underpressure relative to adjacent rooms
Workshop	30

In addition to the above requirements, the maximum differential pressure on a door shall be limited to 65 Pa. In accidental situation (failure of one *HVAC* equipment of concerned loop), the maximum acceptable opening force, on a door located on escape route, shall never exceed 250N on the considered door.

Negative pressure (relative to the outdoor pressure reference) is forbidden.

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 27 of 51

In case of use of a fire extinguishing gas system, the above pressures in concerned rooms does not need to be maintained during the gas release. However, appropriate devices and / or automation from F&G system shall be installed (out of *HVAC* scope of work, but *HVAC CONTRACTOR* is in charge to highlight this requirement to discipline in charge of fire extinguishing system), in order to prevent pressure increase above 65 Pa inside concerned rooms, during the extinguishing gas release. The excess of extinguishing gas from the room (to avoid overpressure) has to be routed to outdoor. It is required (mandatory) to *CONTRACTOR* to demonstrate that, the inside pressure of a room protected by an extinguishing system:

- Cannot prevent entering of an operator into this room during the fire extinguishing gas release (because of excess of pressure inside the room, on the access door)
- Cannot damage the structure of the building
- Cannot damage the equipment located in this room.

The requirements from SOLAS shall be maintained during the fire extinguishing gas release.

Leakage air flow rates taken into account for *HVAC* equipment design shall be justified by calculation note and/or *MANUFACTURER*'s certificates. In addition to this calculation note, *CONTRACTOR* shall indicate the opening force on each door.

The pressurization of rooms, when required for safety reasons (in order to avoid transfer of explosive atmosphere) shall be guaranteed when electrical power supply is available from a generator. It means that these rooms have to be served from an *ESSENTIAL HVAC SYSTEM*.

7.8 Air Flow Rates

7.8.1 OUTDOOR AIR Flow Rates

The *OUTDOOR AIR* flow rates indicated below are the minimum rates for hygienic purpose⁹. These rates may be increased to ensure the suitable pressurization in the rooms:

The *OUTDOOR AIR* flow rates (for hygiene only) shall be in accordance with the following values:

Room	OUTDOOR AIR flow rate
Electrical/Instrumentation room	0.5 VOLUME OF ROOM /hour
Machinery spaces (when non Air Conditioned)	0.3 VOLUME OF ROOM /hour
Unoccupied room	0.3 VOLUME OF ROOM /hour
Occupied room	25 m ³ /h/person
Conference room	30 m ³ /h/m ² of floor
Dining room	30 m ³ /h/person
HVAC PLANT ROOM	Refer to GS EP HVA 301
Kitchen 1 to 150 meals	25 m ³ /h/meal
Kitchen 151 to 500 meals	20 m ³ /h/meal

⁹ According to French regulation ([Order in Council n°2008-244](#) dated 7-03-2008)

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 28 of 51

Room	OUTDOOR AIR flow rate
Meeting room	30 m ³ /h/person, based on 3 m ² /person
Mortuary	2 VOLUME OF ROOM /hour
Recreation room, TV room, tea room	30 m ³ /h/person
Showers	45 m ³ /h/person
Sport room	60 m ³ /h/person
Storage	0.3 VOLUME OF ROOM /hour
Welding area	60 m ³ /h/person
Workshop	45 m ³ /h/person

For winterisation purpose of oil and gas process equipment located inside a closed space, the minimum *OUTDOOR AIR* flow rate shall be in accordance with the following range: 12 to 20 *VOLUME OF ROOM* per hour. *OUTDOOR AIR* flow rate shall be calculated (mandatory) and shall take into account local regulation. In all cases, the above minimum *OUTDOOR AIR* flow rate (12 to 20 *VOLUME OF ROOM* per hour) is required but can be higher according to the calculation results.

7.8.2 EXTRACT AIR Flow Rates

The *EXTRACT AIR* flow rates shall be in accordance with the following values:

Room	EXTRACT AIR flow rate
Changing room	2 VOLUME OF ROOM / hour
Kitchen	Depending on hood characteristics
Mortuary	2 VOLUME OF ROOM / hour
Smoking area	10 VOLUME OF ROOM / hour
Sport room	Blown air flow rate ¹⁰
Showers	45 m ³ /h/cabin when isolated 30 + (5xN) m ³ /h/cabin when grouped (N= Number of showers)
Toilets	35 m ³ /h/cabin when isolated 30 + (5xN) m ³ /h/cabin when grouped (N= Number of toilets)

¹⁰ Blown air flow rate shall be converted to indoor conditions of room (temperature and relative humidity inside room). It means that mass of blown air flow and mass of exhaust air shall be equal.

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 29 of 51

7.8.3 Air Change Volume

The minimum air change volumes defined hereafter are independent of any pressurization or *OUTDOOR AIR* volume requirement.

7.8.3.1 Battery Room and Cabinets with Batteries

Natural air change is forbidden.

Whatever the type of batteries, the following method for air change calculation shall be applied:

The purpose of ventilation within the battery room is to maintain the hydrogen concentration below the 4% hydrogen threshold. The battery room will be considered as safe from explosion when the concentration of hydrogen is kept below the safe limit.

The minimum air flow rate for ventilation shall be calculated by the following formula:

$$Q = v \times q \times s \times n \times I_{gaz} \times C_{rt} \times 10^{-3}$$

Where: Q = air change volume in m³/h

v = necessary dilution of hydrogen

$q = 0.42 \cdot 10^{-3}$ m³/Ah

$s = 6$ (safety factor)

n = number of cells

I_{gaz} = current producing gas in mA per Ah rated capacity for the float charge current I_{float} or the boost charge current I_{boost} .

C_{rt} = capacity C_{10} for lead acid cells (Ah), $U_f = 1.80$ V/cell at 20°C

capacity C_5 for NiCd cells (Ah), $U_f = 1.0$ V/cell at 20°C

With $v \times q \times s = 0,05 \text{ m}^3 / \text{Ah}$, the ventilation air flow calculation formula is:

$$Q = 0,05 \times n \times I_{gas} \times C_{rt} \times 10^{-3} \text{ [m}^3/\text{h]}$$

The current I_{gas} producing gas is determined by the following formula:

$$I_{gas} = I_{float/boost} \times F_g \times F_s \text{ [mA/Ah]}$$

Where: I_{float} = float charge current (per cell) under fully charged condition at a defined float charge voltage at 20°C

I_{boost} = boost charge current (per cell) under fully charged condition at a defined boost charge voltage at 20°C

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 30 of 51

F_g = gas emission factor, proportion of current at fully charged state producing hydrogen

F_s = safety factor, to accommodate faulty cells in a battery string and an aged battery

Whatever the battery type installed, only vented batteries shall be considered to define the exhaust air flow rate.

Unless otherwise stated by the *MANUFACTURER*, preferred values for I_{float} (per cell) and I_{boost} (per cell) with supporting data are given in the following table:

Data	Pb Vented cell Sb < 3% ¹¹	NiCd Vented cell
Gas emission factor, F_g	1	1
Gas emission safety factor, F_s (incl.10% faulty cells and ageing)	5	5
Float charge voltage, U_{float} ¹² (V / cell)	2.23	1.40
Typical float charge current, I_{float} (mA per Ah)	1	1
Current (float), I_{gas} (mA per Ah) (under float charge conditions relevant for air flow calculation)	5	5
Boost charge voltage, U_{boost} ¹³ (V / cell)	2.40	1.55
Typical boost charge current, I_{boost} (mA per Ah)	4	10
Current (boost), I_{gas} (mA per Ah) (under boost charge conditions relevant for air flow calculation)	20	50

¹¹ For higher Antimony content, contact the manufacturer for suitable values.

¹² Float and boost charge voltage can vary with the specific gravity of electrolyte in lead-acid cells.

¹³ Float and boost charge voltage can vary with the specific gravity of electrolyte in lead-acid cells.

HVAC Basis of Design

Rev.: 10

Effective date: 10/2012

Page: 31 of 51

7.8.3.2 Other Rooms

Room	Minimum air change volumes, in <i>VOLUME OF ROOM</i> / hour
Ablution room	4
Air lock	40 to 60 - see note (1)
Bakery	20
Bed room	4
Chemical store (refer to Note (2))	6
Coffee or tea room	3
Control room	3
Corridors and staircases	1.5
Dining room	3
Dryer room	10
Electrical room	3
Grocery / dry goods store	3
<i>HVAC PLANT ROOM</i>	Refer to GS EP HVA 301
Instrument room	3
Kitchen	30
Laboratory room	Refer to Note (2)
Laundry	10
Library	3
Lockers room	5
Meeting room, conference room	4 - see note (3)
Mortuary	2 - see note (4)
Office	3 - see note (3)
Paint store (refer to Note (2))	6
Photocopy room	3
Prayer room	4
Radio room	3
Recreation room	4
Shaft, riser	0,25

HVAC Basis of Design

Rev.: 10

Effective date: 10/2012

Page: 32 of 51

Room	Minimum air change volumes, in <i>VOLUME OF ROOM</i> / hour
Showers ¹⁴ , baths	3
Sick bay, first aid, infirmary	4
Smoking room (or room where smoking is authorized) ¹⁵	10 ¹⁶
Sport room	4
Store	2
Telecom room	3
TV room	4
Vegetables preparation	3
Waste room / garbage	No mechanical air change
Workshop	3

Notes:

(1) Depending on leakage air flow rate, particularly on doors. For air locks, air change volumes are not considered as a parameter. The blown air flow rate shall be designed taking into account the differential pressures for all doors, walls, partitions, to maintain the required overpressure inside air locks.

(2) A dilution approach shall be in accordance with the following items:

- Chemicals pollutants
- Mixing of pollutants
- Masses of pollutants
- Limit exposure values, mean exposure values, Inferior exposure limit.

For a Basic Engineering study, a minimum of 12 Air Change volumes per hour shall be assumed.

(3) In case of variable flow, the air change volume shall be increased to 5.

(4) Air change volume is defined when cooled drawers are used.

7.9 Air Velocity

In occupied rooms, the air distribution shall be such that air velocity at 0.9 m from floor shall never exceed 0.15 m/s.

¹⁴ Room given access to showers baths shall be maintained at 24°C.

¹⁵ According to the French regulation (Décret n° 2007-1133 du 24 juillet 2007 relatif aux dispositions réglementaires du code du sport), the surface of the floor for this room is limited to 35 m².

¹⁶ A dedicated EXHAUST AIR system is required for this(these) room(s).

HVAC Basis of Design

Rev.: 10

Effective date: 10/2012

Page: 33 of 51

7.10 Tropicalisation

Electrical equipment shall withstand their environment (their position in the installation, the psychrometric conditions surrounding the equipment).

7.11 Hazardous Area Classification

The *HVAC* equipment shall be certified for the *HAZARDOUS AREA* where they are located in accordance with Project classification.

Furthermore, they shall comply with the specific requirements of the room or package where they are installed or connected with battery room, gas storage, fume cupboard...

Every *HVAC* equipment for *HAZARDOUS AREA* shall fulfill the ATEX directives.

7.12 Sound Pressure Levels

Maximum sound pressure levels (at any frequency), measured at any point of an occupied room, and due to *HVAC* equipment, shall be lower than Noise Criterion as indicated below:

Room	NC
Ablution room	45
Air lock	45
Bakery	45
Battery room	55
Bed room	30
Chemical store	55
Coffee or tea room	35
Control room	35
Corridors	45
Dining room	40
Dryer room	45
Electrical room	45
Grocery / dry goods store	50
<i>HVAC PLANT ROOM</i>	70
Instrument room	45
Kitchen	45
Laboratory	35
Laundry	40
Lockers room	50
Meeting room	35

HVAC Basis of Design

Rev.: 10

Effective date: 10/2012

Page: 34 of 51

Room	NC
Mortuary	35
Office	35
Paint store	55
Photocopy room	40
Prayer room	35
Radio room	35
Recreation room (games)	40
Recreation room (reading room)	30
Showers baths	45
Sick bay, first aid, infirmary	30
Sport room	45
Staircase (in normal mode – out of fire situation)	45
Storage	55
Telecom room	45
Toilets	45
TV room	30
Vegetables preparation	45
Waste room / garbage	50
Workshop	45

In order to account for possible inaccuracies in *VENDOR* declared values and prediction inaccuracies, the target values for all noise levels shall be 3 dB lower than the noise limits specified here (i.e. a 3 dB safety margin shall be applied).

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 35 of 51

The table below sum up the sound pressure levels (dB) not to exceed for each frequency for a given Noise Criterion (NC limit indicated in the above table):

NC	63 (Hz)	125	250	500	1000	2000	4000	8000
NC 20	54	43	35	28	23	20	17	16
NC 25	57	47	39	32	28	25	22	21
NC 30	60	51	43	37	32	30	28	27
NC 35	63	55	47	41	37	35	33	32
NC 40	66	59	52	46	42	40	38	37
NC 45	69	62	56	50	47	45	43	42
NC 50	73	66	60	55	52	50	48	47
NC 55	76	69	64	59	57	55	53	52
NC 60	79	73	68	64	62	60	58	57
NC 65	82	76	72	68	66	65	63	62
NC 70	85	80	76	73	71	70	69	68

HVAC equipment located outside of building:

The maximum sound pressure levels of *HVAC* equipment installed outside of building, shall be 85 dB(A) at 1 meter from noise emitting equipment. In any case, the sound pressure level of *HVAC* equipment measured at 0.5 m from a wall, shall be inferior to 65 dB(A). Sound pressure levels shall be measured according to [ISO 9614-1](#).

7.13 Over-Design

An over-design coefficient of 10% shall be applied on the heat gains and heat losses calculation final results (results used for air flow rate calculations).

7.14 Equipment Minimum Performances

Equipment shall be designed for continuous operation at maximum capacity and for the specified range, when indicated.

During *FAT* and/or *COMMISSIONING*, the performances of equipment shall be checked. Results of checking, including the tolerances on measurement, shall be in accordance with requested_Design Values with “no negative tolerance”.

(See also [GS EP HVA 801](#), section “Definitions”).

7.15 Specific Algorithms

Calculation notes shall be provided by *CONTRACTOR* with clear indication of each used algorithm.

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 36 of 51

Air flow calculations shall be done using air mass flow instead of air volume flow. Final results (e.g. for commissioning activity) can be expressed in volume flow (correspondence table), taking into account the temperature and relative humidity of considered air.

The *CONTRACTOR* shall use the calculation codes available in the country where equipment will be installed. In case where country codes are different from codes stated in "Reference documents" section, the most stringent code shall apply.

The following specific approaches shall be used for calculation:

7.15.1 Psychrometrics Calculation

Psychrometric calculations notes and calculation notes using results from psychrometric calculations notes have to be issued taking into account the location of Project, including altitude.

The gas relations and their use for *HVAC* calculations, to be taken into account for the Project, are indicated hereafter.

Unit and symbols:

p = barometric pressure, kPa

P_{da} = partial pressure of dry air

P_w = partial pressure of water vapor in moist air, kPa

V = total mixture volume

n_{da} = number of moles of dry air

n_w = number of moles of water vapor

R = universal gas constant, 8314,41 J/(kg mol·K)

t = dry bulb temperature of moist air, °C

T = absolute temperature, °C + 273,15 K

Z = altitude, m

Constants to use for psychrometric calculations:

- Air constant $R_{da} = 287,055 \text{ J/ kg}_{da} \cdot \text{K}$ ("da" means "dry air") [1]
- Air constant for water vapour $R_w = 461,520 \text{ J/kg}_w \cdot \text{K}$ ("w" means "water") [2]

7.15.1.1 Standard Atmosphere

$$p = 101,325 \times (1 - 2,255 \, 77 \times 10^{-5} \times Z)^{5,2559} \quad [3]$$

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 37 of 51

7.15.1.2 Temperature as a Function of Altitude

$$t = 15 - 0,0065 \times Z \quad [4]$$

7.15.1.3 Water Vapor Saturation Pressure P_{ws}

P_{ws} = pressure of saturated pure water, kPa

The saturation pressure over ice for the temperatures between -100°C and 0°C is given from:

$$\ln P_{ws} = \frac{C_1}{T} + C_2 + C_3 \times T + C_4 \times T^2 + C_5 \times T^3 + C_6 \times T^4 + C_7 \times \ln T \quad [5]$$

Where:

$$C1 = -5,674\,535\,9 \times 10^3$$

$$C2 = +6,392\,524\,7$$

$$C3 = -9,677\,843\,0 \times 10^{-3}$$

$$C4 = +6,221\,570\,1 \times 10^{-7}$$

$$C5 = +2,074\,782\,5 \times 10^{-9}$$

$$C6 = -9,484\,024\,0 \times 10^{-13}$$

$$C7 = +4,163\,501\,9$$

The saturation pressure over liquid for the temperatures between 0°C and 200°C is given from:

$$\ln P_{ws} = \frac{C_8}{T} + C_9 + C_{10} \times T + C_{11} \times T^2 + C_{12} \times T^3 + C_{13} \times \ln T \quad [6]$$

Where:

$$C8 = -5,800\,220\,6 \times 10^3$$

$$C9 = +1,391\,499\,3$$

$$C10 = -4,864\,023\,9 \times 10^{-2}$$

$$C11 = +4,176\,476\,8 \times 10^{-5}$$

$$C12 = -1,445\,209\,3 \times 10^{-8}$$

$$C13 = +6,545\,967\,3$$

7.15.1.4 Humidity Ratio W

$$W = 0,62198 \times \frac{P_w}{P - P_w}$$

With:

W = humidity ratio of moist air, kg water / kg dry air

P_w = partial pressure of water vapor in moist air, kPa

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 38 of 51

P = total pressure of moist air, kPa

7.15.1.5 Saturation Vapour Pressure: P_s

$$\ln P_s = \frac{A \cdot t}{B + t} + C$$

With:

t (°C): air temperature

P_s (Pa): saturation vapour pressure

$\ln$: Neperian logarithm

The values A, B and C reported in this calculation note are taken from "Vapour-pressure equation for water in the range 0 to 100°C", A. Wexler and L. Greenspan, publication of Research of the National Bureau of Standards, Vol. 75A - N° 3, May - June 1971.

A: 17,438 B: 239,78 C: 6,4178

The vapour pressure difference given by the above relation and by reference charts is lower than 0.1% from 0 to +35°C.

7.15.1.6 Partial Pressure of the Water Vapour: P_v

$$P_v = P_s \times RH$$

With:

RH (%): *RELATIVE HUMIDITY* of air

7.15.1.7 Density of the Moist Air

$$\rho = \rho_0 \times \frac{T_0}{T} \times \frac{P}{P_0} \times \frac{\delta(1+r)}{\delta+r}$$

With:

ρ (kg/m³): density of the moist air

T (K): temperature of the moist air

P (Pa): pressure of the moisture air

r (g/kg dry air): specific humidity

δ : $M_v/M_a = 0.62198$

M_v : Molar mass of water vapour (18.01534 10⁻³ kg)

M_a : Molar mass of dry air (28.9654 10⁻³ kg)

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 39 of 51

7.15.1.8 Variation of Air Volume with Temperature and/or Pressure Variation

$$V_2 = \frac{P_1}{P_2} \times \frac{T_2}{T_1} \times V_1$$

With:

V_1 (m³): volume at T_1 temperature

V_2 (m³): volume at T_2 temperature

T_1 (K): absolute temperature

T_2 (K): absolute temperature

P_1 (Pa): absolute pressure at T_1 temperature

P_2 (Pa): absolute pressure at T_2 temperature

7.15.2 Singular Pressure Loss

$$\Delta p = \zeta \times \frac{\rho}{2} \times v^2$$

With:

Δp (Pa): singular pressure loss

ζ : singular pressure loss coefficient (according Idel'Cik - Mémento des pertes de charges -, and Porcher - Cours de climatisation)

ρ (kg/m³): air density

v (m/s): average air velocity

7.15.3 Equivalent Diameter

$$d = \frac{2 \times a \times b}{a + b}$$

With:

d (mm): duct equivalent diameter

a (mm): duct width

b (mm): duct height

7.15.4 Static Pressure Gain

The velocity reduction inside a duct leads to a static pressure gain:

$$\Delta p_s = 4,5 \times 9,81 \times 10^{-2} (V_2^2 - V_1^2)$$

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 40 of 51

With:

Δp_s (Pa): static pressure

V_1 (m/s): downstream velocity

V_2 (m/s): upstream velocity

In practice, pressure gain will only be calculated in case of main velocity changes and only 75% of theoretic gain will be considered as effectively obtained.

7.15.5 Air Temperature Increase Between Inlet and Outlet of FAN

Air temperature increase between inlet and outlet of the FAN is defined by:

$$\Delta t = \frac{\Delta P_t}{1,02 \times \rho \times \eta_v \times c_p \times 9,81} \times x$$

With:

ρ (kg/m³): density of air at FAN inlet

η_v : FAN efficiency

c_p (kJ/kg.K): mass heat of air

x : factor of air compressibility

$$x = -0.35 \times \frac{\Delta P_t}{p \times 10^3} + 1$$

With:

ΔP_t (Pa): total pressure of the FAN

7.15.6 Convection Factors (used in U-values calculations)

For U-values calculation, the outside convection factor shall be calculated as following:

$$h_c = 6,2 + 4,2 \times w \text{ when } w < 5 \text{ m/s}$$

$$h_c = 7,15 \times w^{0,78} \text{ when } w \geq 5 \text{ m/s}$$

With:

h_c : outside convection factor

w : wind velocity in m/s

8. Project Data to be Completed by Engineering

Data to be completed by Engineering are indicated with the symbol "Δ".

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 41 of 51

8.1 Location

- Latitude: Δ
- Longitude: Δ

8.2 Building Types

Building type: Δ

The building type and its localization shall impact on the *HVAC* design (e.g. choice of materials, etc.).

The building type shall be selected by *ENGINEERING*, with *COMPANY* approval, in the following list:

Building or part of building classified as	Building type
Rural environment	RU
Industrial equipment	IN
General activity in industrial environment	INT
Marine environment	MA
General activity in marine environment	MAT

8.3 Segregation of HVAC Equipment

8.3.1 Segregation of the HVAC Systems

During the Basic Engineering studies (or during Detailed Engineering studies in case of the segregation has not been studied earlier), the *ENGINEERING* shall classify the *HVAC* equipment in two categories, according to the services required by the rooms served by the *HVAC* equipment.

The two categories of *HVAC* equipment are;

- the *NON ESSENTIAL HVAC* equipment;
- the *ESSENTIAL HVAC* equipment.

The definitions of *NON ESSENTIAL* and *ESSENTIAL* are indicated in **GS EP HVA 801**.

Several independent *NON ESSENTIAL HVAC* systems or several independent *ESSENTIAL HVAC* systems can be defined on a plant.

The design criteria expressed in the definition an *ESSENTIAL HVAC* system shall be taken into account for the design of an *HVAC* system classified as an *ESSENTIAL HVAC* system. It is the same for the design of an *HVAC* system classified as a *NON ESSENTIAL HVAC* system.

It is part of *HVAC* scope of work to classify the *HVAC* equipment in among the two above categories. However, the following rooms must be served from an *ESSENTIAL HVAC* system:

- air locks

HVAC Basis of Design

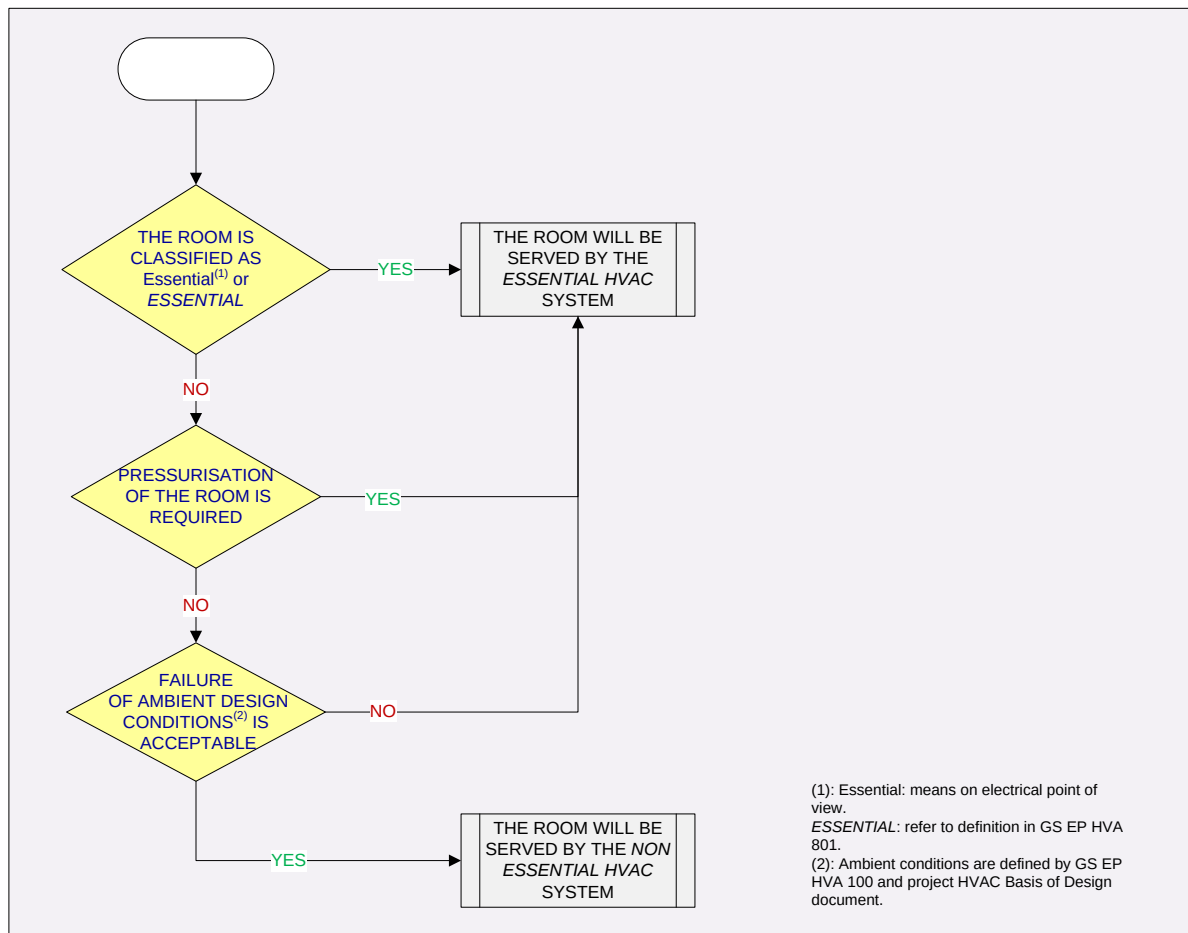
Rev.: 10

Effective date: 10/2012

Page: 42 of 51

- the rooms which are essential for operation of the plant (essential electrical, essential instrument rooms, telecom, radio room...)
- *HVAC PLANT ROOM*, boiler room
- essential diesel generator room
- sick bay.

The above list is not an exhaustive list. The exhaustive list of the *NON ESSENTIAL HVAC* systems and of the *ESSENTIAL HVAC* systems shall be submitted to COMPANY approval during the Basic Engineering phase¹⁷ (mandatory). It is full responsibility of Engineering to obtain comments / approval from COMPANY, during the Basic Engineering phase. This list shall be defined according to the above requirements and shall take into account the indications of the following scheme:



¹⁷ or during Detailed Engineering studies in case of the segregation has not been studied earlier.

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 43 of 51

8.3.2 Classification of Rooms

The following shall be supplied from the concerned *HVAC* systems according to the hereafter table. It is part of Engineering to validate the following classification with all COMPANY project Specialists and to amend this table with the rooms of the project which are not listed inside the present table.

8.4 External Conditions

The following conditions shall be taken into account for equipment calculation and selection:

- Extreme climatic conditions applicable to the site where equipment are stored during construction (item 1);
- Extreme climatic conditions of construction site (item 2);
- Extreme conditions during transportation of equipment (item 3);
- Project design conditions (item 4).

For each of the above items, the following data shall be indicated:

Data	Item			
	1	2	3	4
Atmospheric pressure (hPa):				Δ to Δ
Extreme temperatures (winter / summer) - dry bulb:	$\Delta^{\circ}\text{C}$ (Protection against freezing and / or condensation, equipment preservation)			
Extreme <i>RELATIVE HUMIDITIES</i> (winter / summer) - (concomitant with above dry bulb temperatures):	$\Delta\%$ (Protection against freezing and / or condensation, equipment preservation)			
Design winter temperature - dry bulb, to define hour by hour temperature profile, for steady states heat gains and heat losses calculations:			For floating units (FPSO, FPU,...) to be defined by Project Management ¹⁸	$\Delta^{\circ}\text{C}$
Design winter temperature - wet bulb, to define hour by hour temperature profile, for steady states heat gains and heat losses calculations:				$\Delta^{\circ}\text{C}$
Design summer temperature - dry bulb, to define hour by hour temperature profile, for steady states heat gains and heat losses calculations:				$\Delta^{\circ}\text{C}$

¹⁸ Technical Query shall be submitted by HVAC Engineering during Basic Engineering phase.

HVAC Basis of Design

Rev.: 10

Effective date: 10/2012

Page: 44 of 51

Data	Item			
	1	2	3	4
Design summer temperature - wet bulb, to define hour by hour temperature profile, for steady states heat gains and heat losses calculations:				$\Delta^{\circ}\text{C}$
Design winter temperature - dry bulb, for <i>OUTDOOR AIR</i> intakes:				$\Delta^{\circ}\text{C}$
Design winter temperature - wet bulb, for <i>OUTDOOR AIR</i> intakes:				$\Delta^{\circ}\text{C}$
Design summer temperature - dry bulb, for <i>OUTDOOR AIR</i> intakes:				$\Delta^{\circ}\text{C}$
Design summer temperature - wet bulb, for <i>OUTDOOR AIR</i> intakes:				$\Delta^{\circ}\text{C}$
Design winter temperature - dry bulb, for air entering to air cooled exchangers:				$\Delta^{\circ}\text{C}$
Design summer temperature - dry bulb, for air entering to air cooled exchangers:				$\Delta^{\circ}\text{C}$
Daily range:				$\Delta^{\circ}\text{C}$
Atmospheric clearness number:				Δ ($0 < \Delta \leq 1$)
Average sea or ground reflectance:				Δ ($0 < \Delta \leq 1$)
Minimum sea water temperature (when used for <i>HVAC</i> equipment)				$\Delta^{\circ}\text{C}$
Minimum sea water temperature (when used for <i>HVAC</i> equipment) ¹⁹				$\Delta^{\circ}\text{C}$

Temperature profile to use for heat gains calculations:

¹⁹ According to the Project, several sea water temperatures have to be indicated (temperature and pumping depth).

HVAC Basis of Design

Rev.: 10

Effective date: 10/2012

Page: 45 of 51

The following table shall be filled-up for each month:

Hour	Dry bulb (°C)	Wet bulb (°C)	Hour	Dry bulb (°C)	Wet bulb (°C)
0	Δ	Δ	12	Δ	Δ
1	Δ	Δ	13	Δ	Δ
2	Δ	Δ	14	Δ	Δ
3	Δ	Δ	15	Δ	Δ
4	Δ	Δ	16	Δ	Δ
5	Δ	Δ	17	Δ	Δ
6	Δ	Δ	18	Δ	Δ
7	Δ	Δ	19	Δ	Δ
8	Δ	Δ	20	Δ	Δ
9	Δ	Δ	21	Δ	Δ
10	Δ	Δ	22	Δ	Δ
11	Δ	Δ	23	Δ	Δ

• **Maximum sun radiation (expressed in W/m²)**

Month	NE	E	SE	S	SO	W	NO	N	Horizontal
January	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
February	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
March	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
April	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
May	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
June	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
July	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
August	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
September	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
October	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
November	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
December	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ

- **Wind**

(Accuracy on wind velocities is $\pm 5\%$)

Wind		Return Periods			Direction
		100 years	10 years	1 year	
Maximum Wind at 10 m	V_{1mn} (m/s)	Δ	Δ	Δ	Δ
	V_{10mn} (m/s)	Δ	Δ	Δ	Δ
	V_{1h} (m/s)	Δ	Δ	Δ	Δ

100 Year Return Period 10 min sustained wind		Direction							
		N	NE	E	SE	S	SW	W	NW
Wind at +10 m	V_{1mn} (m/s)	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
	V_{10mn} (m/s)	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
	V_{1h} (m/s)	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ

10 Year Return Period 10 min sustained wind		Direction							
		N	NE	E	SE	S	SW	W	NW
Wind at +10 m	V_{1mn} (m/s)	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
	V_{10mn} (m/s)	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
	V_{1h} (m/s)	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ

1 Year Return Period 10 min sustained wind		Direction							
		N	NE	E	SE	S	SW	W	NW
Wind at +10 m	V_{1mn} (m/s)	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
	V_{10mn} (m/s)	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
	V_{1h} (m/s)	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ

8.5 Additional Requirements for External Conditions

In addition to the above data, the following hypothesizes shall be taken into account for HVAC equipment design:

- *OUTDOOR AIR* temperature for the air handling units: Δ ° Celsius
- *OUTDOOR AIR* relative humidity for the air handling units: Δ %
- atmospheric pressure: Δ hPa

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 47 of 51

- *OUTDOOR AIR* temperature inlet on condensers (when air cooled condensers are used):
 Δ ° Celsius
- air condensers calculation shall take into account the wind effect when wind velocity is:
 Δ m/s.

8.6 Calculated U-Values

WALLs	Calculated U-value in W/m ² /°C
External walls	Δ
Roof	Δ
Floor	Δ
Doors	Δ
Windows	Δ
Partitions/internal walls	Δ

Note: The calculated U-Values shall not be inferior to the reference U-Values indicated in section "Data fixed by COMPANY".

8.7 Utility Data

8.7.1 Utility Fluids (main characteristics)

Utility	Operating conditions		Design conditions	
	P (barg)	T (°Celsius)	P (barg)	T (°Celsius)
Compressed air	Δ	Δ	Δ	Δ
Sea water	Δ	Δ	Δ	Δ
Fresh water	Δ	Δ	Δ	Δ

8.7.2 Compressed Air

Characteristic	Target values	Average
Filtration (µm)	Δ	Δ
Dew point	Δ	Δ
Temp. at delivery point (°C)	Δ	Δ

8.7.3 Sea Water Analysis

Sea water analysis report (water to use for chilled water unit(s) condensation):

Characteristic	Target values	Average
pH at 25°C	Δ	Δ
Chlorine Resistance (mg/l)	Δ	Δ
Salinity (g/l)	Δ	Δ
Calcium (mg/l)	Δ	Δ
Magnesium (mg/l)	Δ	Δ
Total Iron (mg/l)	Δ	Δ
Total dissolved Solid (mg/l)	Δ	Δ
Turbidity (NTU)	Δ	Δ
Total oil content (ppmV)	Δ	Δ
Total hardness	Δ	Δ

8.7.4 Fresh Water Analysis

Fresh water analysis report (water to use for chilled water unit(s) network):

Characteristic	Target values	Average
pH at 25°C	Δ	Δ
Resistance Chlorine (mg/l)	Δ	Δ
Salinity	Δ	Δ
Calcium	Δ	Δ
Magnesium	Δ	Δ
Total Iron (mg/l)	Δ	Δ
Total dissolved solid (mg/l)	Δ	Δ
Turbidity (NTU)	Δ	Δ
Total oil content (ppmV)	Δ	Δ
Total hardness	Δ	Δ

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 49 of 51

8.7.5 Supply Temperatures for Heat Exchangers

Type of exchanger	Parameter	Value
Heating coil	Water inlet temperature (°C)	Δ
Cooling coil	Water inlet temperature (°C)	Δ
Direct expansion coil	Minimum evaporating temperature (°C)	+1.5 (air flow rate with dirty filters)

8.7.6 Water Characteristics for Heat Exchangers

Characteristic	Target values	Average
PH at 25°C	Δ	Δ
Residual Chlorine (mg/l)	Δ	Δ
Salinity	Δ	Δ
Calcium	Δ	Δ
Magnesium	Δ	Δ
Total Iron (mg/l)	Δ	Δ
Total dissolved solid (mg/l)	Δ	Δ
Turbidity (NTU)	Δ	Δ
Total oil content (ppmV)	Δ	Δ
Total hardness	Δ	Δ

Percentage of glycol for hot water (% in mass)	Δ
Viscosity of mixing for hot water (cSt)	Δ
Percentage of glycol for cold water (% in mass)	Δ
Viscosity of mixing for cold water (cSt)	Δ

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 50 of 51

8.7.7 Normal Electrical Power Supply

The voltage systems available are the following:

Characteristic	Nominal value	Variations
Main supply	Δ	Δ
Main switchboard short circuit current value	Δ	Δ
Ground system	Δ	Δ
Frequency (Hz)	Δ	Δ
Control voltage ²⁰	Δ	Δ
Fire dampers motor supply	Δ	Δ

8.7.8 Emergency Electrical Power Supply

The voltage systems available are the following:

Characteristic	Nominal value	Variations
Main supply	Δ	Δ
Main switchboard short circuit current value	Δ	Δ
Ground system	Δ	Δ
Frequency	Δ	Δ
Control voltage VAC ²¹	Δ	Δ
Fire dampers motor supply VDC	Δ	Δ

8.8 Heat Gains from Equipment

Heat gains from equipment have to be indicated, room by room, for each Electrical / Instrument / Telecom cabinet and, generally speaking for each equipment producing heat dissipation. For each value, it shall be indicated if data is estimated value or calculated value from equipment *MANUFACTURER / VENDOR*. Estimated values are only acceptable during basic engineering phase and during early stage of detailed engineering phase. However, only calculated data shall be indicated in *HVAC AFC* (Approved For Construction) documents.

²⁰ Generated in main HVAC electrical cabinet by transformer

²¹ Generated in main HVAC electrical cabinet by transformer

General Specification		GS EP HVA 100
HVAC Basis of Design		
Rev.: 10	Effective date: 10/2012	Page: 51 of 51

Data shall be indicated in the following table:

Room number	Cabinet / equipment designation	Cabinet / equipment number	Absorbed power (W)	Nominal Heat dissipation (W)		DUTY RATIO (%) (One column for each OPERATING PROCESS)	
				Sensible	Latent		
Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ

The following values shall be taken into account for cooling loads calculations:

Room designation	Room tag number	Sensible heat gains in Watts	Latent heat gains in Watts
Δ	Δ	Δ	Δ

9. Other References

Following external documents are applicable:

- [ADC, AFI, AGA, AICVF Codes, AMCA, ARI, ASHRAE, Circulaire DGS n° 97/311, Directives 94/9/EC referred to a ATEX 100a/95, 97/23/EC dated 29 May 1997, 98/37/EC dated 27 June 1988, 1999/92/EC referred to a ATEX 118/137, 2004/108/EC dated 15 December 2004, 2006/42/EC dated 17 May 2006, 2006/95 dated 12 December 2006, 2009/125/CE, EN 12100 \(Parts 1; 2\), EN 13831, EN 60204-1, IEC 60335-1, IEC 60529, IEC 61131-2, NF C15-100, UTE C63-100, Regulation No 327/2011/SMACNA.](#)