Exhibit 11R

Drawings and Specifications of Gamesa Eolica Wind Turbines

The Applicant plans to use Gamesa G90 Wind Turbines at the Marble River Wind Farm (see enclosure #1, press announcement of purchase of Gamesa turbines). Gamesa is a leading company in the design, manufacturing, installation, operation and maintenance of wind turbines. In 2004, Gamesa was ranked second worldwide in a ranking of the Top 10 wind turbine manufacturers by BTM Consult, with a market share of 18.1%. In Spain, Gamesa Eólica is the leading manufacturer and supplier of wind turbines, with a market share of 56.8% in 2004. One of the partners in the Marble River Wind Farm, Acciona, has had a significant and successful history with Gamesa turbines.

Gamesa has used the experience gained in its home market to develop a robust, adaptable wind turbine suitable for most wind conditions in the USA. Gamesa Wind US will carry out a major portion of the manufacturing of the wind turbines planned for Marble River in the Mid-Atlantic region, where Gamesa is already active in development and construction of wind energy projects.

Gamesa G90

The Gamesa G90 is a 2-MW, three-bladed, upwind pitch regulated and active yaw wind turbine. The G90 has a blade length of 44m which, when added to the diameter of the hub, gives a total diameter of 90m and a swept area of 6362m2. The turbine blades are bolted to a hub at the low speed end of a 1:120 ratio gear box. Enclosure #2, **G90-2.0MW,** contains a picture of the G90 with a summary of the technical data. Enclosure # 3 contains more detailed descriptions, design parameters and technical specifications for the G90 turbine.

The use of a 2-MW turbines, as opposed to a 1.5-MW machine, allows the Applicant to decrease the environmental impact on the ground (less roads, less cable per MW) relative to a smaller machines, which is an important consideration given the expanse of wetlands in the project area.

Enclosure # 4 contains a noise analysis for the G90 2-MW wind turbines, showing a maximum noise of 105.3dB(A) at a hub height of 78m.

Enclosure # 5 is the Lubrication Chart. Enclosure # 6 has Material Safety Data Sheets for the turbines containing generic information concerning health and safety for compositions and materials related to operation of turbines.

The Applicant has completed a Preliminary Transportation Assessment Report (enclosure #7) to transport wind turbine components to Clinton County, looking at two options to cross the County to the project area and examining in detail possibilities and constraints within the project area.

Enclosures

1. Announcement of Purchase of up to 600MW of Gamesa Wind Turbines for Installation in 2006 and 2007
2. G90-2.0MW Technical Data
3. Characteristics and General Operation of Gamesa G8X 2.0MW Wind turbine (including G90)
4. Noise Analysis for the G90 2-MW Wind Turbine
5. Lubrication Chart
6. Material Safety Data Sheet
7. Preliminary Transportation Assessment Report

Horizon Wind Energy

LATEST NEWS AND CONTENT

HORIZON NEWS: Horizon Signs Frame Agreement with Gamesa for Supply of 600 MW of Wind Turbines

Horizon Will Install Turbines during 2006 and 2007

Vitoria–Gasteiz, November 21, 2005 – Gamesa Wind US LLC., a subsidiary of Gamesa Eólica, the world's second leading wind turbine manufacturer and a market leader in Spai the manufacturing, sales, and installation of wind turbines, has been selected by Horizon Energy for the supply of up to 600 MW of wind turbines for projects located in the United States.

The agreement between Gamesa and Horizon involves the supply of the full line of Game G8X-2.0 MW products, including the Gamesa G80, Gamesa G83, Gamesa G87, and Gar G90 wind turbines. Most of the manufacturing of these wind turbines will be carried out in plants that the Spanish company owns in the US.

The frame agreement initially calls for the supply of 400 MW with an option for an additior 200 MW. The turbines will be installed during 2006 and 2007. The estimated value of this agreement, depending on its final scope and the combination of the wind turbine models, reach up to $700 million.

"We are very pleased that Horizon has turned to Gamesa for their wind turbines needs. T transaction strengthens the position of Gamesa Wind in the US, which together with Chin one of our target markets as we expand internationally," said Iñaki López Gandásegui, Gamesa's CEO. "Horizon has shown its commitment to our multi-MW portfolio of Gamesa 8X-2.0 turbines. These turbines are known for their robustness and adaptability to any wi site," he added.

"We look forward to installing Gamesa turbines over the next two years. Gamesa is know the high quality of its equipment. We appreciate their commitment to the USmarket, and t turbines will be an important part of our growth over the next several years," said Alec Dre CEO of Horizon Wind Energy.

Gamesa Eólica is a leading company in the design, manufacturing, installation as well as operation and maintenance of wind turbines. In 2004, it was ranked second worldwide in Top 10 manufacturers ranking, with a market share of 18.1% (BTM Consult ApS).

In Spain, Gamesa Eólica is the leading manufacturer and supplier of wind turbines, with a market share of 56.8% of installed wind power in 2004. Countries like the USA, Germany France, Portugal, the UK, Ireland, Greece, Mexico, Argentina, Morocco, Egypt, India, Chi Japanalready have wind turbines supplied by Gamesa Eólica.

G90-2.0 MW

Maximum output at minimum cost per kWh for low wind sites

Advantages

- Optimum price-quality ratio provided by Gamesa's vertically integrated supply structure
- New 44 m blade using state-of-the-art manufacturing technology: carbon fibre and pre-preg technology for a lighter rotor design
- IEC IIIA/WZII classes with the largest swept area
- Improved service capabilities through discrete components at drive train
- Reduced sound level for standard power level and different low-noise level versions
- Gamesa Technology with a proven track-record in complex terrains: active yaw, optimised control, fast pitch dynamics

Gamesa Eólica

Rotor

Diameter	90 m
Swept area	6,362 m²
Rotational speed, rotor	9.0 - 19.0 r.p.m.
Rotational direction	Clockwise (frontal view)

Blades

Number of blades	3
Length	44 m
Airfoils	DU (Delft University) + FFA-W3
Material	Preimpregnated epoxy glass fibre + carbon fibre
Total blade weight	Approx. 7,000 kg

Gearbox G90-2.0 MW

Type	1-stage planetary / 2-stage helical
Ratio	50 Hz 1:100.5 60 Hz 1:120.515
Cooling	Oil pump with heat exchanger
Oil heater	2.2 kW

2.0 MW Generator

Type	Doubly fed generator
Rated power	2.0 MW
Voltage	690 V ac
Frequency	50 Hz / 60 Hz
Protection class	IP 54
Number of poles	4
Rotation speed	900:1,900 r.p.m. (rated/1,680 r.p.m.)
Rated current	
Stator	1,500 A @ 690 V
Rated power factor, default	1.0
Power factor range	0.98 CAP - 0.96 IND (option)

Weights

Class	IEC IIIA Dibt WZII	IEC IIIA Dibt WZII	IEC IIIA Dibt WZII
Tower height	67 m	78 m	100 m
Tower (tubular)	153 T	200 T	286 T
Nacelle	65 T	65 T	65 T
Rotor (incl.hub)	39,4 T	39,4 T	39,4 T
TOTAL	**257,4 T**	**304,4 T**	**390,4 T**

Control System

The Generator is a doubly fed machine (DFM), whose speed and power is controlled through IGBT converters and PWM (Pulse Width Modulation) electronic control.
Advantages:

- Active and reactive power control.
- Low harmonics content and minimum losses.
- Increased efficiency and production.
- Prolonged working life of the turbine.

Remote Control System

A remote control system that ensures real-time monitoring of the machines' parameters as well as communication with the weather masts and the electrical sub-station from a central or remote site. Ability for controlling active and reactive power.

Predictive Maintenance System SMP-8C

Predictive Maintenance System for the early detection of wear and faults in the wind turbine's main components.
Advantages:

- Capacity for signal processing and detection of alarms within the equipment.
- Integration within the control system.
- Reduction in major corrective measures.
- Increase in the availability and working life of the machine.
- Preferential terms in negotiations with insurance companies.

Grid Code Compliance

Dynamic regulation of active and reactive power in order to contribute to the stability of the grid and overcome voltage dips by means of a device that ensures grid code compliance.

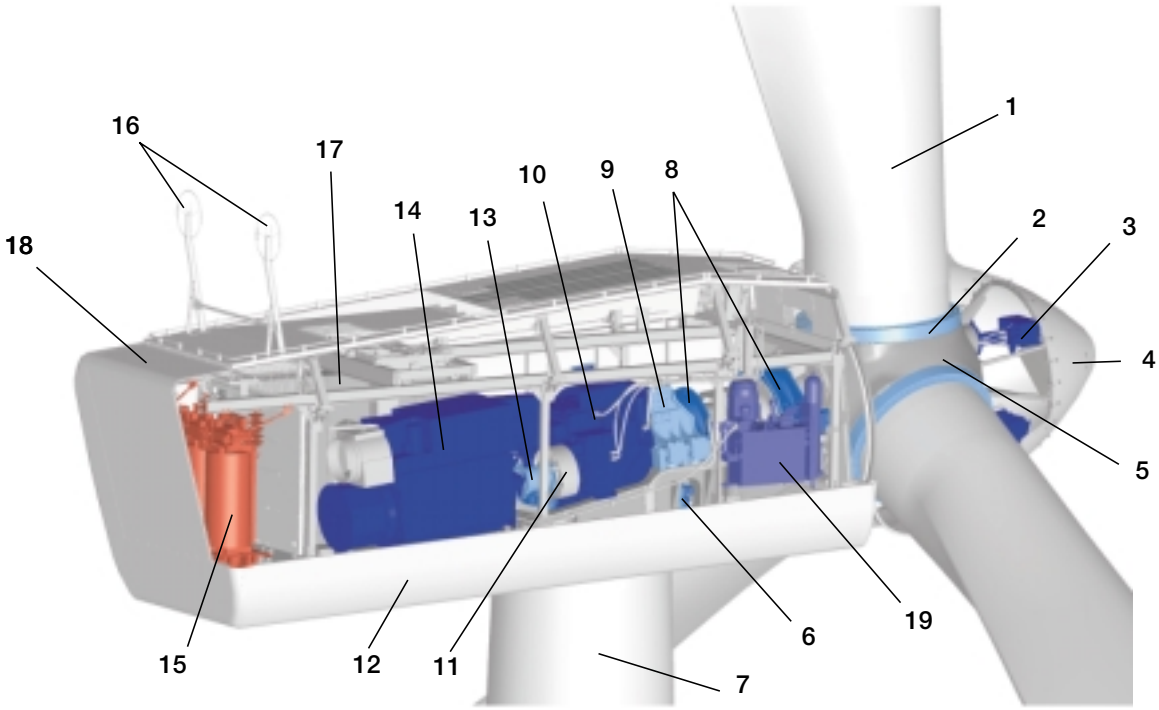
The wind turbine is equipped with an active crowbar system that maintains connection during voltage dips in the supply system.

Brake

Aerodynamic primary brake by feathering of blades. In addition, mechanical emergency disc brake hydraulically activated and mounted on the gearbox's high-speed shaft.

Lightning protection

The G90 wind turbine generator uses the "total lightning protection" system, according to IEC 1024-1 standard. This system conducts the lightning from both sides of the blade tip down to the root joint and from there to the nacelle, tower and earthing system. Therefore, the blade is protected and electrical component damage is avoided.



1. Blade
2. Blade bearing
3. Hydraulic pitch actuator
4. Hub cover
5. Hub
6. Active yaw control
7. Tower
8. Main bearing house
9. Gear tie rod
10. Gearbox
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12. Nacelle support frame
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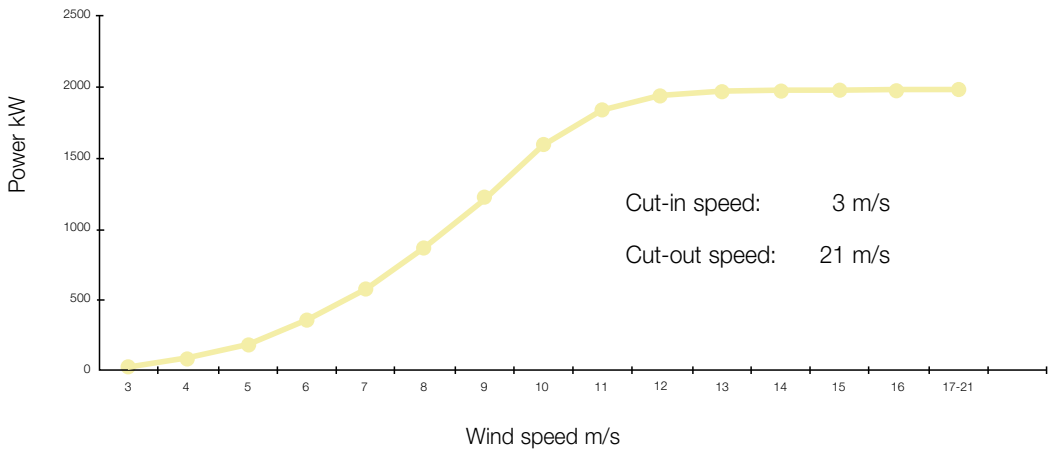
14. Doubly fed generator
15. Transformer
16. Anemometer and wind vane
17. Top controller
18. Nacelle cover
19. Hydraulic unit

Power curve G90-2.0 MW (for an air density of 1.225 kg/m^3 and a sound level of 105.3 dB(A))



Power curve calculation based on DU (Delft University) and FFA-W3 airfoil data.

Calculation parameters: 50 Hz grid frequency; pitch regulated tip angle (pitch control), a 10%turbulence intensity and a variable rotor speed ranging from 9.0 - 19.0 r.p.m.

Reduced sound level versions. The G90-2.0 MW wind turbine is supplied in different low-noise versions: 104 dB(A), 103dB(A), 102dB(A), 101dB(A).

Gamesa Eólica

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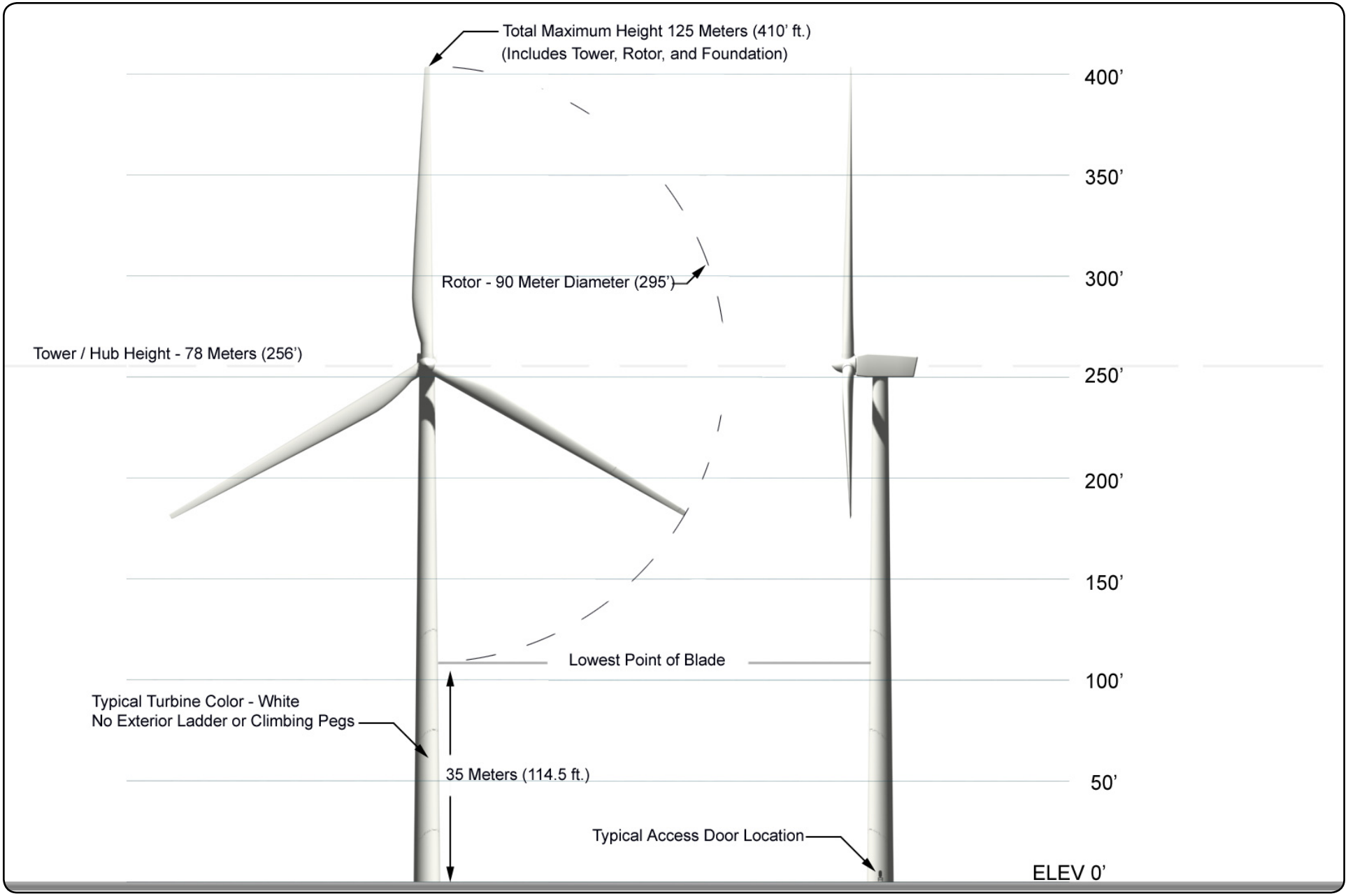

Exhibit 11 - Gamesa G90 Turbine Diagram

Título: **FT Características y funcionamiento general del aerogenerador G8X 2.0 MW** Title: **FT Characteristics and general operation of G8X 2.0 MW Wind-turbine**	Confidencialidad: 3
	Doc VWS:
	AUTOR/ AUTHOR: DGF/JRI/ALG
	REVISADO/CHECKED: CLP/MBU/CDC/DSS/JGS/NAV
	APROBADO/APPROVED: FCA

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REGISTRO DE CAMBIOS/ RECORD OF CHANGES

Rev.	Fecha/ Date	Autor/ Author	Descripción	Description
0	15/04/05	DGF/JRI/ALG	Versión Inicial	Initial Version

1 DESCRIPCIÓN DEL AEROGENERADOR

El aerogenerador G8X – 2.0 MW de Gamesa Eólica es un aerogenerador de rotor tripala a barlovento, regulado por sistema de cambio de paso y con sistema de orientación activo. Utiliza el sistema de control capaz de adaptar el aerogenerador para operar en grandes intervalos de velocidad de rotor.

El rotor consiste en tres palas con cambio de paso en la envergadura completa de la pala, rodamiento de pala y buje en fundición nodular. Los diámetros posibles de rotor son los siguientes: 80m, 83m, 87m y 90m.

Las palas son de 39m (G80 y G83 extender metálico), 40,5m (G83), 42,5m (G87) y 44m (G90) de longitud y están realizadas en fibra de vidrio y carbono (en el caso de G87 y G90) utilizando tecnología prepreg. Cada pala consiste de dos conchas pegadas a una viga soporte principal. Insertos especiales de acero conectan la pala al rodamiento de la misma. El rodamiento de la pala es de bolas de 4 – puntos, atornillado al buje.

El sistema de cambio de paso del rotor proporciona una regulación constante del ángulo de operación de la pala con respecto a las condiciones de viento del momento optimizando la producción de potencia y minimizando la emisión de ruido.

A altas velocidades de viento, el sistema de control y el sistema de cambio de paso mantienen la potencia en su valor nominal, independientemente de la temperatura del aire y su densidad. En vientos de velocidades bajas el sistema de cambio de paso variable y de control optimizan la producción de energía seleccionando la combinación óptima de revoluciones y ángulo de paso.

El eje principal transmite la potencia al generador a través de la multiplicadora. La multiplicadora se compone de 3 etapas combinadas, una planetaria y dos de ejes helicoidales paralelos. Desde la multiplicadora la potencia se transmite al generador a través de una junta de composite.

El generador eléctrico es altamente eficiente, de 4 polos, doblemente alimentado con rotor devanado y anillos rozantes.

El freno primario del aerogenerador es aerodinámico por puesta en bandera de las palas. El sistema de cambio de paso independiente proporciona un sistema de seguridad con triple redundancia. El

1 WIND-TURBINE DESCRIPTION

The Gamesa Eólica's G8X – 2.0 MW wind-turbine is a three bladed, upwind, pitch regulated and active yaw wind-turbine. It uses the control system concept that enables the wind-turbine to operate in a broad range of variation of rotor speed.

The rotor has three-blades with full span control, pitch bearings and the nodular cast iron hub. The possible diameters of the rotor are the following: 80m, 83m, 87m and 90m.

The blades are 39 m lenght (G80 and G83 with metallic extender), 40.5m (G83), 42,5m (G87) and 44m (G90) and are made of glass fibre reinforced epoxy and also Carbon in G87 and G90, using the pre-preg moulding technology. Each blade consists of two blade shells, bonded to a supporting beam. Special steel inserts connect the blade to the blade bearing. This bearing is a 4 – point ball type bolted to the hub.

The rotor pitch is variable. This feature provides fine adjustment of the blade-operating angle all the time with respect to the wind conditions each moment. This provides a better power production and a noise emission reduction.

At high wind speeds the control system and the pitch system keep the power output at its nominal value, independently of air temperature and air density. At lower wind speeds the variable pitch system and the control system maximise the power output by choosing the combination of rotor speed and pitch angle which give maximum power coefficient.

The main shaft transmits the power to the generator through the gearbox. The gearbox is a 3-combined-stages, one planetary and two helical parallel shafts, gearbox. From it the power is transmitted via a composite coupling to the generator.

The generator is a high efficiency 4 – pole doubly fed generator with wound rotor and slip rings.

The wind-turbine primary brake is given by full feathering the blades. The individual pitch system gives a triple redundant safety system. The mechanical brake is a parking disc brake system

freno mecánico de aparcamiento es un freno de disco, hidráulicamente activado que se monta en la salida del eje de alta velocidad de la multiplicadora.

hydraulically activated and mounted on the gearbox high-speed shaft.

Todas las funciones del aerogenerador son monitorizadas y controladas por varias unidades de control basadas en microprocesadores. El sistema de control va instalado en la góndola. El autómata que gobierna dicho sistema puede estar colocado en la góndola o en la base de la torre. Las variaciones del ángulo de paso de la pala son activadas por un sistema hidráulico que deja que la pala rote 95º. Este sistema hidráulico también proporciona presión al sistema de frenado mecánico y al sistema de orientación de la Nacelle.

All functions of the wind turbine are monitored and controlled by several microprocessor based control units. The controller system is placed in the nacelle. The programmable logic controller (PLC) could be placed in the nacelle or in the ground. Blade pitch angle variation is regulated by a hydraulic system actuator which enables the blade to rotate 95º. This system also supplies pressure to the brake system .

El sistema de orientación consiste en cuatro motores operados eléctricamente y controlados por el sistema de control del aerogenerador de acuerdo a la información recibida de los dos anemómetros sónicos colocados en la parte superior de la góndola. El motor del sistema de orientación hace girar los piñones del sistema de giro, los cuales engranan con los dientes de la corona de orientación montada en la parte superior de la torre. El bastidor con las motorreductoras puede girar respecto a la corona de orientación en la torre mediante un cojinete de fricción, el cual posee dispositivos hidráulicos y mecánicos para proveer par de retención.

The yaw system consists of four gears electrically operated and controlled by the wind turbine controller based on information received from the sonic anemometers mounted on top of the nacelle. The yaw gears rotate the yaw pinions, which mesh with a large toothed yaw ring mounted on the top of the tower. The yaw bearing is a plain bearing system with hydraulic and mechanical devices to provide retention torque.

La cubierta de la góndola es de fibra de vidrio con poliéster, la cual protege todos los componentes de la góndola frente a lluvias, nieve, polvo, rayos solares, etc. El acceso a la góndola desde la torre se realiza a través de la abertura central. La góndola contiene en su interior una grúa de servicio de 800 kg, que puede ser ampliada para elevar los componentes principales hasta 6400kg (8000kg para carga de prueba).

The nacelle cover is made of glass fibre reinforced polyester and protects all the components inside against rain, snow, dust, sun, etc. Access to the nacelle from the tower is through a central opening. The nacelle houses the internal 800 kg service crane, which can be enlarged to hoist the main components up to 6400kg (8000 kg for test loads).

La torre del aerogenerador es tubular y de acero y se suministra pintada con pintura de protección especial anti-corrosión. Gamesa Eólica ofrece un ascensor opcional.

The steel tubular tower is delivered painted. Gamesa Eólica S. A. offers a service lift in the tubular tower.

1.1 SISTEMA DE CONTROL

1.1 CONTROL SYSTEM

El sistema de control asegura que las rpm y el par motor del aerogenerador siempre suministren una potencia eléctrica estable a la red. Este sistema de control además suministra la energía con un factor de potencia deseado a la red eléctrica.

The control system ensures that both the rotor speed and the drive torque of the wind turbine always transform into a steady and stable electric power eventually injected into the grid. This control system also obtains an optimum power factor to the grid.

El sistema de control consiste en un generador

The control system consists of an effective

asíncrono de rotor devanado, anillos rozantes, dos convertidores de 4 cuadrantes de tecnología IGBT, contactores y protección eléctrica. Debido a la forma de funcionamiento que tiene el generador y como se controla, desde la red (es decir, desde el estator) éste es visto como un generador síncrono.

El generador está protegido frente a corto-circuitos y sobrecargas. La temperatura es también continuamente monitorizada mediante PT100 en puntos del estator, de rodamientos y de cajón de anillos.

El generador con sistema de control es un generador asíncrono especial el cual es capaz de trabajar con velocidad variable y mantener la potencia constante simultáneamente. Esta mejora es ejecutada por control de las intensidades en el rotor. Por medio del control de las corrientes en el rotor, el factor potencia se puede ver como un parámetro definible por el sistema de control. Como resultado las pérdidas en la red eléctrica decrecen.

Otro resultado de la generación síncrona que caracteriza al sistema de control es la "suave" conexión a la red eléctrica. Por lo tanto, conexiones y desconexiones suaves a la red eléctrica se obtienen fácilmente.

La turbina G8X – 2.0 MW es capaz de operar a una velocidad variable entre 900 o 1000 rpm (dependiendo de la electrónica de potencia) y 1900 rpm para 50Hz y entre 1080 o 1200 rpm (dependiendo de la electrónica de potencia) y 2280 rpm para 60Hz. El sistema de control tiene flexibilidad intrínseca respecto a optimización de energía, mínimo ruido durante el funcionamiento y reducción de cargas en la multiplicadora y en otros componentes.

1.2 CERTIFICADOS

El Diseño del aerogenerador G80 – 2.0 MW ha sido realizado de acuerdo con la norma IEC 61400 – 1, Ed. 2 para Clases IA (60m, 67m y 78m) y IIA. (60m, 67m, 78m y 100m) y de acuerdo a la norma DIBt (para Alemania) para zonas de viento II (60m, 67m, 78m y 100m) y III (60m, 67m y 78m). Asimismo para las clases IA y IIA se dispone de los Certificados de Tipo.

El diseño del aerogenerador G83 – 2.0 MW está certificado de acuerdo con la norma IEC 61400–1, Ed. 2 como Clase IIA (67m y 78m). En estos días Gamesa está trabajando para conseguir el

asynchronous generator with wound rotor, slip rings, two 4-quadrant converters with IGBT switches, contactors and protection. Because the way this generator is controlled it is seen from the grid (i.e., from the stator) as a synchronous generator.

The generator is protected against short-circuits and overloading. The temperatures are also continuously monitored by PT100's in stator hotspot points, bearings and in slip ring unit.

The generator in the control system is a special asynchronous generator which is able to run with variable speed and simultaneously keep the power constant. This feature is achieved by control of the rotor currents. By means of controlling of the these currents, the power factor can be viewed as a configurable parameter of the control system. As a result the losses in the electrical grid decrease.

Another result of the synchronous generation that characterizes the control system is the 'soft' connection to the grid which means a smooth connection/disconnection to grid.

Wind-turbine G8X – 2.0 MW operates with a variable speed range of 900 or 1000 (depending on the power electronics) and 1900 rpm.for 50Hz and 1080 or 1200 (depending on the power electronics) and 2280 rpm for 60Hz. The control system has built in flexibility regarding energy optimisation, low noise during operation and reduction in loads on gearbox and other components.

1.2 CERTIFICATES

The G80 – 2.0 MW wind turbine's design has been certified according to the IEC 61400 – 1, Ed. 2 Standard as Class IA (60m, 67m and 78m) and IIA (60m, 67m, 78m and 100m) and according to DIBt Rules (for Germany) for Wind zone II (60m, 67m, 78m and 100m) and wind zone III (60m, 67m and 78m). As well as these certifications for the Classes IA and IIA it is available the Type Certificates.

The G83–2.0 MW wind turbine's design has been certified according to the IEC 61400 – 1, Ed. 2 Standard as Class IIA (67m and 78m). In these days Gamesa is working on the Type Certificate.

certificado Tipo.

El diseño del aerogenerador G87 – 2.0 MW está certificado de acuerdo con la norma IEC 61400–1, Ed. 2 como Clase IIA (67m y 78m) y de acuerdo a la norma DIBt (para Alemania) para zonas de viento II (67m y 78m). En estos días Gamesa está trabajando para conseguir el certificado Tipo.

El diseño del aerogenerador G90 - 2.0 MW se encuentra en proceso de certificación de acuerdo con la norma IEC 61400–1, Ed. 2 como Clase IIIA (67m y 78m) y DIBt WZ II(67m y 78m).

1.3 CONDICIONES CLIMÁTICAS

El aerogenerador está diseñado para temperaturas ambiente exteriores entre –20º C y +30º C. Bajo petición expresa del cliente, se suministrarán aerogeneradores en versiones de alta y baja temperatura.

Versión Altas Temperaturas.

- El rango de funcionamiento de la versión de altas temperatura es de -20º+40º

Versión Bajas Temperaturas.

- El aerogenerador está diseñado para funcionar a temperaturas ambiente entre –30º C y +30ºC, siendo el límite inferior de –40º C en condiciones de máquina parada. En condiciones de arranque en frío tras parada prolongada el límite inferior es de –25º C.

El aerogenerador se puede colocar en parques con una distancia de al menos 5 diámetros de rotor (400m - 450m) entre aerogeneradores en la dirección predominante del viento. Si los aerogeneradores se sitúan en fila, perpendicularmente a la dirección predominante del viento, la distancia entre los mismos deberá ser de al menos 3 diámetros de rotor (240 m – 270m).

La humedad relativa puede ser de 100% (máximo el 10% del tiempo). Se proporciona protección contra corrosión conforme a ISO 12944-2 para corrosión de tipo C5-M (fuera), C4-H dentro del buje y C3-H dentro de la Nacelle. A petición del cliente se puede suministrar una máquina para ambientes corrosivos, la cual dispone de protección C4-H también en los elementos no calientes del interior de la Nacelle.

1.4 CONEXIÓN CON LA RED ELÉCTRICA

El aerogenerador debe conectarse a una red de media tensión a 10-33 kV. El aerogenerador

The G87–2.0 MW wind turbine's design has been certified according to the IEC 61400 – 1, Ed. 2 Standard as Class II_A (67m and 78m) and according to DIBt Rules (for Germany) for Wind zone II (67m and 78m). In these days Gamesa is working on the Type Certificate.

The design assessment of the G90–2.0 MW wind turbine is currently being carried out according to the IEC 61400 – 1, Ed. 2, Standard as Class IIIA (67m and 78m) and DIBt WZ II (67m and 78m).

1.3 CLIMATIC CONDITIONS

The wind turbine is designed for ambient temperatures ranging from –20º C to +30º C. Under explicit request of the customer, the wind turbine can be supplied in High and Low temperature versions.

High Temperature Version.

- The operating rank of the High Temperature version increases temperature to -20º+40º

Low Temperature Version.

- The wind turbine is designed for operating at ambient temperatures ranging from –30º C to +30º C, with this range extended until –40º C with the machine stopped. If the operation of the machine starts after being stopped during long time at low temperatures, this lower temperature limit is –25º C.

The wind turbines should be placed in wind farms with a distance of at least 5 rotor diameters (400 m – 450m) between each other measured along the predominant wind direction. If wind turbines are placed along a row, perpendicularly to the predominant wind direction, the distance between them should be of at least 3 rotor diameters (240m – 270m).

The relative humidity can be 100 % (10% of time maximum). Corrosion protection for corrosion class C5-M (outside), C4-H inside the hub and C3-H inside the Nacelle according to ISO 12944-2 are provided. Under request of the customer a corrosive ambient version can be supplied, this machine has a C4-H corrosion class also on the non hot components inside the Nacelle.

1.4 GRID CONNECTION

The wind turbines must be connected to medium-voltage grid at 10-33 kV. The standard wind turbines

estándar se conecta a una red de 20 kV, otros niveles de tensión dentro del intervalo indicado pueden ser desarrollados a petición del cliente. El voltaje máximo del equipamiento es 36 kV (U_m). La conexión del cable de media tensión se realiza en la parte inferior de la torre.

is connected to a 20 kV grid, other voltage levels inside the indicated range can be developed when asked by the customer. The maximum voltage of the equipment is 36 kV (Um). The MV-cable connection is made in the bottom of the tower.

El transformador de la turbina debe estar ajustado a la tensión de la red eléctrica. Al realizar el pedido, Gamesa Eólica necesitará información precisa sobre la tensión de la red para elegir la tensión nominal del transformador y el tipo de conexión del devanado. Gamesa Eólica ofrece como opción las celdas de conexión.

The transformer in the turbine must be adjusted to the grid voltage. When ordering GAMESA EÓLICA S.A. will need precise information about grid voltage, as to choice the transformer's nominal voltage as well as the type of winding connection. GAMESA EÓLICA S.A. offers the switch gear as an option.

El aerogenerador puede generar energía reactiva. No obstante, en algunas ocasiones, el aerogenerador limitará la potencia reactiva para preservar su funcionamiento.

The wind-turbine may generate reactive. Nevertheless, in some occasions, the wind-turbine will limit the reactive power so as to preserve its operation.

El voltaje de la red de media tensión estará dentro del intervalo ± 5%. Variaciones entre +1/-3 Hz (50 Hz) son aceptables. Intermitentes o rápidas fluctuaciones de la frecuencia de la red eléctrica pueden causar serios problemas al aerogenerador.

The voltage of the medium voltage grid shall be within the range ± 5%. Variations within +1/-3 Hz (50 Hz) are acceptable. Intermittent or rapid grid frequency fluctuations may cause serious damage to the turbine.

Caídas de la red eléctrica solamente deberían ocurrir una vez por semana como promedio durante la vida del aerogenerador.

Grid dropouts must, as an average over the entire lifetime of the wind-turbine, only take place once a week.

Debe existir una conexión de tierra de máx. 10 Ω.

A ground connection of maximum 10 Ω must be present.

El sistema de tierra se deberá acomodar a las condiciones del terreno. La resistencia al neutro de la conexión a tierra deberá ser conforme a los requisitos de las autoridades locales.

The earthing system must be accommodated to local soil conditions. The resistance to neutral earth must be according to the requirements of the local authorities.

1.5 RESTRICCIONES GENERALES

1.5 GENERAL RESERVATIONS

Durante los periodos de vientos bajos, es de esperar un aumento del consumo de potencia para el calentamiento y la deshumidificación de la góndola.

During periods of low wind, an increased own consumption of power for heating and dehumidification of the nacelle must be expected.

Respecto a la acumulación de fuertes hielos, es de esperar interrupciones en la operación. En algunas combinaciones de vientos altos, altas temperaturas, temperatura baja del viento, baja densidad y/o bajo voltaje, puede ocurrir una disminución de la potencia nominal para asegurar que las condiciones térmicas de algunos componentes principales como la multiplicadora, generador, transformador, cables de potencia, etc. se mantengan dentro de los límites.

Regarding heavy icing up, interruptions in operation may be expected. In certain combinations of high wind speeds, high temperature, low air temperature, low air density and/or low voltage, power derating may happen to ensure that the thermal conditions of the main components such as gearbox, generator, transformer, power cables, etc, are kept within limits.

Generalmente se recomienda que el voltaje de red

It is generally recommended that the grid voltage is

eléctrica se mantenga tan cerca del nominal como sea posible. En caso de caída de la red eléctrica y muy bajas temperaturas, se debe esperar un cierto tiempo para el calentamiento antes de que el aerogenerador comience a operar.

Si el terreno, dentro de un radio de 100 m a partir de un aerogenerador, tiene una pendiente de más de 10º, pudieran ser necesarias consideraciones particulares.

Si el aerogenerador se sitúa a más de 1000 m sobre el nivel del mar, podría ocurrir una subida de temperatura mayor de lo normal en el generador, el transformador y otros componentes eléctricos. En dicho caso, podría suceder una reducción periódica de la potencia nominal, incluso si la temperatura ambiente está dentro de los límites especificados. Además en los emplazamientos situados a más de 1000 m sobre el nivel del mar el riesgo de congelación se verá aumentado.

Debido a los cambios y actualizaciones en nuestros productos, Gamesa Eólica S.A. se reserva el derecho a cambiar las especificaciones.

2 ELEMENTOS DEL AEROGENERADOR

La Figura 1 muestra la disposición de los diferentes elementos en la góndola del aerogenerador G8X – 2.0 MW.

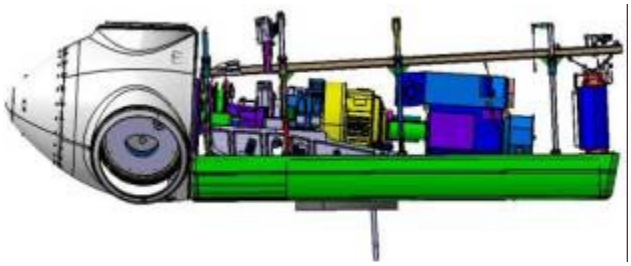

Figura 1 *Vista lateral de la del aerogenerador G8X-2.0 MW.*

2.1 ROTOR

2.1.1 General

El rotor del aerogenerador G8X-2.0 MW es un rotor de tres palas unidas a un buje esférico mediante los rodamientos de pala. El rotor está dotado de un ángulo de conicidad de 2º, que aleja la punta de las palas de la torre.

as close to nominal as possible. In case of grid dropout and very low temperatures, a certain time for heating must be expected before the wind turbine can start to operate.

If the terrain within a 100 m radius of the turbine has a slope of more than 10º, particular considerations may be necessary.

If the wind-turbine is placed in more that 1000 m above the sea level, a higher temperature rise than usual might occur in the generator, transformer and other electrical components. In this case a periodic reduction of rated power might occur, even if the ambient temperature is within the specified limits. Furthermore, also at sites in more than 1000 m above sea level, there will be an increased risk of icing-up.

Due to continuous updating of our products, Gamesa Eolica S.A. reserves the right to change these specifications.

2 WIND-TURBINE ELEMENTS

Figure 1 shows the location of the different elements in the nacelle of the G8X– 2.0 MW wind-turbine.

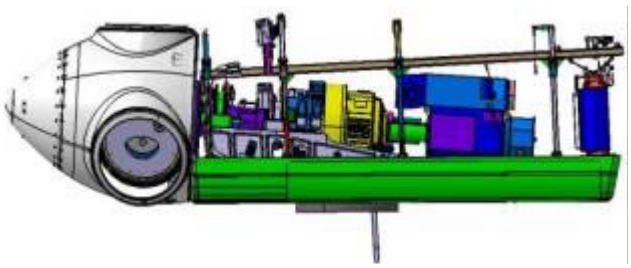

Figure 1 *Side view of G8X-2.0 MW wind-turbine.*

2.1 ROTOR

2.1.1 General

The rotor of G8X-2.0 MW consists of three blades attached to a cast iron hub through the blade bearings and the pitch regulation system. The blade coning is 2º so that, the blade tip is kept away from the tower

2.1.2 Palas

Las palas del aerogenerador G8X-2.0 MW tienen un sistema conductor de rayos que recoge las descargas eléctricas mediante receptores y las transmite, vía un cable de cobre que recorre la pala longitudinalmente hasta la raíz y que se transmiten a la nacelle. La distancia de la raíz de las palas hasta el centro del buje es de 1 m.

Las palas del aerogenerador G8X-2.0 MW están fabricadas en material compuesto, con resina epoxy y fibra de vidrio. En su fabricación se emplea la tecnología de los preimpregnados ("prepreg"), que permiten controlar de un modo muy preciso el volumen de fibra del material y, con él, las propiedades mecánicas de las palas. En el caso de G87 y G90 se ha optimizado el diseño mediante la utilización de un sistema híbrido (vidrio – carbono) en la viga. El método de fabricación de la viga es manual y por Tape Winding hasta ser automatizado en su totalidad, en G87 y G90, mediante la técnica de Tape Placement y Tape Winding. Esto repercute en la repetitividad de sus características mecánicas y por tanto aumenta la calidad respecto a otras tecnologías.

La estructura de las palas del aerogenerador G8X-2.0 MW está formada por un larguero interior alrededor del cual va pegado el revestimiento, formado por dos conchas fabricadas por separado. La misión del larguero es aportar resistencia estructural al conjunto, resistir las cargas propias de la pala y transmitir esfuerzos al buje.

El revestimiento tiene la forma aerodinámica adecuada para convertir la energía cinética del viento en par motor para la generación de electricidad.

El larguero es en sí mismo una viga de sección tubular cerrada con una geometría adaptada a la forma aerodinámica de los perfiles de la pala. El revestimiento es una estructura sándwich con núcleo de PVC y laminados de fibra de vidrio en resina epoxy.

Es en el larguero de G87 y G90 donde se introduce fibra de carbono. Esto provoca un aumento de rigidez y una disminución de peso respecto a las palas de fibra de vidrio. Las palas de fibra de vidrio están dimensionadas por deflexión máxima. En palas de gran longitud esto provocaría un gran aumento de peso. La introducción de fibra de carbono permite dimensionar las palas por tensión,

2.1.2 Blades

The blades of the G8X-2.0 MW are fitted with lightning receptors to ensure that lightning discharges are conducted via the cooper cable through the blade to the root and transmitted to the nacelle. The distance between the blade root and the centre of the hub is 1 m.

The blades of the G8X-2.0 MW windturbine are made of glass fibre reinforced epoxy. Their manufacture is based on the pre-preg moulding technology. This technique allows a very accurate control of the volume of material and, therefore, of the mechanical properties of the resulting blade. On G87 and G90 the design has been optimised using an hybrid system on the beam (glass – carbon). The fabrication method of the beam is manual and using Tape Winding until it's being totally automated on G87 and G90 with the Tape Placement and Tape Winding techniques. This processes increase the quality of the blades because the mechanical properties are highly controlled.

The structure of the G8X-2.0 MW is an internal spar and two shells -made separately- surrounding it.
The role of this spar is to provide structural resistance to the whole system, bear the own blade loads and transmit the stresses to the hub.

On the other hand, the shells have no structural mission but own the adequate aero-dynamical shape to convert the kinetic energy of the wind into drive torque to generate electricity.

The internal spar is essentially a closed beam of tubular cross-section and its geometry is adapted to the aero-dynamic profile of the blade at each station. The outer part (shells) is a sandwich-like construction formed by a PVC core and glass fibre-*epoxy* laminates.

The carbon – fibre is introduced on the internal spar of the G87 and G90. This increases the rigidity and reduces the total weight comparing to the glass – fibre. The glass – fibre blades are dimensioned by the maximum deflection. On high length blades this would increase the weight so much. The carbon – fibre permits to dimension the blades by the tension, optimising the amount of material. This fact, added

quedando por tanto la cantidad de material optimizada. Este hecho, unido a la sensiblemente mayor relación rigidez / peso de la fibra de carbono respecto de la fibra de vidrio, reduce considerablemente el peso final de la pala y, a la postre, las cargas del resto de componentes del aerogenerador.

with higher rigidity/weight relation of the carbon – fibre, reduces the total weight and as a result the loads of the rest of the components.

La unión de la pala al rodamiento de pala es atornillada. Se practican 90 agujeros en la sección de raíz del larguero en los que se introducen insertos metálicos roscados, para facilitar la unión atornillada.

The attachment of the blade to its bearing is bolted. This is attained by means of 90 steel threaded inserts embedded in the laminate of the blade root.

2.1.3 Buje

El buje es de forma esférica y está fabricado en fundición nodular. Está montado directamente en el eje principal. Posee una abertura en la parte frontal que permite el acceso al interior para realizar inspecciones y mantenimiento tanto de la hidráulica del buje como del par de apriete a los tornillos de las palas.

2.1.3 Hub

The hub is spherical and manufactured in nodular cast iron. It is directly mounted on the main shaft and has an frontal opening for internal inspections and maintenance of the hydraulic system of the hub and tightening the blade bolts.

2.1.4 Cono de la nariz

El cono de la nariz protege el buje y los rodamientos de pala del ambiente. El cono se atornilla a la parte frontal del buje.

2.1.4 Nose cone

The hub and the blade bearings are entirely enclosed and protected from the outside environmental conditions by the nose cone. It is bolted on front of the hub and supported by the blade bearings.

2.1.5 Rodamientos de pala

Los rodamientos de la pala son la interfaz entre la pala y el buje y permiten el movimiento de cambio de paso. Son rodamientos de bolas con doble hilera con juntas sellantes y agujeros pasantes en la pista exterior para la unión con el buje y en la pista interior para la unión a la pala.

2.1.5 Blade bearings

The blade bearings fasten the blade with a rotating connection to the hub. The bearing is a double row 4-point contact ball bearing with seals. It has through holes in the outer ring for connecting with the hub and in the inner ring for connecting with the blade.

2.2 SISTEMA DE CAMBIO DE PASO

El sistema de cambio de paso actúa durante todo el tiempo de funcionamiento del aerogenerador: (i) Cuando la velocidad del viento es inferior a la nominal el ángulo de paso seleccionado es aquel que maximiza la potencia eléctrica obtenida para cada velocidad del viento; (ii) Cuando la velocidad del viento es superior a la nominal el ángulo de paso es aquél que proporciona la potencia nominal de la máquina.

2.2 PITCH SYSTEM

The pitch system is working all the times of operation of the wind turbine: (i) When the wind speed is below the rated one the pitch angle is chosen so the electrical power output is maximised for each wind speed; (ii) When the wind speed is above the rated one the pitch angle is adjusted to yield the rated power.

El movimiento de cambio de paso de la pala es un giro alrededor de su eje longitudinal. Para conseguir este movimiento en el aerogenerador G8X-2.0 MW se utiliza un sistema hidráulico, que a través de un

The pitch movement of the blade is a rotation around its longitudinal axis. This movement in G8X-2.0 MW wind-turbine is attained by an hydraulic system, which set the three blades at the same pitch angle

cilindro independiente por pala, coloca las tres palas al mismo ángulo de paso en cada instante.

every time by means of an independent cylinder for each blade.

2.3 EJE PRINCIPAL

La transmisión del par motor que provoca el viento sobre el rotor hasta la multiplicadora se realiza a través del eje principal. El eje se une al buje con una brida atornillada y está apoyado sobre rodamientos alojados en soportes fundidos. Todas las cargas, excepto el par torsor, son transmitidas al bastidor a través de estos soportes. La unión con la entrada de baja velocidad de la multiplicadora se consigue con un disco cónico de apriete que transmite el par por fricción.

El eje está fabricado en acero forjado y tiene un orificio central longitudinal para alojar las mangueras hidráulicas y los cables de control del sistema de cambio de paso.

2.3 MAIN SHAFT

The main shaft transmits the drive torque from the rotor to the gearbox. The shaft is joined to the hub through a bolted flange and is supported by two bearings in cast main bearing houses. All loads, except the driving torque, are transmitted to the main frame through the supports. The main shaft is fixed to the low speed hollow shaft of the gearbox with a conical joint that transmits the torque by friction.

The main shaft is manufactured in forged alloy steel. It features a hole to house the hoses for hydraulic oil and cables for pitch control system.

2.4 BASTIDOR

El bastidor del aerogenerador G8X-2.0 MW se ha diseñado bajo los criterios de simpleza mecánica y robustez adecuada para soportar los elementos de la góndola y transmitir las cargas hasta la torre. La transmisión de estas cargas se realiza a través del cojinete de la corona de orientación.

El bastidor se divide en dos partes:

(i) El bastidor delantero es una pieza de fundición donde se fijan los soportes del eje principal y la corona de orientación.
(ii) El bastidor trasero está formado por dos vigas unidas por su parte delantera y trasera. Esta parte ha sido diseñada para soportar al generador (derecha), el controlador del *Top* (izquierda) y el transformador. Entre ellas el suelo de la góndola permite el acceso para la realización de tareas de reparación y mantenimiento.

2.4 MAIN FRAME

The machine main frame has been designed to result in a simple and robust foundation suitable for the nacelle components and machinery. It transmits the loads from these elements to the tower through the yaw bearing system.

The nacelle main frame is divided in two parts:

(i) The front foundation is a cast piece where the supports of the main shaft and the yaw ring are fixed.
(ii) The rear frame is composed by two beams joined both at their rear and front ends. This part has been designed as to support the generator (right), controller (left) and the transformer. Between them, the nacelle floor allows both repair and maintenance tasks to be done.

2.5 CARCASA

La carcasa es la cubierta que protege los componentes del aerogenerador que se encuentran en la góndola. Está fabricada en resina poliéster con fibra de vidrio.

En el interior de la góndola hay suficiente espacio

2.5 NACELLE COVER

The nacelle housing is the cover for the protection of the mechanical components from the actions of the environment. This cover is manufactured in glass fibre reinforced polyester. Sufficient standing and working area is provided in the inner of the nacelle for service and maintenance work.

A hatch at the front of the cabin gives access to the

para realizar las operaciones de reparación y mantenimiento del aerogenerador. Una trampilla en la parte frontal permite el acceso al interior del cono, y una trampilla en el suelo de la parte trasera permite operar con la grúa. Las 2 claraboyas del techo proporciona luz solar por el día, ventilación adicional y acceso al exterior, donde se encuentran los instrumentos de medida de viento y el pararrayos.

inside of the nose cone and the hub. A hatch in the ground of the rear part of the nacelle cover can be opened to operate the service crane. The 2 skylight hatches provide diurnal lighting and additional ventilation and enables easy access to the nacelle roof where the wind sensors and the lightning rods are placed.

Las partes giratorias están debidamente protegidas para garantizar la seguridad del personal de mantenimiento.

High-speed rotating parts are conveniently covered by protective screens providing adequate safety for maintenance personnel.

2.6 MEDIDA DE VIENTO

En el exterior de la capota, en la parte trasera, dos mástiles verticales sirven de soporte del anemómetro sónico y anemo+veleta para medida del viento.

2.6 WIND MEASUREMENT

Outside the nacelle, in the rear part, two vertical mast support the ultrasonic anemometer and the cup anemometer + windvane for measuring the wind speed and direction.

2.7 SISTEMA DE CONTROL

El sistema de control monitoriza y gobierna todas las funciones del aerogenerador G8X-2.0 MW de manera que las actuaciones sean óptimas en todo momento. El sistema de control registra continuamente las señales de los distintos sensores del aerogenerador, y cuando detecta algún error realiza las acciones oportunas para subsanarlo. El sistema de control detiene el aerogenerador si el error detectado así lo requiere.

Existe una pantalla táctil en la que se presentan datos de operación y que permite la interacción del usuario con el aerogenerador, y un sistema de control que está preparado para la monitorización y el control remoto si es necesario.

2.7 CONTROL SYSTEM

The controller monitors and controls all functions in the G8X wind-turbine to ensure that its performance is optimal at any wind speed. It continuously scans the signals from the sensors in the wind turbine so that as soon as an error is detected, the appropriate handling takes place. The controller will stop the turbine if the detected error requires so.

There exists a touch screen in which operational data are displayed. The controller is designed as to allow remote monitoring and control in case these features are required. It is also supervised by the system watchdog so that, its correct operation is permanently guaranteed

2.7.1 Disposición del sistema de control

El soporte físico del sistema de control se reparte en tres armarios:

1. Controlador de la “nacelle” situado en la nacelle.
2. Controlador “ground” situado en la base de la torre.
3. Controlador del buje situado en la parte giratoria del aerogenerador.

A su vez, el controlador de la “nacelle” se divide en tres partes:

1. Sección de control: se encarga de las tareas

2.7.1 Layout of the controller

The control system hardware is placed in three parts:

1. “Nacelle” controller, located at the nacelle.
2. “Ground” controller, located at the bottom of the tower.
3. “Hub” controller, located at the rotating element of the wind-turbine (inside the hub).

The “nacelle” controller is divided into three parts further:

1. Control section: It in charged of the proper

propias del gobierno de la góndola, i.e. monitorización del viento, cambio del ángulo de paso, orientación, control de la temperatura interior.

2. Convertidor de frecuencia: se encarga del control de potencia y de gestionar la conexión y desconexión del generador de la red.
3. Sección de embarrados y protecciones: en esta parte se encuentra la salida de la potencia producida con las protecciones eléctricas necesarias.

tasks of govern of the nacelle, i. e. wind monitoring, pitch angle change, orientation, inside temperature control.

2. Frequency converter: It is charged of the power control and generator-grid connection/disconnection management.

3. Bars and protection section: This is in charge of the power output yield with the necessary electrical protections.

2.7.2 Pantalla de control

Desde la pantalla táctil del "ground" se puede tanto observar algunos datos de la operación del aerogenerador como detener y arrancar la máquina, entre otras acciones. También se puede conectar una pantalla portátil al controlador de la "nacelle" para realizar estas tareas.

2.7.2 Control touch terminal

When an operator wants to look at operational data from the turbine, or to start or stop the turbine, he can use the operating panel in the "ground" controller or connect a service panel to the "nacelle" controller.

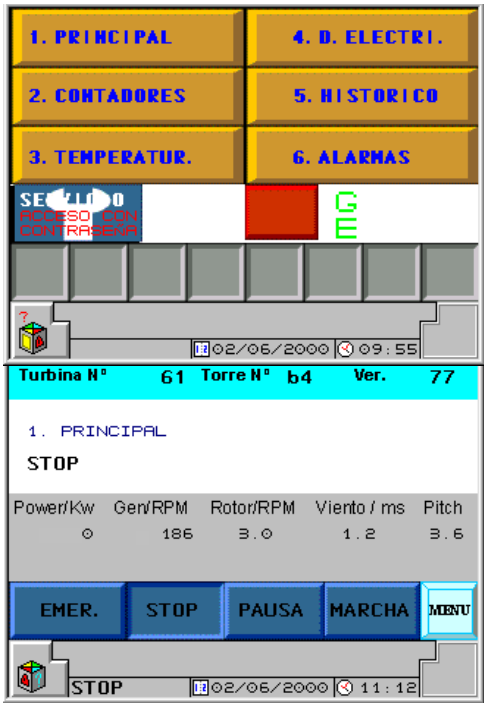

Figura 2. *Distintos modos de la pantalla de control.*

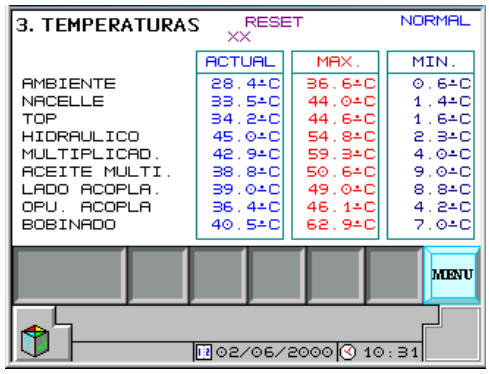

Figure 2. *Different operating panel modes.*

2.7.3 Control del aerogenerador

La velocidad de giro del aerogenerador y el ángulo de paso de las palas se modifican en cada instante dependiendo de la velocidad de viento que llega a la máquina. El sistema de control se encarga de elegir los valores adecuados de estas variables.

2.7.3 Wind-turbine control

The rotational speed and the pitch angle of the wind-turbine are modified at every instant depending on the existing wind-speed. The control system chooses the adequate values of these variables.

Atendiendo a la velocidad de viento se pueden establecer cuatro fases:

1. *Viento bajo*, con el generador desconectado de la red.
2. *Viento medio*, con el generador conectado, pero sin llegar a generar potencia nominal.
3. *Viento alto*, el generador produce potencia nominal.
4. *Viento muy alto*, el generador está desconectado y la turbina parada.

Viento bajo

Cuando la velocidad del viento es inferior a la velocidad de arranque de la máquina pero próxima a ésta, el sistema de control coloca las palas a un ángulo de paso cercano a 45º, que proporciona un par de arranque suficientemente alto.

A medida que la velocidad de viento aumenta la velocidad de rotación del rotor también aumenta, y el ángulo de paso se hace disminuir hasta que se alcanzan las condiciones adecuadas para que el generador se conecte.

Viento medio

A velocidades de viento por encima de la velocidad de arranque y por debajo de la velocidad nominal el sistema de control elige la velocidad de rotación y el ángulo de paso que proporcionan la máxima potencia para cada velocidad de viento.

Viento alto

Cuando la velocidad de viento es superior a la nominal, la energía contenida en el viento es suficiente para producir potencia nominal, y el ángulo de paso se incrementa para regular la potencia a su valor nominal.

Viento muy alto

Si la velocidad del viento es superior a la velocidad de parada, el generador se desconecta y el sistema de control lleva las palas a la posición de bandera (cercana a 90º) hasta que la velocidad de viento desciende por debajo de la velocidad de re-arranque y la máquina reanuda la generación de potencia.

Depending on the wind-speed 4 stages can be established:

1. *Low wind*, with the generator disconnected from the grid.
2. *Medium wind*, with the generator connected to the grid, but rated power is not accomplished.
3. *High wind*, the turbine produces rated power.
4. *Very high wind (stop wind)*, the generator is disconnected and the wind-turbine stopped.

Low wind

When the wind-speed is below, but close to, the start-wind-speed, the pitch angle will be approximately set equal to 45 degrees. This situation will give a sufficiently high start moment to the rotor.

As the wind-speed increases the rotational speed -rotor and generator- also increases, and the pitch angle is shifted down to small angles by the controller till the conditions to generator connection are achieved.

Medium wind

For wind speeds above the start-wind-speed and below the rated-wind-speed the control system works out the most suitable rotor speed -within a certain range of available operating speeds- and pitch angle so that the electrical power yield is maximum for each wind speed.

High wind

When the wind-speed exceeds the rated wind speed, the wind kinetic energy is sufficient for the turbine to produce rated power, and the pitch angle is increased to regulate the power to its rated value.

Very high wind

If the wind-speed is greater than the stop value the generator is disconnected and the control system pitches the blades to full feathered position (~ 90º). Then, the system will wait until the wind-speed has decreased below the re-start wind-speed to re-start the power generation.

2.8 COMUNICACIÓN DE TRANSFORMADOR, ARMARIO DE CONTROL Y CELDA

2.8.1 Alimentación del rotor del generador

La alimentación del rotor del generador se realiza a través de una salida del transformador principal 690V o a 480V dependiendo del convertidor.

2.8.2 Características de los cables del generador.

Estator: Los cables que unen tanto el estator del generador con el armario de control de potencia situado en la nacelle son cables 0.6/1kV 3x240 mm^2 y diseñados de acuerdo a la norma UNE 21150.

Rotor: Se utilizan cables 0.6/1kV 3x70 mm^2

Los cables que unen el armario de control de potencia con el transformador son cables de tipo 0.6/1kV 1x240 mm^2.

2.8.3 Fibra óptica

Pueden existir dos tipos de fibra óptica utilizadas para comunicaciones en el interior del aerogenerador. Una de ellas es de diámetro 200/230 μm, 4 hilos por manguera. Esta fibra óptica se utiliza para comunicaciones entre los distintos procesadores del aerogenerador y además está protegida contra humedad y roedores. La otra fibra óptica utilizada es de tipo HCS (200/230 μm) para la comunicación entre el autómata y los módulos de la góndola.

El sistema de telemando utiliza fibra de diámetro 62.5/125 μm, igualmente protegida contra la humedad y los roedores, para comunicar los distintos aerogeneradores.

2.9 CIMENTACIONES

A continuación se definen los datos principales de las cimentaciones estándar para el aerogenerador G8X – 2.0 MW con torres IEC IIA de 60, 67, 78 y 100 m y torres IEC IA de 60, 67 y 78m.

Estas cimentaciones se han calculado suponiendo cargas certificadas o en proceso de certificación y un terreno estándar.

En el caso de que las hipótesis manejadas sufran variaciones, los valores definidos no tendrán valor y será necesario un recálculo de la cimentaciones.

2.8 COMMUNICATION OF TRANSFORMER, CONTROL SYSTEM AND MEDIUM VOLTAGE SWITCH GEAR

2.8.1 Generator rotor supply

The power supply of the rotor of the generator is performed by means of an 690v or 480 V output of the main transformer depending on the converter.

2.8.2 Generator cables characteristics.

Stator: The generator stator and the power control board located in the nacelle are connected by means of DN-K 0.6/1kV 3 x 240 mm^2 cables which are designed according to the normative UNE 21150.

Rotor: As in the stator but with a section of 3 x 70 mm^2.

The power control board and the transformer are connected by means of 0.6/1kV 240 mm^2 cables

2.8.3 Optical fibre

There can be two kinds of optical fibre used for communications inside the turbine. One of these has a diameter of 200/230 μm, 4 wires per cable. This fibre is used for the communications between the different processors inside the turbine and besides, it is protected against the humidity and rodents action. The other optical fibre used is HCS (200/230 μm) for the communication between the PLC and the modules in the nacelle.

The remote control uses fibre of diameter 62.5/125 μm to communicate different wind-turbines. This fibre is also protected against the humidity and rodents action.

2.9 FOUNDATIONS

Below the main data of standard foundations of the G8X – 2.0 MW wind-turbine with 60 m, 67 m 78 m, and 100 m IEC IIA towers and 60, 67m and 78m IEC IA towers.

These foundations have been calculated using certified loads (or in certification process) and supposing a standard terrain.

In case these hypothesis change, the defined values will not be valid and a new calculation will be necessary.

Para cada emplazamiento, será necesario revisar las características del terreno junto con los datos de viento para seleccionar la cimentación más adecuada.

It will be necessary to revise the characteristics of the terrain and wind data to select the most convenient foundation for each site.

2.9.1 Datos principales:

- Dimensiones de las zapatas para torres IEC IIA:

Dimensión	**Dimensions**	**T60m**	**T67m**	**T78m**	**T100m**	**Unit**
Lado zapata, L	**Foundation length, L**	12.8	12.8	14.5	16	m
Canto exterior, h_e	**Exterior height, h_e**	1	1.5	1	1.6	m
Canto central, h_c	**Central height, h_c**	1.5	1.5	1.5	1.6	m
Diámetro virola cimentación	**Foundation belt diameter**	4.034	4.034	4.038	4038	m

- Mediciones de materiales para zapatas de torres IEC IIA:

Material	**Material**	**T60m**	**T67m**	**T78m**	**T100m**	**Unit**
Hormigón limpieza HM-20	**HM-20 concrete**	16.4	16.4	21	25.6	m^3
Hormigón estructural HA-30	**HA-30 structural concrete**	254.2	254.2	324	418	m^3
Acero armaduras B 500 S	**Steel reinforcement B 500 S**	22132	22132	35471	44100	kg

- Dimensiones de las zapatas para torres IEC IA:

Dimensión	**Dimensions**	**T60m**	**T67m**	**T78m**	**Unit**
Lado zapata, L	**Foundation length, L**	15	14.9	15.4	m
Canto exterior, h_e	**Exterior height, h_e**	1.5	1.5	1.5	m
Canto central, h_c	**Central height, h_c**	1.5	1.5	1.5	m
Diámetro virola cimentación	**Foundation belt diameter**	4.034	4.034	4.038	m

- Mediciones de materiales para zapatas de torres IEC IA:

Material	**Material**	**T60m**	**T67m**	**T78m**	**Unit**
Hormigón limpieza HM-15	**HM-15 concrete**	22.5	22.2	23.8	m^3
Hormigón estructural HA-30	**HA-30 structural concrete**	346	341.5	364.2	m^3
Acero armaduras B 500 S	**Steel reinforcement B 500 S**	40300	38100	40800	kg

2.9.1 Main data

- Dimensions of foundations of IEC IIA towers:

- Materials of foundations of IEC IIA towers::

- Dimensions of foundations of IEC IA towers:

- Materials of foundations of IEC IA towers:

3 PARÁMETROS DE DISEÑO.

3.1 CONDICIONES DEL VIENTO.

Las condiciones de viento para un emplazamiento se especifican normalmente por una distribución de Weibull. Esta distribución viene descrita por el factor de escala *A* y el factor de forma *k*. El factor *A* es proporcional a la velocidad media del viento y el factor *k* define la forma de la distribución para diferentes velocidades de viento. La turbulencia es el parámetro que describe las variaciones / fluctuaciones a corto plazo del viento.

Las condiciones de diseño de la máquina G8X-2.0 MW se indican a continuación:

3 DESIGN PARAMETERS.

3.1 WIND CONDITIONS.

The wind climate for a given site is normally specified by a Weibull distribution. The Weibull distribution is described by the scale factor A and the shape factor K. The A factor is proportional to the mean wind speed and the K factor defines the shape of the Weibull distribution for different wind speeds. Turbulence is the factor, which describes short-term wind variation/fluctuations.

The design conditions of G8X-2.0 MW are given below:

Tabla 4 Parámetros de diseño del aerogenerador G8X– 2.0 MW.
Table 4 Design parameters of G8X – 2.0 MW wind-turbine.

Class IEC	**DIBT II 60m**	**DIBT II 67m**	**DIBT II 78m**	**DIBT II 100m**	**DIBT III 67m**	**DIBT III 78m**	**II_A**	**I_A**	**Unidad /Unit**	**Comentarios Comments**
										IEC 61400-1 Ed. 2
Annual mean wind speed	5.9	6	6.2	6.4	8.4	8.6	8.5	10	m/s	Referred to hub height
Weibull* shape parameter, *K	2	2	2	2	2	2	2	2		
Turbulence intensity at 15 m/s, I_{15}	18	18	18	18	18	18	18	18		
Reference wind 10 min. averaged	36.7	37.4	38.3	39,9	43.4	44.5	42.5	50	m/s	Recurrente period 50 years
Reference wind 3 sec. averaged	-	-	-	-	-	-	59.5	70	m/s	Recurrente period 50 years
Stop / restart wind speed	25 / 20	25 / 20	25 / 20	25 / 20	25 / 20	25 / 20	25 / 20	25 / 20	m/s	-

Las curvas de potencia (calculadas para una turbulencia del 10 %) junto con las curvas C_p y C_t y la producción anual de cada aerogenerador se incluyen en los siguientes documentos:
G80 – 2.0 MW: **FT002002**
G83 – 2.0 MW: **FT002302**
G87 – 2.0 MW: **FT002404**
G90 – 2.0 MW: **FT002403**

The power curves (calculated for a turbulence of 10 %) together with the C_p and C_t curves and the annual production of each wind-turbine are included in the following documents:
G80 – 2.0 MW: **FT002002**
G83 – 2.0 MW: **FT002302**
G87 – 2.0 MW: **FT002404**
G90 – 2.0 MW: **FT002403**

3.2 VERIFICACIÓN DE LAS CONDICIONES DE VIENTO.

Los aerogeneradores se pueden colocar bajo diferentes y variadas condiciones climáticas: donde la densidad del aire, la intensidad de turbulencia, la velocidad media del viento y el parámetro de forma *k* son los parámetros a considerar. Si la intensidad de turbulencia es alta las cargas en el aerogenerador aumentan y su tiempo de vida disminuye. Por el contrario, las cargas se reducirán y su tiempo de vida aumentará si la velocidad media del viento o la intensidad de turbulencia o ambas son bajas. Por lo tanto, los aerogeneradores pueden colocarse en emplazamientos con alta intensidad de turbulencia si la velocidad media del viento es adecuadamente baja. Las condiciones climáticas han de examinarse si lo prescrito es excedido.

El valor característico, a altura de buje, de la intensidad de turbulencia I_{15} a la velocidad de viento media *diez-minutal* de 15 m/s se calcula sumando la desviación estándar medida de la intensidad de turbulencia a su valor medio medido o estimado.

En terreno complejo las condiciones de viento serán verificadas sobre la base de medidas realizadas en el emplazamiento. Además, habrá que considerar el efecto de la topografía en la velocidad y perfil del viento, la intensidad de turbulencia y la inclinación del flujo de viento sobre cada aerogenerador.

4 ESPECIFICACIONES TÉCNICAS.

A continuación se detallan las especificaciones técnicas de los diferentes componentes del aerogenerador G8X – 2.0 MW.

3.2 WIND CONDITION ASSESSMENT.

The turbines can be placed under various climatic conditions: where the air density, the turbulence intensity, the mean wind speed and the shape factor K are the parameters to be considered. If the turbulence intensity is high the turbine loading increases and the turbine lifetime decreases. On the contrary, the loading will be reduced and the lifetime extended if the mean wind speed or the turbulence intensity, or both, are low. Therefore, the wind-turbines can be placed on sites with high turbulence intensity if the mean wind speed is appropriately low. The climatic conditions have to be examined if the prescribed is exceeded

The characteristic value of hub-height turbulence intensity, I_{15}, at a min. average wind speed of 15 m/s is calculated by adding the measured standard deviation of the turbulence intensity to the measured or estimated mean value.

For complex terrain, the wind conditions shall be assessed from measurements made at the site. In addition, consideration shall be given to the effect of topography on the wind speed, wind profile, turbulence intensity and flow inclination at each turbine location.

4 TECHNICAL SPECIFICATIONS.

The technical specifications of the different components of the G8X – 2.0 MW wind-turbine are listed below:

4.1 CONO / NOSE CONE

Dimensiones	Distancia punta-base: 4237 mm Ø max. 3957 mm / Ø base 3300 mm
Material	Fibra de vidrio y resina de poliéster
Peso	310 kg

Dimensions	Tip-base distance: 4237 mm Ø max. 3957 mm; Ø base 3300 mm
Material	Glass fibre and polyester resin
Weight	310 kg

4.2 ROTOR / ROTOR

Diámetro	G80 D 80000mm G83 D 83000mm G87 D 87000mm G90 D 90000mm
Área barrida	G80 5026,5 m2 G83 5410,6 m2 G87 5944,7 m2 G90 6361,7 m2
Velocidad de rotación de operación	9.0 : 19.0 rpm
Sentido de rotación	Sentido agujas de reloj (vista frontal)
Orientación	Barlovento
Ángulo de inclinación	6º
Conicidad del rotor	2º
Número de palas	3
Freno aerodinámico	Puesta en bandera de palas

Diameter	G80 D 80000mm G83 D 83000mm G87 D 87000mm G90 D 90000mm
Swept Area	G80 5026,5 m2 G83 5410,6 m2 G87 5944,7 m2 G90 6361,7 m2
Rotational Speed Operation Interval	9.0 : 19.0 rpm
Sense of Rotation	Clockwise (front view)
Rotor Orientation	Upwind
Tilt angle	6º
Blade coning	2º
Number of blades	3
Aero-dynamic brake	Full feathering

4.3 PALAS / BLADES

Concepto estructural	Conchas pegadas a viga soporte principal
Material	- G80/83 Pre-impregnados de fibra de vidrio – epoxy - G87/G90 Pre-impregnados de fibra de carbono - epoxy y fibra de vidrio - epoxy
Conexión de palas	Insertos de acero en raíz
Perfiles aerodinámicos	- G80/83 NACA 63.XXX + FFA – W3 - G87/G90 DU-WX + FFA – W3
Longitud	- G80 39m - G83 40,5m - G87 42,5m - G90 44m
Cuerda de la pala (máxima / mínima)	- G80 3,36m / 0.48 m - G83 3,36m / 0.48 m - G87 3,36m / 0,013m - G90 3,36m / 0,013m
Torsión	- G80 18,74º - G83 18,74º - G87 15,74º - G90 15,74º
Masa nominal	- G80 6719 Kg - G83 7274 kg 8656 Kg (extender metálico) - G87 5981 Kg - G90 5983 Kg

Principle	Shells bonded to supporting beam
Material	- G80/83 Glass fibre reinforced epoxy - G87/G90 Carbon and glass fibre reinforced epoxy
Blade connection	Steel root inserts
Airfoils	- G80/83 NACA 63.XXX + FFA – W3 - G87/G90 DU-WX + FFA – W3
Length	- G80 39m - G83 40,5m - G87 42,5m - G90 44m
Chord (root/ tip)	- G80 3,36m / 0.48 m - G83 3,36m / 0.48 m - G87 3,36m / 0,013m - G90 3,36m / 0,013m
Max. Twist	- G80 18,74º - G83 18,74º - G87 15,74º - G90 15,74º
Weight	- G80 6719 Kg - G83 7274 kg; 8656 Kg (metallic extender) - G87 5981 Kg - G90 5983 Kg

4.4 RODAMIENTO DE PALA / BLADE BEARING

Tipo	Rodamiento de bola en doble fila 4 puntos de contacto
Dimensiones	ø2120 mm / ø1700 mm x 192 mm
Peso	1475 kg
Lubricación	Grasa Aeroshell 14

Type	Double row 4 point contact ball bearing
Dimensions	ø2120 mm / ø1700 mm x 192 mm
Weight	1475 kg
Lubrication	Grease Aeroshell 14

4.5 CARCASA / NACELLE COVER

Dimensiones	10050x1050x3300 mm
Material	Fibra de vidrio y resina de poliéster
Peso	2000 kg

Dimensions	10050x1050x3300 mm
Material	Glass fibre and polyester resin
Weight	2000 kg

4.6 BUJE DE PALA / ROTOR HUB

Tipo	Esférico
Material	Fundición nodular

Type	Spherical
Material	Nodular Cast Iron
Material specifications	EN-GJS-400-18U-LT per EN 1563

4.7 EJE PRINCIPAL / MAIN SHAFT

Tipo	Eje forjado
Dimensiones	Ø630 mm / brida ø1500 mm / longitud 2690 mm
Material	Acero templado y revenido
Especificación de material	42CrMo4 ó 34CrNiMo6 EN10083
Peso	6100 kg

Type	Forged shaft
Dimensions	Ø630 mm / flange ø1500 mm / length 2690 mm
Material	Quenched and tempered steel
Material specification	42CrMo4 or 34CrNiMo6 EN10083
Weight	6100 kg

4.8 SOPORTE DEL EJE / MAIN SHAFT SUPPORT

Tipo	Soporte de fundición
Material	Fundición nodular
Especificación de material	EN-GJS-400-18U-LT según EN 1563
Peso	1600 kg

Type	Cast
Material	Nodular Cast Iron
Material specification	EN-GJS-400-18U-LT per EN 1563
Weight	1600 kg

4.9 RODAMIENTOS DEL EJE / MAIN SHAFT BEARING

4.9.1 Rodamiento delantero del eje principal / Front main shaft bearing

Tipo	Rodamientos de rodillos a rótula. 230 / 630
Dimensiones	Ø920 mm / ø630 mm x 212 mm
Peso	485 kg
Lubricación	Grasa LG WM1

Type	Spherical Roller Bearings. 230 / 630
Dimensions	Ø920 mm / ø630 mm x 212 mm
Weight	485 kg
Lubrication	Grease LG WM1

4.9.2 Rodamiento trasero del eje principal / Rear main shaft bearing

Tipo	Rodamientos de rodillos a rótula. 24188
Dimensiones	Ø720 mm / ø440 mm x 280 mm
Peso	460 kg
Lubricación	Grasa LG WM1

Type	Spherical Roller Bearings. 24188
Dimensions	Ø720 mm / ø440 mm x 280 mm
Weight	460 kg
Lubrication	Grease LG WM1

4.10 BASTIDOR DELANTERO / FRONT MAIN FRAME

Material	Fundición nodular
Especificación de material	EN-GJS-400-18U-LT según EN 1563

Material	Nodular Cast Iron
Material specification	EN-GJS-400-18U-LT per EN 1563

4.11 SISTEMA DE GIRO / YAW SYSTEM

Tipo	Corona de orientación con cojinete de fricción
Materiales	
Corona de orientación	Forjado. 34CrNiMo 6 / 42CrMo4 EN10083
Elemento de fricción	PETP
Velocidad de orientación	< 0.5º/s
Freno de yaw	Activo hidráulico + Pasivo

Type	Plain bearing system with built-in friction
Materials	
Yaw ring	Forged. 34CrNiMo 6 / 42CrMo4 EN10083
Plain bearing	PETP
Yawing speed	< 0.5º/s.
Yaw brake	Hydraulic active + Passive

4.12 MECANISMO DE GIRO. MOTORREDUCTORAS / YAW GEARS

Tipo	3 etapas epicicloidales
	1 etapa sinfín (ratio máximo 1:10)
Motor	2.2 kW, motor asíncrono de 6 polos con freno

Type	3 planetary stages
	1 worm gear non – locking stage (maximum ratio 1:10)
Motor	2.2 kW, 6 pole asynchronous motor with brake.

4.13 TORRE / TOWER

Tipo	Tronco-cónica tubular
Material	Acero al carbono estructural
Especificación material	
Virolas	S235 JO / S235 JRG2 / S275J2G3/ S355J2G3 / S235 J2G3 / S355 NL
Bridas	S355 NL
Tratamiento superficial	Pintada
Tipo de corrosión, exterior / interior	C5-H (ISO 12944-2) / C3-H (ISO 12944-2)
Diámetro en parte superior	2.3 m (todas las alturas)
Diámetro en parte inferior	4.0 m (todas las alturas)
Altura del buje	
Torre modular de 3 tramos IEC (60 m)	60 m
Torre modular de 3 tramos IEC (67 m)	67 m
Torre modular de 4 tramos IEC (78 m)	78 m
Torre modular de 5 tramos IEC (100m)	100 m

Características de los tramos de torres IEC IIA / DIBT II				
	Longitud [mm]	**Ø Inferior Externo [mm]**	**Ø Superior Externo [mm]**	**Peso [kg]**
Torre IEC IIA / DIBT II 60 m				
Inferior	10391	4034	3490	34000
Intermedio	23822	3490	2778	56000
Superior	24367	2778	2314	43000
Torre IEC IIA/ DIBT II 67 m				
Inferior	16665	4034	3490	52000
Intermedio	23822	3490	2780	56000
Superior	24367	2780	2314	43000
Torre IEC IIA / DIBT II 78 m				
Inferior	11100	4038	3810	54000
Intermedio 1	16980	3810	3494	62000
Intermedio 2	23822	3494	2781	56000
Superior	24367	2781	2314	43000
Torre IEC IIA / DIBT II 100m				
Inferior	15619	4038	3855	65000
Intermedio 1	16961	3855	3810	65000
Intermedio 2	16980	3810	3494	58000
Intermedio 3	23822	3494	2781	56000
Superior	24367	2781	2314	52000

Características de los tramos de torres IEC IA /DIBT III				
	Longitud [mm]	**Ø Inferior Externo [mm]**	**Ø Superior Externo [mm]**	**Peso [kg]**
Torre IEC IA / DIBT III 60 m				
Inferior	10391	4034	3492	31400
Intermedio	23822	3492	2778	51600
Superior	24367	2778	2314	40000
Torre IEC IA / DIBT III 67 m				
Inferior	16665	4034	3492	49400
Intermedio	23822	3492	2781	51600
Superior	24367	2781	2314	40000
Torre IEC IA / DIBT III 78 m				
Inferior	11100	4038	3810	45200
Intermedio 1	16980	3810	3494	55200
Intermedio 2	23847	3494	2781	55700
Superior	24392	2781	2314	41200

(*) La altura exacta del buje incluye 0.60 m de distancia desde la brida de cimentación al suelo y 1.7 m desde la parte más alta de la torre hasta el centro del buje.

Type	Trunk-conical Tubular
Material	Non-alloy structural steel
Material specification	
Shells	S235 JO / S235 JRG2 / S275J2G3 / S355J2G3 / S235 J2G3 / S355 NL
Flanges	S355 NL
Surface treatment	Painted
Corrosion class, outside / inside	C5-M (ISO 12944-2) / C3 (ISO 12944-2)
Top diameter	2.3 m (all heights)
Bottom diameter	4.0 m (all heights)
Hub height	
3 parted modular tower IEC (60 m)	60 m
3 parted modular tower IEC (67 m)	67 m
4 parted modular tower IEC (78 m)	78 m
5 parted modular tower IEC (100 m)	100 m

Characteristics of the IEC IIA / DIBT II tower sections				
	Length [mm]	**Outer Ø at Bottom [mm]**	**Outer Ø at Top [mm]**	**Weight [kg]**
Tower IEC IIIA/ DIBT II 60 m				
Bottom	10391	4034	3490	34000
Intermediate	23822	3490	2778	56000
Top	24367	2778	2314	43000
Tower IEC IIA/ DIBT II 67 m				
Bottom	16665	4034	3490	52000
Intermediate	23822	3490	2780	56000
Top	24367	2780	2314	43000

Tower IEC IIA / DIBT II 78 m				
Bottom	11100	4038	3810	54000
Intermediate 1	16980	3810	3494	62000
Intermediate 2	23822	3494	2781	56000
Top	24367	2781	2314	43000
Tower IEC IIA / DIBT II 100 m				
Bottom	15619	4038	3855	65000
Intermediate 1	16961	3855	3810	65000
Intermediate 2	16980	3810	3494	58000
Intermediate 3	23822	3494	2781	56000
Top	24367	2781	2314	52000

Characteristics of the IEC IA / DIBT III tower sections				
	Length [mm]	**Outer Ø at Bottom [mm]**	**Outer Ø at Top [mm]**	**Weight [kg]**
Tower IEC IA / DIBT III 60 m				
Bottom	10391	4034	3492	31400
Intermediate	23822	3492	2778	51600
Top	24367	2778	2314	40000
Tower IEC IA / DIBT III 67 m				
Bottom	16665	4034	3492	49400
Intermediate	23822	3492	2781	51600
Top	24367	2781	2314	40000
Tower IEC IA / DIBT III 78 m				
Bottom	11100	4038	3810	45200
Intermediate 1	16980	3810	3494	55200
Intermediate 2	23847	3494	2781	55700
Top	24392	2781	2314	41200

(*) The exact hub height includes 0.7 m (distance from the foundation section to ground level) and 1.7 m (distance from top flange to hub).

4.14 MULTIPLICADORA / GEARBOX

Tipo	1 etapa planetaria / 2 paralelas
Ratio	1 : 100.5 (50 Hz) 1 : 120,5 (60Hz)
Refrigeración	Bomba de aceite con intercambiador.
Calentador de aceite	2.25 kW a 690V
Filtro de aceite	3 µm / 10 µm
Proveedor	Varios.
Dimensiones (aprox.)	2 x 2.2 x 2.2 m^3
Peso (max.)	16500 kg

Type	1 planetary stage / 2 palrallel stages
Ratio	1 : 100.5 (50 Hz) 1 : 120,5 (60Hz)
Cooling system	Oil pump with oil cooler; Aux. pump
Oil heater power	2.25 kW, 690V
Oil filter	3 μm / 10 μm
Supplier	Several
Dimensions (approx.)	2 x 2.2 x 2.2 m^3
Weight (max.)	16500 kg

4.15 ACOPLAMIENTO EJE DE ALTA / HIGH SPEED SHAFT COUPLING

Eje principal – multiplicadora	Disco cónico de apriete
Multiplicadora – generador	Acoplamiento flexible

Main shaft – gearbox	Shrink Disc Conical
Gearbox – generador	Flexible joint

4.16 GENERADOR CON CONVERTIDOR / GENERATOR WITH CONVERTER

Tipo	Doblemente alimentado con rotor devanado y anillos deslizantes
Potencia nominal	2000 kW (estátor + rotor)
Voltaje	690 Vac
Frecuencia	50 Hz / 60 Hz
Nº de polos	4
Clase de protección	IP54 (IP 23 para anillos rozantes)
Velocidad nominal de rotación	1680 rpm
Intensidad nominal	
Estator	1500 A @ 690 V
Rotor	260 A @ 480 V / 167 A @ 690 V
Factor de potencia	1.0
Intervalo de factor de potencia (*)	0.98_{CAP} – 0.96_{IND} (opción 1)
	0.95_{CAP} – 0.95_{IND} (opción 2)
Dimensiones	3224mm x 1883 mm x 1310 mm
Pesos	7100 kg
Rodamiento DE	6330 M / C3
Rodamiento NDE	6330 M / C3
	Ver sección 1.5

(*) En bornas de baja tensión del transformador.

Type	Doubly fed machine with wound rotor and slip-rings
Rated power	2000 kW (stator + rotor)
Voltage	690 Vac
Frequency	50 Hz / 60 Hz
Number of poles	4
Class of protection	IP54(IP23 for slip rings)
Rated speed	1680 rpm
Nominal current	
Stator	1500 A @ 690 V
Rotor	260 A @ 480 V / 167 A @ 690 V
Default power factor	1.0
Power factor range (*)	0.98_{CAP} – 0.96_{IND} (option 1)
	0.95_{CAP} – 0.95_{IND} (option 2)
Dimensions	3224mm x 1883 mm x 1310 mm
Weight	7100 kg
DE Bearing	6330 M / C3
NDE Bearing	6330 M / C3
	Ver sección 1.5

(*) At Low Voltage tranformer side.

4.17 FRENO DE APARCAMIENTO / PARKING BRAKE

Tipo	Freno de disco
Diámetro	600 mm
Material	EN-GJV-300-LT

Type	Disc brake
Diameter	600 mm
Material	EN-GJV-300-LT

4.18 GRUPO HIDRÁULICO / HYDRAULIC UNIT

Capacidad de la bomba	44 l/min
Presión máxima	200 bar
Contenido de aceite	300 l
Motor	18.5 kW / 22kW

Pump capacity	44 l/min
Maximum pressure	200 bar
Oil quantity	300 l
Motor	18.5 kW / 22kW

4.19 SENSORES DE VIENTO / WIND SENSORS

Tipo	1 anemómetro ultrasónico 2D con medida de velocidad y dirección simultánea + 1 anemómetro de cazoletas y veleta
Número	1 + 1

Type	1 ultrasonic anemometer 2D with simultaneous measurement of wind speed and direction + 1 cup anemometer and windvane
Number	1 + 1

4.20 UNIDAD DE CONTROL / CONTROL UNIT

Alimentación		
Frecuencia	50 Hz / 60 Hz	
Voltaje	3 x 690 Vca o 3 x 690 Vca +3 x 480 Vca	
Potencia para iluminación	1 x 10 A, 230 Vac (50Hz) / 1 x 10 A, 110 Vca (60Hz)	
PLC	Sisteam A / RFC 430 ETH-IB (Phoenix Contact)	
Comunicación	CAN / DDCS /Interbus	
Memoria de programa	EPROM (flash)	
Lenguaje de programación	ST (IEC-1131)	
Configuración	Módulos a un rack frontal	
Operación	Pantalla táctil	
Pantallas	Terminales táctiles, 320 x 240 pixels, 5,7 pulg.	
Supervisión / control		
	Potencia activa	Ambiente (temperatura del aire)
	Potencia reactiva	Rotación
	Orientación	Generador
	Hidráulicos	Sistema de cambio de paso
	Red eléctrica	Monitorización remota
Información		
		Datos de operación
		Producción
		Listado de operación
		Listado de alarmas
Ordenes		
	Arranque / pausa	
	Inicio / parada de orientación manual	
	Tests de mantenimiento	
Supervisión remota		
	Posibilidad de conexión a comunicación serie (para PLC Sistema A) o Ethernet (para PLC Phoenix Contact)	

Datos de controladores Nacelle, Buje, Ground		
Grado de protección		
	Nacelle	IP-43
	Buje	IP-54
	Ground	IP-54
Dimensiones aprox.	Nacelle	4000 x 2200 x 500 mm^3
	Buje	800 x 800 x 400 mm^3
	Ground	800 x 1600 x 400 mm^3
Tipo de alojamiento	Acero: chapa de 3 mm (armario y pedestal) y de 1,5 mm (puerta)	
Protección personas	UNE 60439-1; UNE 60204	

Power supply		
Frequency	50 Hz / 60 Hz	
Voltage	3 x 690 Vca or 3 x 690 Vac + 3 x 480 Vac	
Illumination	1 x 10 A, 230 Vac (50Hz) or (1 x 10 A, 110 Vca) (60Hz)	
PLC	Sisteam A / RFC 430 ETH-IB (Phoenix Contact)	
Communication	CAN / DDCS / Interbus	
Program memory	EPROM (flash)	
Programming language	ST (IEC-1131)	
Configuration	Modules to a front rack	
Operation	Touch terminal	
Display	Touch terminal, 320 x 240 pixels, 5,7 inch	
Supervision / control		
	Active power	Ambient (air temperature)
	Reactive power	Rotation
	Yawing	Generator
	Hydraulics	Pitch system
	Grid	Remote monitoring
Information		
	Operating data	Operation log
	Production	Alarm log
Commands		
	Run /pause	
	Start / Stop. Manual yaw	
	Maintenance tests	
Remote supervision		
	Possibility of connection of serial communication (for PLC Ssiteam A) or Ethernet (for PLC Phoenix Contact).	

Nacelle, hub and ground controller data		
Protection level		
	Nacelle	IP-43
	Hub	IP-54
	Ground	IP-54
Dimensions aprox		
	Nacelle	4000 x 2200 x 500 mm^3
	Hub	800 x 800 x 400 mm^3
	Ground	800 x 1600 x 400 mm^3
Type of enclosure	Steel. Thickness 3 mm (cabinet, pedestal); 1,5 mm (door)	
Method of protection of persons	UNE 60439-1; UNE 60204	

4.21 CELDA DE MEDIA TENSIÓN / MEDIUM VOLTAGE SWITCH GEAR

La celda de conexión del aerogenerador a la red eléctrica en Media Tensión se incluye en el suministro de Gamesa Eólica de forma opcional. La elección de esta celda debe ser realizada de acuerdo a las características eléctricas de la red de conexión, a continuación se muestran las características básicas de una celda-tipo.
Esta celda corresponde al aerogenerador G8X 2MW estándar para una red de conexión de 20kV. Para otros niveles de tensión de la red de conexión, es necesario consultar con Gamesa Eólica.

Tipo	Aparamenta Blindada aislada SF6
Servicio	Continuo
Instalación	Interior
Nº de fases	3
Nº embarrados	1
Tensión nominal asignada	24 kV
Tensión del servicio	20 kV
Frecuencia nominal	50 Hz
Intensidad nominal	
Función de protección (P)	200 A
Función de conexión a red (L)	400 A
Nivel de aislamiento	
A tierra, entre polos y entre bornas (frecuencia industrial / tipo rayo))	50 kV / 125 kV
Intensidad de cortocircuito	
Admisible de corta duración (1 s)	16 kA
Nominal cresta	40 kA
Resistencia arcos internos	
Intensidad	16 kA-0,5 s (UNE 20099-CEI 298
Voltaje	24 kV
Dimensiones (aprox.) (*)	1200 x 800 x 2090 (alto) mm^3
Peso (aprox.) (*)	415 kg

(*) Celda mayor
(**) El tipo de celda depende de las características del puerto de conexión del aerogenerador. Los datos indicados corresponden a una de las situaciones posibles.

The switch gear of the windturbine is included in the supply of Gamesa Eólica, S. A. as an option. This gear has to be chosen according to the electrical characteristics of the grid connection. Below, characteristics of one type of gear are shown. This gear corresponds to the G8X-2.0 MW standard for a grid connection of 20 kV. For other voltage levels, it is necessary to contact Gamesa Eólica, S. A.

Type	Armored isolated SF6
Service	Continuous
Installation	Inside
Number of phases	3
Busbar number	1
Assigned nominal voltage	24 kV
Service voltage	20 kV
Nominal frequency	50 Hz /
Nom. Intensity, Protection function (P)	200 A
Nom. Intensity, Grid connection function (L)	400 A
Insulation level	
Ground, between poles and between terminals	50 kV (industrial freq.) / 125 kV (peak freq.)
Short-circuit intensity	
Permissible of short duration (1 s)	16 kA
Nominal pulse	40 kA
Resistance	
Intensity	16 kA-0.5 s (UNE 20099-CEI 298)
Voltage	24 kV
Dimensions (approx. for larger unit)	1200 x 800 x 2090 (height) mm^3
Weight (approx. for larger unit)	415 kg

(*) Biggest gear
(**) The switch gear depends on the characteristics of the connection port of the generator. The indicated data correspond to one of the possible situations.

4.22 TRANSFORMADOR / TRANSFORMER

Tipo	Trifásico, seco encapsulado
Relación de transformación	6,6 kV ~ 34,4 kV / 690 V o 690 V + 480 V
Potencia nominal	2100 kVA / 2500 kVA (opción)
Frecuencia	50 Hz / 60Hz
Grupo de conexión	Dyn11
Clase de aislamiento	F
Nivel de aislamiento (kV)	24 kV
Peso (aprox.)	<5000 kg

Type	3 phase, dry-encapsulated
Transformation relation	6,6 kV ~ 34,4 kV / 690 V or 690 V + 480 V
Nominal power	2100 kVA / 2500 kVA (option)
Frequency	50 Hz / 60Hz
Connection group	Dyn11
Insulation class	F
Insulation level (kV)	24 kV.
Weight (approx.)	< 5000 kg

4.23 PESOS / WEIGHTS

PESO TORRES / TOWER WEIGHT	60 m	67 m	78 m	100 m
Torres IEC IIA (*)	127 t	145 t	201 t	283 t
Torres DIBt Zona II (*)			201 t	283 t
Torres IEC IA / DIBt Zona III (*)	136 t	153 t	203 t	

(*) Estos pesos no incluyen la celda de media tensión y el *ground*.
(*) It does not include the switch gear and the ground controller.

PESO NACELLE / NACELLE WEIGHT	70 t

PESO ROTOR / ROTOR WEIGHT	G80	G83 EXTENDER MECANOSOLDADO	G83 EXTENDER ROOT BLADE	G87	G90
	38,6 t	45,0 t	40,7 t	36,4 t	38,0 t

PESO TOTAL NACELLE /NACELLE TOTAL WEIGHT		G80	G83 EXTENDER MECANOSOLDADO	G83 EXTENDER ROOT BLADE	G87	G90
Towers IEC IIA (*)	**60 m**	235,6 t	242 t	237,7 t	233,4 t	234,9 t
	67 m	253,6 t	260 t	255,7 t	251,4 t	252,9 t
	78 m	309,6 t	316 t	311,7 t	307,4 t	308,9 t
	100 m	391,6 t	398 t	393,7 t	389,4 t	390,9 t
Towers DIBt Zone II (*)	**78 m**	309,6 t	316 t	311,7 t	307,4 t	308,9 t
	100 m	391,6 t	398 t	393,7 t	389,4 t	390,9 t
Towers IEC IA / DIBt Zone III (*)	**60 m**	244,6 t	233 t	246,7 t	242,4 t	243,9 t
	67 m	261,6 t	268 t	263,7 t	259,4 t	260,9 t
	78 m	311,6 t	318 t	313,7 t	309,4 t	310,9 t

Título:
Análisis de ruido aerogenerador G90 - 2 MW

Title:
Noise analysis for the G90-2 MW wind turbine

Confidencialidad: 3

Doc VWS: FT002413.R2

AUTOR/ AUTHOR: NCD

REVISADO/CHECKED: AMG

APROBADO/APPROVED: JMY

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REGISTRO DE CAMBIOS/ RECORD OF CHANGES

Rev.	Fecha/ Date	Autor/ Author	Descripción	Description
B	06/08/03	BML	Versión Inicial	Initial Version
2	16/04/04	NCD	Versión con actualización de formato y con tablas de valores	Initial Version with new format and including tables with numerical values

Título: **Análisis de ruido aerogenerador G90 - 2 MW**
Title: **Noise analysis for the G90-2 MW wind turbine**

1 OBJETO

El presente documento da una estimación del nivel de emisión de ruido del aerogenerador G90 – 2MW de Gamesa Eólica.

2 ALCANCE

El alcance del cálculo presentado es aplicable en las condiciones indicadas en **4 Descripción**

3 DEFINICIONES Y ACRÓNIMOS

-

4 DESCRIPCIÓN

Hay que hacer notar que las expresiones empleadas en el cálculo de la emisión de ruido son aproximadas.

5 RESULTADOS

La Figura 1 muestra el nivel de ruido ocasionado por el aerogenerador G90 para diferentes alturas de torre en función de la velocidad del viento medido a una altura de 10m.

1 AIM

This document provides an estimate of the noise associated to the G90-2MW wind turbine.

2 SCOPE

The calculation scope only apply in the terms described in **4 Description**

3 DEFINITIONS AND ACRONYMS

-

4 DESCRIPTION

Methods used to carry out this estimate are based on semiempirical correlations.

5 RESULTS

Figure 1 shows noise level generated by the G90 wind turbine for different tower heights and wind velocities measured at 10 meters above ground.

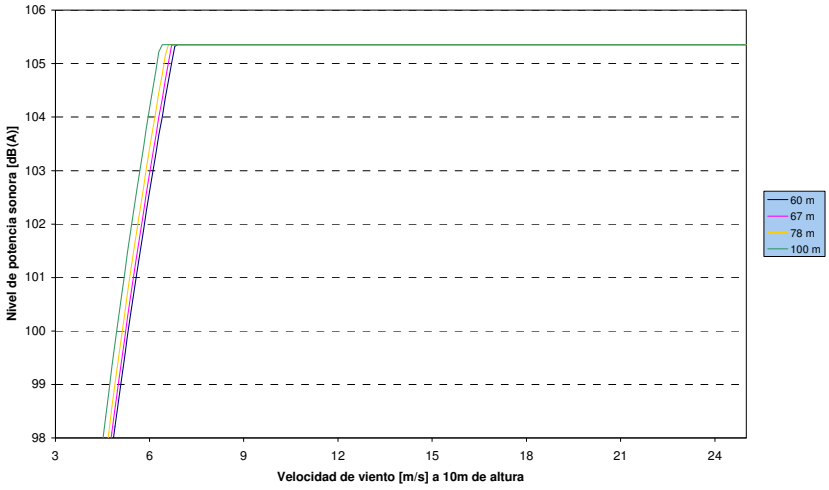

Figura 1. Nivel de ruido del aerogenerador G90 – 2 MW en función de la altura de torre y de la velocidad del viento a 10m sobre el nivel del suelo. $\lambda = 9.0$

Figure 1. Noise level of G90 – 2MW wind turbine for different tower heights and wind velocities measured at 10 meters above ground.

La Tabla 1 muestra los valores numéricos de nivel de ruido en dB(A) para las distintas velocidades de viento, desde 3m/s hasta la velocidad de corte.

Table 1 shows noise numerical values in dB(A) for different wind velocities, from 3m/s to cut wind speed.

v_{wind} [m/s]	dB(A) H= 60m	dB(A) H= 67m	dB(A) H= 78m	dB(A) H= 100m
3	91.86	91.86	91.86	91.86
4	93.80	94.14	94.60	95.36
5	98.65	98.99	99.45	100.2
6	102.6	102.9	103.4	104.2
7	105.3	105.3	105.3	105.3
8	105.3	105.3	105.3	105.3
9	105.3	105.3	105.3	105.3
10	105.3	105.3	105.3	105.3
11	105.3	105.3	105.3	105.3
12	105.3	105.3	105.3	105.3
13	105.3	105.3	105.3	105.3
14	105.3	105.3	105.3	105.3
15	105.3	105.3	105.3	105.3
16	105.3	105.3	105.3	105.3
17	105.3	105.3	105.3	105.3
18	105.3	105.3	105.3	105.3
19	105.3	105.3	105.3	105.3
20	105.3	105.3	105.3	105.3
21	105.3	105.3	105.3	105.3

Tabla 1. Nivel de ruido del aerogenerador G90 – 2MW para diferentes velocidades de viento y distintas alturas de torre

Table 1. Noise level of G90 – 2MW wind turbine for different wind velocities and tower heights

La velocidad máxima de punta de pala para este aerogenerador es 78.7 m/s. El nivel estimado máximo* de emisión de ruido en estas condiciones es 105.3 dB(A).

Wingtip maximum velocity is 78.7 m/s . Estimated maximum noise level is 105.3 dB (A).

6 DOCUMENTOS Y ARCHIVOS APLICABLES

7 ANEXOS

8 APPLICABLE DOCUMENTATION AND FILES

9 ANNEXES

(*) Estudio de ruido de los aerogeneradores V80, G83, G87 y G90. Ref: GAMESA A1.aero.002.03, 21/07/03.

Gamesa Eólica

INSTRUCCIÓN DE TRABAJO WORK INSTRUCTION	Nº: 1.941654 Revisión: 03

Título: Title:	CARTA DE LUBRICACION LUBRICATION CHART				Ref. VWS Nº: 941654 R02 Dr./Plano-Instrucción Supl: 942288
Realizado		Revisado	Aprobado		
RSL	Fecha: 01/07/03	R.Z.	Ingeniería: JPT	Fecha Aprobación:	Pág. 1 De 2

POS	PUNTO DE LUBRICACIÓN / LUBRICATION POINT	LUBRICANTE	CANTIDAD	INTERVALO	FECH
1	Rodamiento de pala / *Blade bearings*	*AeroShell Calsium Grease 14 (149047)*	*3 x 400 g*	*6 months*	*24/09/*
2	Rótulas bielas / *Connecting rod joints*	*SKF LGWM1 (149139)*	*3 x 25 g*	*6 months*	*08/08/*
3	Eje antirotación / *Traverse anti rotation device*	*SKF LGWM1(149139) + Teflón Líquido (3003001)*	*As Required*	*6 months*	*13/08/*
4	Eje soporte estrella, casquillo frontal,*Casquillo glicodour / Traverse tube, front bushing, glicodour bushing* → Eje soporte estrella superficie del eje / *Traverse tube, visible part* →	→ *SKF LGWM1 (149139)* → *SKF LGWM1 + Teflón líquido(3003001)*	*100 g* *Lo necesario*	*6 months* *6 months*	*08/08/* *13/08/*
5	Rodamiento caballete, frente / *Main bearing, front* → Rodamiento caballete, trasera / *Main bearing rear* →	→ *SKF LGWM1 (149139)* → *SKF LGWM1 (149139)*	*400 g* *400 g*	*6 months* *6 months*	*08/08/*
6	Multiplicadora / *Gear box, Flender* Multiplicadora / *Gear box, Hansen* Multiplicadora / *Gear box, Valmet* Multiplicadora / *Gear box Fellar* Multiplicadora / *Gear box Lohman* *Multiplicadora / Gear box Echesa*	*Texaco Meropa 320 (149092)* *Texaco Meropa 320 (149092)* *Texaco Meropa 320 (149092)* *Texaco Meropa 320 (149092)* *Texaco Meropa 320 (149092)* *Texaco Meropa 320 (149092)*	*125 l* *130 l* *125 l* *135 l* *125 l* *110 l*	*18 months* *18 months* *18 months* *18 months ** *18 months* *18 months*	*10/02/*
7	Cardan / *Cross cardan shaft*	*Beslux Liplex H-1/2-S (9002601)*	*300 g*	*6 months*	*09/05/*
8	Anillos deslizantes / *Guide rings, pitch bearing housing*	*SKF LGWM1 (149139)*	*10 g*	*6 months*	*08/08/*
9	Rodamiento de Pitch / *Pitch bearing*	*SKF LGWM1 (149139)*	*50 g*	*6 months*	*08/08/*
10	Arrastrador del pitch / *Link bearing: Pitch bearing housing - cylinder*	*AeroShell Calsium Grease 14 (149047)*	*25 g*	*6 months*	*24/09*
11	Montaje cilindro hidraúlico / *Hydraulic cylinder mounting*	*SKF LGWM1 (149139)*	*10 g*	*6 months*	*08/08*
12	Amortiguador multiplicadora / *Gear mounting, disc springs*	*Shell Stamina Grease HDS 2(1.094161)*	*100 g*	*6 months*	*09/05/*
13	PETP de corona / *Yaw bearing (Slide blocks)*	*Shell Stamina HDS 2 (1.094161))*	*200 g*	*6 months*	*10/02*

14	Dientes de corona / *Yaw gear (Yaw teeth)*	*Kluber Grafloscon A-G1 Ultra(149187)*	*100 g*	*6 months*	*10/02/*
15	Reductoras de giro / *Yaw drive gears: Worm gear* *Planetary gear*	*Shell Tivela SC (149107)* *Shell Tivela SC (149107)*	*2,7 l* *6 l*	*5 years* *5 years*	*08/08/*
16	Rodamientos frontales Generador de 660 Kw / *Big Gen: Front bearing* *ABB (660 Kw)* *Leroy Somer (660 kW)* *Weier (660 kW)* *INDAR (660 Kw)*	*Arcanol FAG (3003002)* *Arcanol FAG (3003002)* *Arcanol FAG 3003002))* *Beslux Liplex H-1/2-S (9002601)*	*40 g* *60 g* *72 g* *55 g*	*6 months*	*09/05/*
17	Rodamientos traseros Generador de 660 Kw / *Big Gen: rear bearings* *ABB (660 Kw)* *Leroy Somer (660 kW)* *Weier (660 kW)* *INDAR (660 Kw)*	*Arcanol FAG (3003002))* *Arcanol FAG (3003002))* *Arcanol FAG (3003002)* *Beslux Liplex H-1/2-S (9002601)*	*40 g* *60 g* *83 g* *55 g*	*6 months*	*09/05/*
18	Rodamientos frontales Generador de 200 Kw / *Small Gen.: Front bearing ABB (200 Kw)*	*Arcanol FAG (3003002))*	*25 g*	*6 months*	*13/08/*
19	Rodamientos traseros Generador de 660 Kw / *Small Gen.: Rear bearing ABB (200 Kw)*	*Arcanol FAG (3003002)*	*25 g*	*6 months*	*13/08/*
20	Grupo Hidraúlico / *Hydraulic unit*	*Texaco Rando HDZ 32 (149115)*	*60 l*	*5 years*	*08/08/*
21	Polipasto / *Crane*	*Mobilgear 630*	*Lubricated for life*		*08/08/*

* En las multiplicadoras Fellar, el primer cambio de aceite se hará a los 6 meses de la puesta en funcionamiento / In Fellar gear-boxes, the first change of oil will be performed at 6 months.

MATERIAL SAFETY DATA SHEET

"READ AND UNDERSTAND MATERIAL SAFETY DATA SHEET
BEFORE HANDLING OR DISPOSING OF PRODUCT"

02324 MEROPA 320

1. PRODUCT AND COMPANY NAME

PRODUCT CODE AND NAME
02324 MEROPA 320
DESCRIPTION
Gear Lubricant
COMPANY
TEXACO PETROLIFERA S.A.
C.Villa de Madrid 34
Pol. Ind. Fuente del Jarro
46988 Paterna (Valencia)
SPAIN
Tel : 0034/96132 2361
Fax : 0034/96132 3704
Emergency Phone Number : 0044/(0)18 65 407 333

2. COMPOSITION/INFORMATION ON INGREDIENTS

Name	% Wt	CAS No.	EC No.
Mineral oil	95 - 99,99	*	*
Olefin sulphide	< 5	CBI	CBI
R 53	May cause long-term adverse effects in the aquatic environment.		
Phosphoric acid ester amine salt	< 2,5	CBI	CBI
N R 51/53	Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.		

(IP 346 DMSO extract < 3%)
* : EC-Nrs.: 278-012-2 ; 295-426-9 ; 265-169-7 ; 265-101-6

3. HAZARDS IDENTIFICATION

Product classification
Product is not classified as dangerous according to Directive 1999/45/EC.

Acute effects of exposure to man

Inhalation
Vapours or mist in unusually high concentrations, as from exposure in poorly ventilated areas or confined spaces, may cause irritation of the nose and throat, headache, nausea, and drowsiness.

Skin contact
Brief contact is not irritating. Prolonged contact, as with clothing wetted with material, may cause defatting of skin or irritation, seen as local redness with possible mild discomfort.

Eye contact
May cause minimal irritation, experienced as temporary discomfort.

Ingestion
No adverse effects expected. If more than several mouthfuls are swallowed, abdominal discomfort, nausea, and diarrhoea may occur.

Chronic effects of exposure to man	
Medical conditions aggravated by exposure	Because of its defatting properties, prolonged and repeated skin contact may aggravate an existing dermatitis (skin condition).
Effects of exposure to the environment	May form an oil film leading to deoxygenation of water and possible harmful effects on aquatic life.

4. FIRST AID MEASURES

Route of exposure	
Inhalation	If irritation, headache, nausea, or drowsiness occurs, remove to fresh air. Get medical attention if breathing becomes difficult or symptoms persist.
Skin contact	Wash skin with plenty of soap and water for several minutes. Get medical attention if skin irritation develops or persists.
Eye contact	Flush eyes with plenty of water for several minutes. Get medical attention if eye irritation persists.
Ingestion	Do not induce vomiting. Get medical attention. Never give anything by mouth to an unconscious or convulsing person.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	Use water fog, dry powder, foam or carbon dioxide. Use water to cool fire-exposed containers. If a leak or spill has not ignited, use water fog to disperse the vapours and to provide protection for personnel attempting to stop the leak.
Extinguishing media which must not be used for safety reasons	Water jet
Special exposure hazards arising from the substance or preparation itself, combustion products, resulting gases	None
Special protective equipment for firefighters	The nature of special protective equipment required will depend upon the size of the fire, the degree of confinement of the fire and the natural ventilation available. Fire-resistant clothing and self-contained breathing apparatus is recommended forfires in confined spaces and poorly-ventilated areas. Full fire-proof clothing is recommended for any large fires involving this

	product. In case of fire - Always call the fire brigade. Small fires, such as those capable of being fought with ahand-held extinguisher, can normally be fought by a person who has received instruction on the hazards of flammable liquid fires. Fires that are beyond that stage should only be tackled by people who have received hands-on training. Ensure escape pathis available.

6. ACCIDENTAL RELEASE MEASURES

Procedures in case of accidental release or leakage	Contain spill if possible. Wipe up or absorb on suitable material and shovel up. Prevent liquid or runoff from entering waterways and sewer systems.

7. HANDLING AND STORAGE

Handling	Avoid prolonged or repeated contact with skin. Avoid breathing vapours.
Storage	Store in the original container securely closed and at room temperature.
Specific use (s)	For intended product uses please refer to the Product Information Leaflet (PIL)

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Respiratory protection	Airborne concentrations should be kept to lowest levels possible. If vapour or mist is generated, use approved respirator as appropriate. Supplied air respiratory protection should be used for cleaning large spills or upon entry into tanks, vessels, or other confined spaces.
Hand and skin protection	Exposed employees should exercise reasonable personal cleanliness. This includes cleansing exposed skin areas several times daily with soap and water, and laundering or dry cleaning soiled work clothing.
Eye protection	Chemical type goggles or face shield recommended to prevent eye contact.
Exposure limit for the product	Oil mist, mineral (excluding metalworking fluids) : TWA : 5 mg/m3 ; STEL : 10 mg/m3

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	Clear liquid
Odour	Mineral oil
Flash point (ASTM D92), °C	> 222
Relative density	min 0,893 kg/L @ 15 °C
Viscosity	304 - 336 mm2/s @ 40°C

10. STABILITY AND REACTIVITY

Materials to avoid	Strong oxidising agents.
Hazardous decomposition products	Oxides of carbon, aldehydes and ketones.

11. TOXICOLOGICAL INFORMATION

Acute

Inhalation	High concentrations of vapours or mist are likely to be irritating to the respiratory tract and may cause nausea, dizziness, headaches and drowsiness.
Skin contact	Slightly irritating to the skin.
Eye contact	Unlikely to cause more than transient stinging or redness if accidental eye contact occurs.
Ingestion	Unlikely to cause harm if accidentally swallowed in small doses, though larger quantities may cause nausea and diarrhoea.
Chronic	Repeated skin contact may cause a persistent irritation or dermatitis.

12. ECOLOGICAL INFORMATION

Mobility	Spillages may penetrate the soil causing ground water contamination.
Persistence and degradability	According to EC criteria : Not readily biodegradable
Potential to bioaccumulate	Considered unlikely to bioaccumulate.
Aquatic toxicity	Not classified as toxic.
Remarks	Believed not to represent a long-term danger to the aquatic environment. WGK=1

13. DISPOSAL CONSIDERATIONS

Disposal	Dispose in accordance with local laws and regulations governing disposal of waste oil. EWC-Nr : 13 02 05

14. TRANSPORT INFORMATION

transport	Not regulated

15. REGULATORY INFORMATION

Classification/Labelling information	Under the criteria of Directive EEC/67/548 (dangerous substances) and EEC/1999/45 (dangerous preparations) : Not classified

16. OTHER INFORMATION

Full text of risk phrases	R 53 May cause long-term adverse effects in the aquatic environment. N R 51/53 Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
Changes were made in sections :	2, 3, 7, 9, 15, 16

DATE ISSUED : 07/01/2004 Supersedes : 07/01/2004

All information contained in this Material Safety Data Sheet and, in particular, the health and safety and environmental information is accurate to the best of our knowledge and belief as at the date of issue specified. However, the Company makes no warranty or representation, express or implied, as to the accuracy or completeness of such information.

The provision of this Material Safety Data Sheet is not intended, of itself, to obviate the need for all users to satisfy themselves that the product described is suitable for their individual purposes and that the safety precautions and environmental advice are adequate for their individual purposes and situation. Further, it is the user's obligation to use this product safely and to comply with all applicable laws and regulations concerning the use of the product.

The company accepts no responsibility for any injury, loss or damage, consequent upon any failure to follow the safety and other recommendations contained in this Material Safety Data Sheet, nor from any hazards inherent in the nature of the material, nor from any abnormal use of the material.

"Data sheet prepared by TEXACO BELGIUM N.V.

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Fax : +/32/9/240 7340"

Version nr : 1.10

MATERIAL SAFETY DATA SHEET

"READ AND UNDERSTAND MATERIAL SAFETY DATA SHEET
BEFORE HANDLING OR DISPOSING OF PRODUCT"

33115 MEROPA WM 320

1. PRODUCT AND COMPANY NAME

PRODUCT CODE AND NAME
33115 MEROPA WM 320
DESCRIPTION
Gear Lubricant
COMPANY
TEXACO PETROLIFERA S.A.
C.Villa de Madrid 34
Pol. Ind. Fuente del Jarro
46988 Paterna (Valencia)
SPAIN
Tel : 0034/96132 2361
Fax : 0034/96132 3704
Emergency Phone Number : 0044/(0)18 65 407 333

2. COMPOSITION/INFORMATION ON INGREDIENTS

Name	% Wt	CAS No.	EC No.
Residual oils (petroleum), solvent-dewaxed	65 - 79,99	64742-62-7	265-166-0
Distillates (petroleum), solvent-dewaxed heavy paraffinic	20 - 34,99	64742-65-0	265-169-7
Olefin sulphide	< 2	CBI	CBI
R 53 May cause long-term adverse effects in the aquatic environment.			
Phosphoric acid ester amine salt	< 2,5	CBI	CBI

N R 51/53 Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

(IP 346 DMSO extract < 3%)

3. HAZARDS IDENTIFICATION

Product classification
Product is not classified as dangerous according to Directive 1999/45/EC.

Acute effects of exposure to man

Inhalation
Vapours or mist in unusually high concentrations, as from exposure in poorly ventilated areas or confined spaces, may cause irritation of the nose and throat, headache, nausea, and drowsiness.

Skin contact
Brief contact is not irritating. Prolonged contact, as with clothing wetted with material, may cause defatting of skin or irritation, seen as local redness with possible mild discomfort.

Eye contact
May cause minimal irritation, experienced as temporary discomfort.

Ingestion
No adverse effects expected. If more than

	several mouthfuls are swallowed, abdominal discomfort, nausea, and diarrhoea may occur.
Chronic effects of exposure to man	
Medical conditions aggravated by exposure	Because of its defatting properties, prolonged and repeated skin contact may aggravate an existing dermatitis (skin condition).
Effects of exposure to the environment	May form an oil film leading to deoxygenation of water and possible harmful effects on aquatic life.

4. FIRST AID MEASURES

Route of exposure	
Inhalation	If irritation, headache, nausea, or drowsiness occurs, remove to fresh air. Get medical attention if breathing becomes difficult or symptoms persist.
Skin contact	Wash skin with plenty of soap and water for several minutes. Get medical attention if skin irritation develops or persists.
Eye contact	Flush eyes with plenty of water for several minutes. Get medical attention if eye irritation persists.
Ingestion	Do not induce vomiting. Get medical attention. Never give anything by mouth to an unconscious or convulsing person.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	Use water fog, dry powder, foam or carbon dioxide. Use water to cool fire-exposed containers. If a leak or spill has not ignited, use water fog to disperse the vapours and to provide protection for personnel attempting to stop the leak.
Extinguishing media which must not be used for safety reasons	Water jet
Special exposure hazards arising from the substance or preparation itself, combustion products, resulting gases	None
Special protective equipment for firefighters	The nature of special protective equipment required will depend upon the size of the fire, the degree of confinement of the fire and the natural ventilation available. Fire-resistant clothing and self-contained breathing apparatus is recommended forfires in confined spaces and

	poorly-ventilated areas. Full fire-proof clothing is recommended for any large fires involving this product. In case of fire - Always call the fire brigade. Small fires, such as those capable of being fought with ahand-held extinguisher, can normally be fought by a person who has received instruction on the hazards of flammable liquid fires. Fires that are beyond that stage should only be tackled by people who have received hands-on training. Ensure escape pathis available.

6. ACCIDENTAL RELEASE MEASURES

Procedures in case of accidental release or leakage	Contain spill if possible. Wipe up or absorb on suitable material and shovel up. Prevent liquid or runoff from entering waterways and sewer systems.

7. HANDLING AND STORAGE

Handling	Avoid prolonged or repeated contact with skin. Avoid breathing vapours.
Storage	Store in the original container securely closed and at room temperature.
Specific use (s)	For intended product uses please refer to the Product Information Leaflet (PIL)

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Respiratory protection	Airborne concentrations should be kept to lowest levels possible. If vapour or mist is generated, use approved respirator as appropriate. Supplied air respiratory protection should be used for cleaning large spills or upon entry into tanks, vessels, or other confined spaces.
Hand and skin protection	Exposed employees should exercise reasonable personal cleanliness. This includes cleansing exposed skin areas several times daily with soap and water, and laundering or dry cleaning soiled work clothing.
Eye protection	Chemical type goggles or face shield recommended to prevent eye contact.
Exposure limit for the product	Oil mist, mineral (excluding metalworking fluids) : TWA : 5 mg/m3 ; STEL : 10 mg/m3

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	Clear liquid
Odour	Mineral oil
Flash point (ASTM D92), °C	250
Relative density	0.895 kg/L @ 15 °C
Viscosity	min 300 mm2/s @ 40 °C

10. STABILITY AND REACTIVITY

Materials to avoid	Strong oxidising agents.
Hazardous decomposition products	Oxides of carbon, aldehydes and ketones.

11. TOXICOLOGICAL INFORMATION

Acute

Inhalation	High concentrations of vapours or mist are likely to be irritating to the respiratory tract and may cause nausea, dizziness, headaches and drowsiness.
Skin contact	Slightly irritating to the skin.
Eye contact	Unlikely to cause more than transient stinging or redness if accidental eye contact occurs.
Ingestion	Unlikely to cause harm if accidentally swallowed in small doses, though larger quantities may cause nausea and diarrhoea.
Chronic	Repeated skin contact may cause a persistent irritation or dermatitis.

12. ECOLOGICAL INFORMATION

Mobility	Spillages may penetrate the soil causing ground water contamination.
Persistence and degradability	According to EC criteria : Not readily biodegradable
Potential to bioaccumulate	Considered unlikely to bioaccumulate.
Aquatic toxicity	Not classified as toxic.
Remarks	Believed not to represent a long-term danger to the aquatic environment. WGK=1

13. DISPOSAL CONSIDERATIONS

Disposal	Dispose in accordance with local laws and regulations governing disposal of waste oil. EWC-Nr. : 13 02 05

14. TRANSPORT INFORMATION

transport	Not regulated

15. REGULATORY INFORMATION

Classification/Labelling information	Under the criteria of Directive EEC/67/548 (dangerous substances) and EEC/1999/45 (dangerous preparations) : Not classified

16. OTHER INFORMATION

Full text of risk phrases	R 53 May cause long-term adverse effects in the aquatic environment. N R 51/53 Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
Changes were made in sections :	2, 3, 7, 9, 15, 16

DATE ISSUED : 07/01/2004 Supersedes : 07/01/2004

All information contained in this Material Safety Data Sheet and, in particular, the health and safety and environmental information is accurate to the best of our knowledge and belief as at the date of issue specified. However, the Company makes no warranty or representation, express or implied, as to the accuracy or completeness of such information.

The provision of this Material Safety Data Sheet is not intended, of itself, to obviate the need for all users to satisfy themselves that the product described is suitable for their individual purposes and that the safety precautions and environmental advice are adequate for their individual purposes and situation. Further, it is the user's obligation to use this product safely and to comply with all applicable laws and regulations concerning the use of the product.

The company accepts no responsibility for any injury, loss or damage, consequent upon any failure to follow the safety and other recommendations contained in this Material Safety Data Sheet, nor from any hazards inherent in the nature of the material, nor from any abnormal use of the material.

"Data sheet prepared by TEXACO BELGIUM N.V.

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Fax : +/32/9/240 7340"

Version nr : 1.12

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MATERIAL IDENTITY
Product code and name:
2324M MEROPA 320
Chemical name and/or family or decription:
Gear Oils
Manufacturer's name and address:
PRODUCTOS TEXACO S.A. de C.V.

Oriente 171-401, Aragon Inguaran
07820, Mexico D.F., Mexico
Telephone numbers:
Transportation emergency:
525-751-0600
CHEMTREC (USA): (800) 424-9300
Health emergency-Company: (504) 680-1900
MSDS Assistance (USA):(845)838-7204
Technical Information - Fuels, Fuel Additives: (845) 838-7611
Technical Information - Coolants: (845) 838-7444

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2. COMPOSITION/INFORMATION ON INGREDIENTS

Product and/or component(s)
Carcinogenic According to:

NONE

-

Name	Cas nr	Range in %
Solvent-dewaxed heavy paraffinic petroleum distillates	64742-65-0	20 - 34.99

5.00 mg/m3 TWA-OSHA (MINERAL OIL MIST)

5.00 mg/m3 TWA-ACGIH (MINERAL OIL MIST)
10.00 mg/m3 STEL ACGIH (MINERAL OIL MIST)

64742-62-7 65 - 79.99

Solvent-dewaxed petroleum residual oil

5.00 mg/m3 TWA-OSHA (MINERAL OIL MIST)
5.00 mg/m3 TWA-ACGIH (MINERAL OIL MIST)
10.00 mg/m3 STEL ACGIH (MINERAL OIL MIST)

PRODUCT IS NON-HAZARDOUS ACCORDING TO OSHA (1910.1200).

---

3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW
WARNING STATEMENT
NONE CONSIDERED NECESSARY
PRECAUTIONARY MEASURES:
-Avoid prolonged breathing of vapor, mist, or gas.
-Workers should wash exposed skin several times daily with soap and water.
HMIS

Health:	0
Flammability:	1
Reactivity:	0
Special:	-

NFPA

Health:	0
Flammability:	1
Reactivity	0
Special:	-

Primary Route of Exposure:
EYES
SKIN
INHALATION
EFFECTS OF OVEREXPOSURE
Acute:
Eyes:
May cause minimal irritation, experienced as temporary discomfort.
Skin:
Brief contact is not irritating. Prolonged contact, as with clothing wetted with material, may cause defatting of skin or irritation, seen as local redness with possible mild discomfort.
Other than the potential skin irritation effects noted above, acute (short term) adverse effects

are not expected from brief skin contact, see other effects, below, and Section 11 for information regarding potential long term effects.
Inhalation:
Vapors or mist, in excess of permissible concentrations, or in unusually high concentrations generated from spraying, heating the material or as from exposure in poorly ventilated areas or confined spaces, may cause irritation of the nose and throat, headache, nausea, and drowsiness.
Ingestion:
If more than several mouthfuls are swallowed, abdominal discomfort, nausea, and diarrhea may occur.
Sensitization Properties:
Unknown.
Chronic:
No adverse effects have been documented in humans as a result of chronic exposure. Section 11 may contain applicable animal data.
Medical Conditions Aggravated by Over Exposure:
Because of its defatting properties, prolonged and repeated skin contact may aggravate an existing dermatitis (skin condition).
Other Remarks:
When overheated, product may release hydrogen sulfide (H2S) gas. H2S concentrations above permissible concentrations can cause irritation of the eyes and respiratory tract, headache, dizziness, nausea, vomiting, diarrhea and pulmonary edema. At concentrations above 300 ppm, respiratory paralysis, causing unconsciousness and death, can occur.

---

4. FIRST AID MEASURES

Eyes:
Flush eyes with plenty of water for several minutes. Get medical attention if eye irritation persists.
Skin:
Wash skin with plenty of soap and water for several minutes. Get medical attention if skin irritation develops or persists.
Ingestion:
If more than several mouthfuls of this material are swallowed, give two glasses of water (16 oz.). Get medical attention.
Inhalation:
If irritation, headache, nausea, or drowsiness occurs, remove to fresh air. Get medical attention if breathing becomes difficult or respiratory irritation persists.
Other Instructions:
Remove and dry-clean or launder clothing soaked or soiled with this material before reuse. Dry cleaning of contaminated clothing may be more effective than normal laundering. Inform individuals responsible for cleaning of potential hazards associated with handling contaminated clothing.
Note to Physician:
None

---

5. FIRE-FIGHTING MEASURES

Ignition Temperature - AIT (degrees C):
Not determined.
Flash Point (degrees C):
238 (COC)
Flammable Limits (%):
Recommended Fire Extinguishing Agents and Special Procedures:

Use water spray, dry chemical, foam, or carbon dioxide to extinguish flames. Use water spray to cool fire-exposed containers. Water or foam may cause frothing.
Unusual or Explosive Hazards:
Hydrogen sulfide (H2S) may be released if overheated.
Extinguishing Media Which Must Not be Used:
Not evaluated.
Special Protective Equipment for Firefighters:
Other than normal protective fire-fighting equipment, no special equipment or procedures required.
FIRE:
In case of fire, use water spray, dry chemical, foam or carbon dioxide. Water may cause frothing. Use water spray to cool fire-exposed containers.

---

6. ACCIDENTAL RELEASE MEASURES

Procedures in Case of Accidental Release, Breakage or Leakage:
Ventilate area. Avoid breathing vapor. Wear appropriate personal protective equipment, including appropriate respiratory protection. Contain spill if possible. Wipe up or absorb on suitable material and shovel up. Prevent entry into sewers and waterways. Avoid contact with skin, eyes or clothing.

---

7. HANDLING AND STORAGE

Precautions to be Taken in
Handling:
Minimum feasible handling temperatures should be maintained.
Storage:
Periods of exposure to high temperatures should be minimized. Water contamination should be avoided.

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8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Protective Equipment (Type)
Eye/Face Protection:
Safety glasses, chemical type goggles, or face shield recommended to prevent eye contact.
Skin Protection:
Workers should wash exposed skin several times daily with soap and water. Soiled work clothing should be laundered or dry-cleaned.
Respiratory Protection:
Airborne concentrations should be kept to lowest levels possible. If vapor, mist or dust is generated and the occupational exposure limit of the product, or any component of the product, is exceeded, use appropriate NIOSH or MSHA approved air purifying or air supplied respirator after determining the airborne concentration of the contaminant. Air supplied respirators should always be worn when airborne concentration of the contaminant or oxygen content is unknown.
Ventilation:
Adequate to meet component occupational exposure limits (see Section 2).
Exposure Control for Total Product:
None established for product, refer to Section 2 for component exposure limits.

---

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Dark red liquid
Odor:	Petroleum odor
Boiling Point (degrees C):	Not determined.
Melting/Freezing point (degrees C):	Not determined.
Specific Gravity (water=1):	.9045
pH of undiluted product:	Not applicable.
Vapor Pressure:	Not determined.
Viscosity (degrees C):	329 cSt (40)
VOC Content:	Not determined.
Vapor Density (air=1):	Not determined.
Solubility in Water (%):	Not determined.
Other:	None

---

10. STABILITY AND REACTIVITY

This material reacts violently with:
Strong Oxidizers
Comments:
Under extreme temperatures or extended storage periods, hydrogen sulfide (H2S) gas may accumulate in the head-space of container.
Products Evolved When Subjected to Heat or Combustion:
Toxic levels of carbon monoxide, carbon dioxide, irritating aldehydes and ketones, and combustion products or compounds of
sulfur (may include hydrogen sulfide)
Hazardous Polimerizations:
No

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11. TOXICOLOGICAL INFORMATION

TOXICOLOGICAL INFORMATION (ANIMAL TOXICITY DATA)
Median Lethal Dose
Oral:

LD50 Believed to be > 5.00 g/kg (rat) practically non-toxic
Inhalation:
Not determined.
Dermal:
LD50 Believed to be > 2.00 g/kg (rabbit) practically non-toxic
Irritation Index, Estimation of Irritation (Species)
Skin:
(Draize) Believed to be < .50 /8.0 (rabbit) no appreciable effect
Eyes:
(Draize) Believed to be < 15.00 /110 (rabbit) no appreciable effect
Sensitization:
Not determined.
Other:
None

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12. DISPOSAL CONSIDERATIONS

Waste Disposal Methods:
Dispose of this product in accordance with local and/or national regulations.
US/RCRA Waste Disposal Methods:
Not evaluated.
Remarks:
None

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13. TRANSPORT INFORMATION

DOT:	Not regulated
IMDG:	Not regulated
ICAO:	Not evaluated
TDG:	Not evaluated

---

14. REGULATORY INFORMATION

Regulatory Information:
SARA 311 Hazard Categorization:
N/A
WHMIS:
Not determined
Regulatory Comments:
None.

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15. ENVIROMENTAL INFORMATION

Aquatic Toxicity:
Not determined.
Mobility:
Not determined.
Persistence and Biodegradability:
Not determined.
Potential to Bioaccumulate:
Not determined.
Remarks:
None

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16. OTHER INFORMATION

Other Information:
Definitions of Terms: OSHA - Occupational Safety and Health Administration (a regulatory and enforcement agency of safety and health in most United States industrial sectors, part of the United States Department of Labor. PEL - Permissible Exposure Limit, OSHA workplace exposure limits for hazardous materials. IARC - International Agency for Research on Cancer (part of the World Health Organization). NTP - National Toxicology Program (overseen by the United States Department of Health and Human Services), develops tests for public health regulation of toxic chemicals. ACGIH - American Conference of Government Industrial Hygienists, develops recommended exposure limits for chemical substances and physical agents. TLV - Threshold Limit Value, ACGIH term for the airborne concentration of a material to which nearly all healthy workers can be exposed without adverse effects. TLV-STEL- Short-term exposure limit, for brief exposure. (15 minutes) TLV-TWA- Time weighted average concentration, for longer exposure.(8 hours) HMIS - Hazardous Materials Identification System, developed by the National Paint and Coatings Association, numbers assigned to indicate the degree of hazard, with 0 for least severe to 4 for most severe. NFPA - National Fire Protection Association (an international organization to promote fire prevention), a hazard rating system similar to HMIS.

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17. PRODUCT LABEL

MATERIAL IDENTITY
Product code and name:
2324M MEROPA 320
-

Name	Cas nr	Range in %
Solvent-dewaxed heavy paraffinic petroleum distillates	64742-65-0	20 - 34.99
Solvent-dewaxed petroleum residual oil	64742-62-7	65 - 79.99

PRODUCT IS NON-HAZARDOUS ACCORDING TO OSHA (1910.1200).
WARNING STATEMENT
NONE CONSIDERED NECESSARY
PRECAUTIONARY MEASURES:
-Avoid prolonged breathing of vapor, mist, or gas.
-Workers should wash exposed skin several times daily with soap and water.
HMIS

Health:
0
Flammability:
1
Reactivity:
0
Special:
-

NFPA

Health:
0
Flammability:
1
Reactivity
0
Special:
-

Eyes:
Flush eyes with plenty of water for several minutes. Get medical attention if eye irritation persists.

Skin:
Wash skin with plenty of soap and water for several minutes. Get medical attention if skin irritation develops or persists.

Ingestion:
If more than several mouthfuls of this material are swallowed, give two glasses of water (16 oz.). Get medical attention.

Inhalation:
If irritation, headache, nausea, or drowsiness occurs, remove to fresh air. Get medical attention if breathing becomes difficult or respiratory irritation persists.

Note to Physician:
None

FIRE:
In case of fire, use water spray, dry chemical, foam or carbon dioxide. Water may cause frothing. Use water spray to cool fire-exposed containers.

DOT:
Not regulated

Manufacturer's name and address:
PRODUCTOS TEXACO S.A. de C.V.

Oriente 171-401, Aragon Inguaran
07820, Mexico D.F., Mexico

Telephone numbers:
Transportation emergency:
525-751-0600
Health emergency-Company:(504) 680-1900

Product Code :

Date Issued : 11/05/1999

CAUTION: Misuse of empty containers can be hazardous. Empty containers can be hazardous if used to store toxic, flammable, or reactive materials. Cutting or welding of empty containers might cause fire, explosion or toxic fumes from residues. Do not pressurize or expose to open flame or heat. Keep container closed and drum bungs in place.

THE INFORMATION CONTAINED HEREIN IS BELIEVED TO BE ACCURATE. IT IS PROVIDED INDEPENDENTLY OF ANY SALE OF THE PRODUCT FOR PURPOSE OF HAZARD COMMUNICATION AS PART OF THE COMPANY'S PRODUCT STEWARDSHIP PROGRAM. IT IS NOT INTENDED TO CONSTITUTE PERFORMANCE INFORMATION CONCERNING THE PRODUCT. NO EXPRESS WARRANTY, OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE IS MADE WITH RESPECT TO THE PRODUCT OR THE INFORMATION CONTAINED HEREIN. DATA SHEETS ARE AVAILABLE FOR ALL THE COMPANY'S PRODUCTS. YOU ARE URGED TO OBTAIN DATA SHEETS FOR ALL THE COMPANY'S PRODUCTS YOU BUY, PROCESS, USE OR DISTRIBUTE AND YOU ARE ENCOURAGED AND REQUESTED TO ADVISE THOSE WHO MAY COME IN CONTACT WITH SUCH PRODUCTS OF THE INFORMATION CONTAINED HEREIN. TO DETERMINE APPLICABILITY OR EFFECT OF ANY LAW OR REGULATION WITH RESPECT TO THE PRODUCT, USER SHOULD CONSULT HIS LEGAL ADVISOR OR THE APPROPRIATE GOVERNMENT AGENCY. THE COMPANY DOES NOT UNDERTAKE TO FURNISH ADVICE ON SUCH MATTERS.

Exhibit 11R

Drawings and Specifications of Gamesa Eolica Wind Turbines

The Applicant plans to use Gamesa G90 Wind Turbines at the Marble River Wind Farm (see enclosure #1, press announcement of purchase of Gamesa turbines). Gamesa is a leading company in the design, manufacturing, installation, operation and maintenance of wind turbines. In 2004, Gamesa was ranked second worldwide in a ranking of the Top 10 wind turbine manufacturers by BTM Consult, with a market share of 18.1%. In Spain, Gamesa Eólica is the leading manufacturer and supplier of wind turbines, with a market share of 56.8% in 2004. One of the partners in the Marble River Wind Farm, Acciona, has had a significant and successful history with Gamesa turbines.

Gamesa has used the experience gained in its home market to develop a robust, adaptable wind turbine suitable for most wind conditions in the USA. Gamesa Wind US will carry out a major portion of the manufacturing of the wind turbines planned for Marble River in the Mid-Atlantic region, where Gamesa is already active in development and construction of wind energy projects.

Gamesa G90

The Gamesa G90 is a 2-MW, three-bladed, upwind pitch regulated and active yaw wind turbine. The G90 has a blade length of 44m which, when added to the diameter of the hub, gives a total diameter of 90m and a swept area of 6362m2. The turbine blades are bolted to a hub at the low speed end of a 1:120 ratio gear box. Enclosure #2, **G90-2.0MW,** contains a picture of the G90 with a summary of the technical data. Enclosure # 3 contains more detailed descriptions, design parameters and technical specifications for the G90 turbine.

The use of a 2-MW turbines, as opposed to a 1.5-MW machine, allows the Applicant to decrease the environmental impact on the ground (less roads, less cable per MW) relative to a smaller machines, which is an important consideration given the expanse of wetlands in the project area.

Enclosure # 4 contains a noise analysis for the G90 2-MW wind turbines, showing a maximum noise of 105.3dB(A) at a hub height of 78m.

Enclosure # 5 is the Lubrication Chart. Enclosure # 6 has Material Safety Data Sheets for the turbines containing generic information concerning health and safety for compositions and materials related to operation of turbines.

The Applicant has completed a Preliminary Transportation Assessment Report (enclosure #7) to transport wind turbine components to Clinton County, looking at two options to cross the County to the project area and examining in detail possibilities and constraints within the project area.

Enclosures

1. Announcement of Purchase of up to 600MW of Gamesa Wind Turbines for Installation in 2006 and 2007
2. G90-2.0MW Technical Data
3. Characteristics and General Operation of Gamesa G8X 2.0MW Wind turbine (including G90)
4. Noise Analysis for the G90 2-MW Wind Turbine
5. Lubrication Chart
6. Material Safety Data Sheet
7. Preliminary Transportation Assessment Report

Horizon Wind Energy

LATEST NEWS AND CONTENT

HORIZON NEWS: Horizon Signs Frame Agreement with Gamesa for Supply of 600 MW of Wind Turbines

Horizon Will Install Turbines during 2006 and 2007

Vitoria–Gasteiz, November 21, 2005 – Gamesa Wind US LLC., a subsidiary of Gamesa Eólica, the world's second leading wind turbine manufacturer and a market leader in Spai the manufacturing, sales, and installation of wind turbines, has been selected by Horizon Energy for the supply of up to 600 MW of wind turbines for projects located in the United States.

The agreement between Gamesa and Horizon involves the supply of the full line of Game G8X-2.0 MW products, including the Gamesa G80, Gamesa G83, Gamesa G87, and Gar G90 wind turbines. Most of the manufacturing of these wind turbines will be carried out in plants that the Spanish company owns in the US.

The frame agreement initially calls for the supply of 400 MW with an option for an additior 200 MW. The turbines will be installed during 2006 and 2007. The estimated value of this agreement, depending on its final scope and the combination of the wind turbine models, reach up to $700 million.

"We are very pleased that Horizon has turned to Gamesa for their wind turbines needs. T transaction strengthens the position of Gamesa Wind in the US, which together with Chin one of our target markets as we expand internationally," said Iñaki López Gandásegui, Gamesa's CEO. "Horizon has shown its commitment to our multi-MW portfolio of Gamesa 8X-2.0 turbines. These turbines are known for their robustness and adaptability to any wi site," he added.

"We look forward to installing Gamesa turbines over the next two years. Gamesa is know the high quality of its equipment. We appreciate their commitment to the USmarket, and t turbines will be an important part of our growth over the next several years," said Alec Dre CEO of Horizon Wind Energy.

Gamesa Eólica is a leading company in the design, manufacturing, installation as well as operation and maintenance of wind turbines. In 2004, it was ranked second worldwide in Top 10 manufacturers ranking, with a market share of 18.1% (BTM Consult ApS).

In Spain, Gamesa Eólica is the leading manufacturer and supplier of wind turbines, with a market share of 56.8% of installed wind power in 2004. Countries like the USA, Germany France, Portugal, the UK, Ireland, Greece, Mexico, Argentina, Morocco, Egypt, India, Chi Japanalready have wind turbines supplied by Gamesa Eólica.

G90-2.0 MW

Maximum output at minimum cost per kWh for low wind sites

Advantages

- Optimum price-quality ratio provided by Gamesa's vertically integrated supply structure
- New 44 m blade using state-of-the-art manufacturing technology: carbon fibre and pre-preg technology for a lighter rotor design
- IEC IIIA/WZII classes with the largest swept area
- Improved service capabilities through discrete components at drive train
- Reduced sound level for standard power level and different low-noise level versions
- Gamesa Technology with a proven track-record in complex terrains: active yaw, optimised control, fast pitch dynamics

Gamesa Eólica

Rotor

Diameter	90 m
Swept area	6,362 m²
Rotational speed, rotor	9.0 - 19.0 r.p.m.
Rotational direction	Clockwise (frontal view)

Blades

Number of blades	3
Length	44 m
Airfoils	DU (Delft University) + FFA-W3
Material	Preimpregnated epoxy glass fibre + carbon fibre
Total blade weight	Approx. 7,000 kg

Gearbox G90-2.0 MW

Type	1-stage planetary / 2-stage helical
Ratio	50 Hz 1:100.5 60 Hz 1:120.515
Cooling	Oil pump with heat exchanger
Oil heater	2.2 kW

2.0 MW Generator

Type	Doubly fed generator
Rated power	2.0 MW
Voltage	690 V ac
Frequency	50 Hz / 60 Hz
Protection class	IP 54
Number of poles	4
Rotation speed	900:1,900 r.p.m. (rated/1,680 r.p.m.)
Rated current	
Stator	1,500 A @ 690 V
Rated power factor, default	1.0
Power factor range	0.98 CAP - 0.96 IND (option)

Weights

Class	IEC IIIA Dibt WZII	IEC IIIA Dibt WZII	IEC IIIA Dibt WZII
Tower height	67 m	78 m	100 m
Tower (tubular)	153 T	200 T	286 T
Nacelle	65 T	65 T	65 T
Rotor (incl.hub)	39,4 T	39,4 T	39,4 T
TOTAL	**257,4 T**	**304,4 T**	**390,4 T**

Control System

The Generator is a doubly fed machine (DFM), whose speed and power is controlled through IGBT converters and PWM (Pulse Width Modulation) electronic control.
Advantages:

- Active and reactive power control.
- Low harmonics content and minimum losses.
- Increased efficiency and production.
- Prolonged working life of the turbine.

Remote Control System

A remote control system that ensures real-time monitoring of the machines' parameters as well as communication with the weather masts and the electrical sub-station from a central or remote site. Ability for controlling active and reactive power.

Predictive Maintenance System SMP-8C

Predictive Maintenance System for the early detection of wear and faults in the wind turbine's main components.
Advantages:

- Capacity for signal processing and detection of alarms within the equipment.
- Integration within the control system.
- Reduction in major corrective measures.
- Increase in the availability and working life of the machine.
- Preferential terms in negotiations with insurance companies.

Grid Code Compliance

Dynamic regulation of active and reactive power in order to contribute to the stability of the grid and overcome voltage dips by means of a device that ensures grid code compliance.

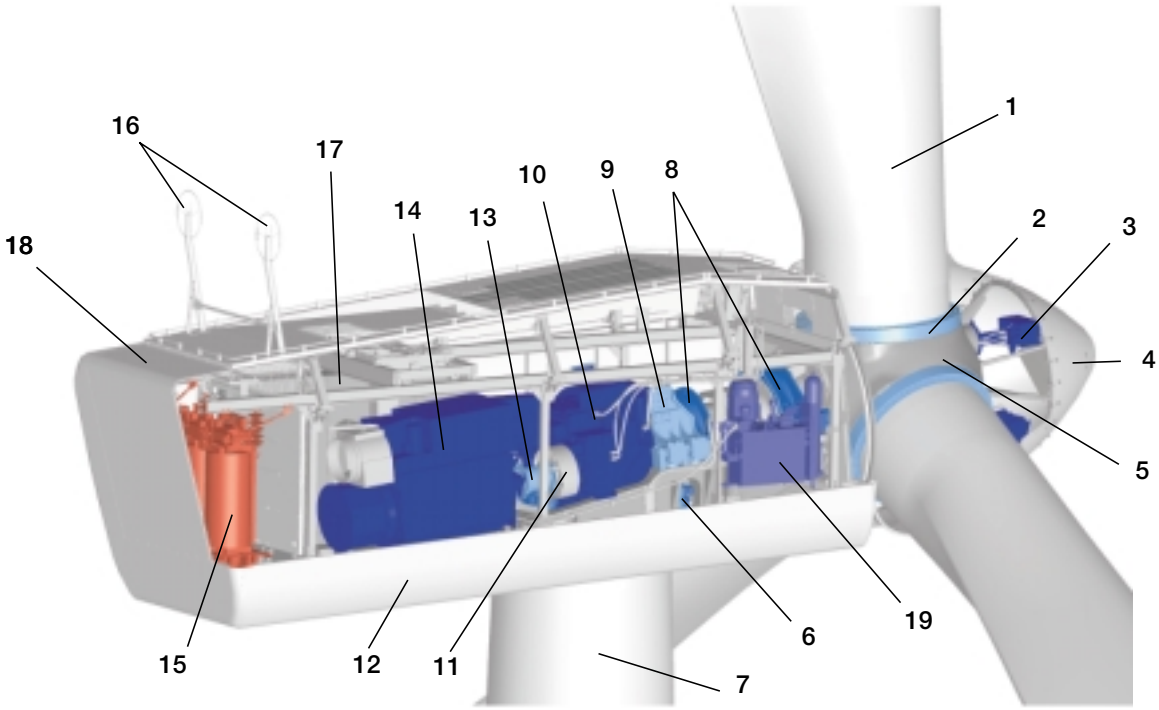
The wind turbine is equipped with an active crowbar system that maintains connection during voltage dips in the supply system.

Brake

Aerodynamic primary brake by feathering of blades. In addition, mechanical emergency disc brake hydraulically activated and mounted on the gearbox's high-speed shaft.

Lightning protection

The G90 wind turbine generator uses the "total lightning protection" system, according to IEC 1024-1 standard. This system conducts the lightning from both sides of the blade tip down to the root joint and from there to the nacelle, tower and earthing system. Therefore, the blade is protected and electrical component damage is avoided.



1. Blade
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5. Hub
6. Active yaw control
7. Tower
8. Main bearing house
9. Gear tie rod
10. Gearbox
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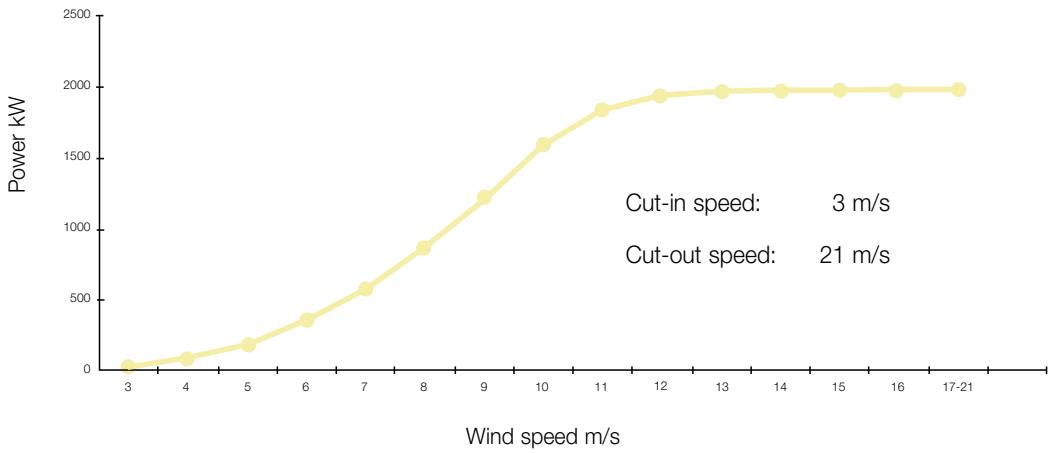
19. Hydraulic unit

Power curve G90-2.0 MW (for an air density of 1.225 kg/m^3 and a sound level of 105.3 dB(A))



Power curve calculation based on DU (Delft University) and FFA-W3 airfoil data.

Calculation parameters: 50 Hz grid frequency; pitch regulated tip angle (pitch control), a 10%turbulence intensity and a variable rotor speed ranging from 9.0 - 19.0 r.p.m.

Reduced sound level versions. The G90-2.0 MW wind turbine is supplied in different low-noise versions: 104 dB(A), 103dB(A), 102dB(A), 101dB(A).

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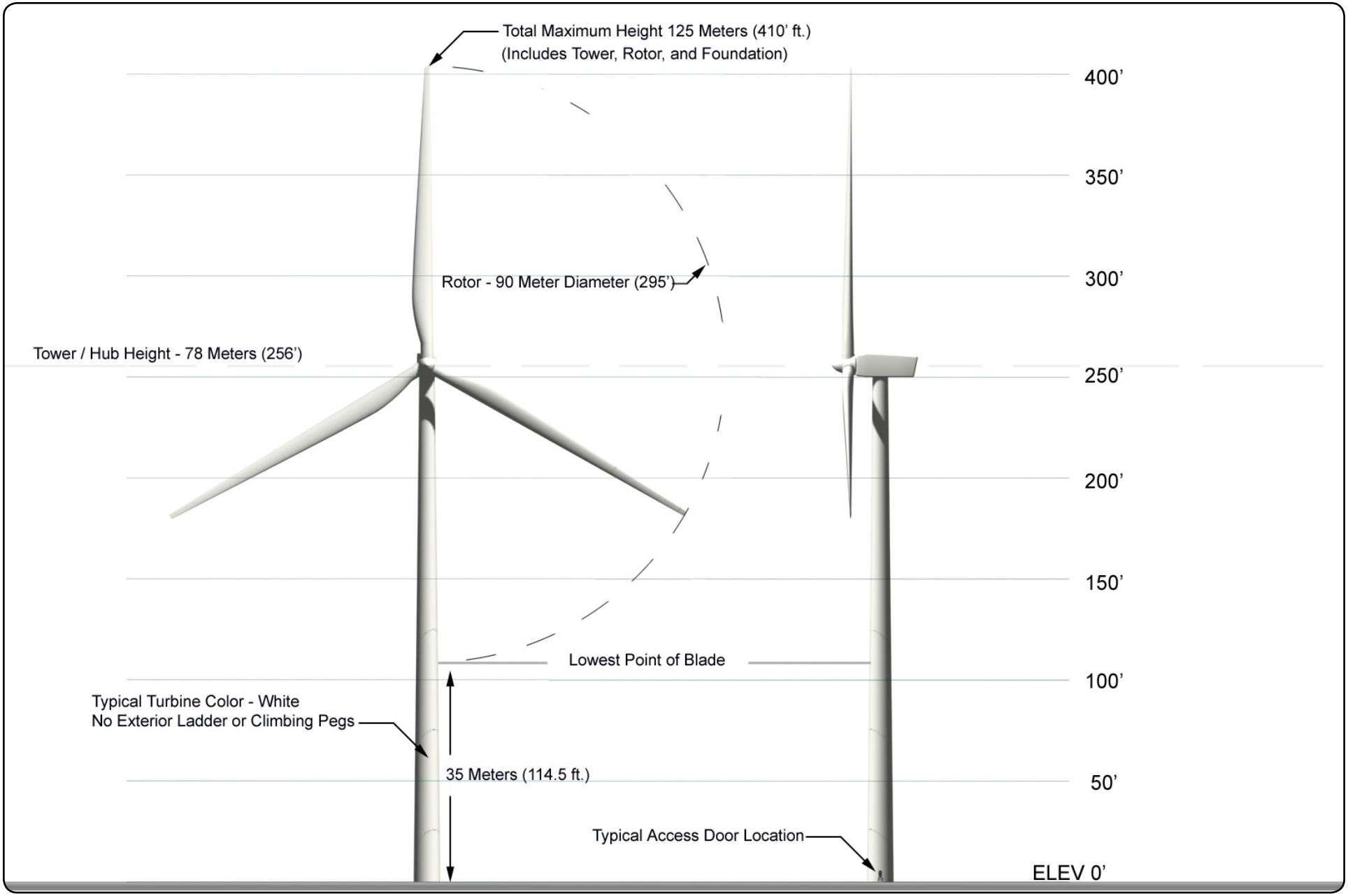

Exhibit 11 - Gamesa G90 Turbine Diagram

Título:
FT Características y funcionamiento general del aerogenerador G8X 2.0 MW

Title:
FT Characteristics and general operation of G8X 2.0 MW Wind-turbine

Confidencialidad: 3

Doc VWS:

AUTOR/ AUTHOR: DGF/JRI/ALG

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CLP/MBU/CDC/DSS/JGS/NAV

APROBADO/APPROVED: FCA

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REGISTRO DE CAMBIOS/ RECORD OF CHANGES

Rev.	Fecha/ Date	Autor/ Author	Descripción	Description
0	15/04/05	DGF/JRI/ALG	Versión Inicial	Initial Version

1 DESCRIPCIÓN DEL AEROGENERADOR

El aerogenerador G8X – 2.0 MW de Gamesa Eólica es un aerogenerador de rotor tripala a barlovento, regulado por sistema de cambio de paso y con sistema de orientación activo. Utiliza el sistema de control capaz de adaptar el aerogenerador para operar en grandes intervalos de velocidad de rotor.

El rotor consiste en tres palas con cambio de paso en la envergadura completa de la pala, rodamiento de pala y buje en fundición nodular. Los diámetros posibles de rotor son los siguientes: 80m, 83m, 87m y 90m.

Las palas son de 39m (G80 y G83 extender metálico), 40,5m (G83), 42,5m (G87) y 44m (G90) de longitud y están realizadas en fibra de vidrio y carbono (en el caso de G87 y G90) utilizando tecnología prepreg. Cada pala consiste de dos conchas pegadas a una viga soporte principal. Insertos especiales de acero conectan la pala al rodamiento de la misma. El rodamiento de la pala es de bolas de 4 – puntos, atornillado al buje.

El sistema de cambio de paso del rotor proporciona una regulación constante del ángulo de operación de la pala con respecto a las condiciones de viento del momento optimizando la producción de potencia y minimizando la emisión de ruido.

A altas velocidades de viento, el sistema de control y el sistema de cambio de paso mantienen la potencia en su valor nominal, independientemente de la temperatura del aire y su densidad. En vientos de velocidades bajas el sistema de cambio de paso variable y de control optimizan la producción de energía seleccionando la combinación óptima de revoluciones y ángulo de paso.

El eje principal transmite la potencia al generador a través de la multiplicadora. La multiplicadora se compone de 3 etapas combinadas, una planetaria y dos de ejes helicoidales paralelos. Desde la multiplicadora la potencia se transmite al generador a través de una junta de composite.

El generador eléctrico es altamente eficiente, de 4 polos, doblemente alimentado con rotor devanado y anillos rozantes.

El freno primario del aerogenerador es aerodinámico por puesta en bandera de las palas. El sistema de cambio de paso independiente proporciona un sistema de seguridad con triple redundancia. El

1 WIND-TURBINE DESCRIPTION

The Gamesa Eólica's G8X – 2.0 MW wind-turbine is a three bladed, upwind, pitch regulated and active yaw wind-turbine. It uses the control system concept that enables the wind-turbine to operate in a broad range of variation of rotor speed.

The rotor has three-blades with full span control, pitch bearings and the nodular cast iron hub. The possible diameters of the rotor are the following: 80m, 83m, 87m and 90m.

The blades are 39 m lenght (G80 and G83 with metallic extender), 40.5m (G83), 42,5m (G87) and 44m (G90) and are made of glass fibre reinforced epoxy and also Carbon in G87 and G90, using the pre-preg moulding technology. Each blade consists of two blade shells, bonded to a supporting beam. Special steel inserts connect the blade to the blade bearing. This bearing is a 4 – point ball type bolted to the hub.

The rotor pitch is variable. This feature provides fine adjustment of the blade-operating angle all the time with respect to the wind conditions each moment. This provides a better power production and a noise emission reduction.

At high wind speeds the control system and the pitch system keep the power output at its nominal value, independently of air temperature and air density. At lower wind speeds the variable pitch system and the control system maximise the power output by choosing the combination of rotor speed and pitch angle which give maximum power coefficient.

The main shaft transmits the power to the generator through the gearbox. The gearbox is a 3-combined-stages, one planetary and two helical parallel shafts, gearbox. From it the power is transmitted via a composite coupling to the generator.

The generator is a high efficiency 4 – pole doubly fed generator with wound rotor and slip rings.

The wind-turbine primary brake is given by full feathering the blades. The individual pitch system gives a triple redundant safety system. The mechanical brake is a parking disc brake system

freno mecánico de aparcamiento es un freno de disco, hidráulicamente activado que se monta en la salida del eje de alta velocidad de la multiplicadora.

hydraulically activated and mounted on the gearbox high-speed shaft.

Todas las funciones del aerogenerador son monitorizadas y controladas por varias unidades de control basadas en microprocesadores. El sistema de control va instalado en la góndola. El autómata que gobierna dicho sistema puede estar colocado en la góndola o en la base de la torre. Las variaciones del ángulo de paso de la pala son activadas por un sistema hidráulico que deja que la pala rote 95º. Este sistema hidráulico también proporciona presión al sistema de frenado mecánico y al sistema de orientación de la Nacelle.

All functions of the wind turbine are monitored and controlled by several microprocessor based control units. The controller system is placed in the nacelle. The programmable logic controller (PLC) could be placed in the nacelle or in the ground. Blade pitch angle variation is regulated by a hydraulic system actuator which enables the blade to rotate 95º. This system also supplies pressure to the brake system .

El sistema de orientación consiste en cuatro motores operados eléctricamente y controlados por el sistema de control del aerogenerador de acuerdo a la información recibida de los dos anemómetros sónicos colocados en la parte superior de la góndola. El motor del sistema de orientación hace girar los piñones del sistema de giro, los cuales engranan con los dientes de la corona de orientación montada en la parte superior de la torre. El bastidor con las motorreductoras puede girar respecto a la corona de orientación en la torre mediante un cojinete de fricción, el cual posee dispositivos hidráulicos y mecánicos para proveer par de retención.

The yaw system consists of four gears electrically operated and controlled by the wind turbine controller based on information received from the sonic anemometers mounted on top of the nacelle. The yaw gears rotate the yaw pinions, which mesh with a large toothed yaw ring mounted on the top of the tower. The yaw bearing is a plain bearing system with hydraulic and mechanical devices to provide retention torque.

La cubierta de la góndola es de fibra de vidrio con poliéster, la cual protege todos los componentes de la góndola frente a lluvias, nieve, polvo, rayos solares, etc. El acceso a la góndola desde la torre se realiza a través de la abertura central. La góndola contiene en su interior una grúa de servicio de 800 kg, que puede ser ampliada para elevar los componentes principales hasta 6400kg (8000kg para carga de prueba).

The nacelle cover is made of glass fibre reinforced polyester and protects all the components inside against rain, snow, dust, sun, etc. Access to the nacelle from the tower is through a central opening. The nacelle houses the internal 800 kg service crane, which can be enlarged to hoist the main components up to 6400kg (8000 kg for test loads).

La torre del aerogenerador es tubular y de acero y se suministra pintada con pintura de protección especial anti-corrosión. Gamesa Eólica ofrece un ascensor opcional.

The steel tubular tower is delivered painted. Gamesa Eólica S. A. offers a service lift in the tubular tower.

1.1 SISTEMA DE CONTROL

1.1 CONTROL SYSTEM

El sistema de control asegura que las rpm y el par motor del aerogenerador siempre suministren una potencia eléctrica estable a la red. Este sistema de control además suministra la energía con un factor de potencia deseado a la red eléctrica.

The control system ensures that both the rotor speed and the drive torque of the wind turbine always transform into a steady and stable electric power eventually injected into the grid. This control system also obtains an optimum power factor to the grid.

El sistema de control consiste en un generador

The control system consists of an effective

asíncrono de rotor devanado, anillos rozantes, dos convertidores de 4 cuadrantes de tecnología IGBT, contactores y protección eléctrica. Debido a la forma de funcionamiento que tiene el generador y como se controla, desde la red (es decir, desde el estator) éste es visto como un generador síncrono.

El generador está protegido frente a corto-circuitos y sobrecargas. La temperatura es también continuamente monitorizada mediante PT100 en puntos del estator, de rodamientos y de cajón de anillos.

El generador con sistema de control es un generador asíncrono especial el cual es capaz de trabajar con velocidad variable y mantener la potencia constante simultáneamente. Esta mejora es ejecutada por control de las intensidades en el rotor. Por medio del control de las corrientes en el rotor, el factor potencia se puede ver como un parámetro definible por el sistema de control. Como resultado las pérdidas en la red eléctrica decrecen.

Otro resultado de la generación síncrona que caracteriza al sistema de control es la "suave" conexión a la red eléctrica. Por lo tanto, conexiones y desconexiones suaves a la red eléctrica se obtienen fácilmente.

La turbina G8X – 2.0 MW es capaz de operar a una velocidad variable entre 900 o 1000 rpm (dependiendo de la electrónica de potencia) y 1900 rpm para 50Hz y entre 1080 o 1200 rpm (dependiendo de la electrónica de potencia) y 2280 rpm para 60Hz. El sistema de control tiene flexibilidad intrínseca respecto a optimización de energía, mínimo ruido durante el funcionamiento y reducción de cargas en la multiplicadora y en otros componentes.

1.2 CERTIFICADOS

El Diseño del aerogenerador G80 – 2.0 MW ha sido realizado de acuerdo con la norma IEC 61400 – 1, Ed. 2 para Clases IA (60m, 67m y 78m) y IIA. (60m, 67m, 78m y 100m) y de acuerdo a la norma DIBt (para Alemania) para zonas de viento II (60m, 67m, 78m y 100m) y III (60m, 67m y 78m). Asimismo para las clases IA y IIA se dispone de los Certificados de Tipo.

El diseño del aerogenerador G83 – 2.0 MW está certificado de acuerdo con la norma IEC 61400–1, Ed. 2 como Clase IIA (67m y 78m). En estos días Gamesa está trabajando para conseguir el

asynchronous generator with wound rotor, slip rings, two 4-quadrant converters with IGBT switches, contactors and protection. Because the way this generator is controlled it is seen from the grid (i.e., from the stator) as a synchronous generator.

The generator is protected against short-circuits and overloading. The temperatures are also continuously monitored by PT100's in stator hotspot points, bearings and in slip ring unit.

The generator in the control system is a special asynchronous generator which is able to run with variable speed and simultaneously keep the power constant. This feature is achieved by control of the rotor currents. By means of controlling of the these currents, the power factor can be viewed as a configurable parameter of the control system. As a result the losses in the electrical grid decrease.

Another result of the synchronous generation that characterizes the control system is the 'soft' connection to the grid which means a smooth connection/disconnection to grid.

Wind-turbine G8X – 2.0 MW operates with a variable speed range of 900 or 1000 (depending on the power electronics) and 1900 rpm.for 50Hz and 1080 or 1200 (depending on the power electronics) and 2280 rpm for 60Hz. The control system has built in flexibility regarding energy optimisation, low noise during operation and reduction in loads on gearbox and other components.

1.2 CERTIFICATES

The G80 – 2.0 MW wind turbine's design has been certified according to the IEC 61400 – 1, Ed. 2 Standard as Class IA (60m, 67m and 78m) and IIA (60m, 67m, 78m and 100m) and according to DIBt Rules (for Germany) for Wind zone II (60m, 67m, 78m and 100m) and wind zone III (60m, 67m and 78m). As well as these certifications for the Classes IA and IIA it is available the Type Certificates.

The G83–2.0 MW wind turbine's design has been certified according to the IEC 61400 – 1, Ed. 2 Standard as Class IIA (67m and 78m). In these days Gamesa is working on the Type Certificate.

certificado Tipo.

El diseño del aerogenerador G87 – 2.0 MW está certificado de acuerdo con la norma IEC 61400–1, Ed. 2 como Clase IIA (67m y 78m) y de acuerdo a la norma DIBt (para Alemania) para zonas de viento II (67m y 78m). En estos días Gamesa está trabajando para conseguir el certificado Tipo.

El diseño del aerogenerador G90 - 2.0 MW se encuentra en proceso de certificación de acuerdo con la norma IEC 61400–1, Ed. 2 como Clase IIIA (67m y 78m) y DIBt WZ II(67m y 78m).

1.3 CONDICIONES CLIMÁTICAS

El aerogenerador está diseñado para temperaturas ambiente exteriores entre –20º C y +30º C. Bajo petición expresa del cliente, se suministrarán aerogeneradores en versiones de alta y baja temperatura.

Versión Altas Temperaturas.

- El rango de funcionamiento de la versión de altas temperatura es de -20º+40º

Versión Bajas Temperaturas.

- El aerogenerador está diseñado para funcionar a temperaturas ambiente entre –30º C y +30ºC, siendo el límite inferior de –40º C en condiciones de máquina parada. En condiciones de arranque en frío tras parada prolongada el límite inferior es de –25º C.

El aerogenerador se puede colocar en parques con una distancia de al menos 5 diámetros de rotor (400m - 450m) entre aerogeneradores en la dirección predominante del viento. Si los aerogeneradores se sitúan en fila, perpendicularmente a la dirección predominante del viento, la distancia entre los mismos deberá ser de al menos 3 diámetros de rotor (240 m – 270m).

La humedad relativa puede ser de 100% (máximo el 10% del tiempo). Se proporciona protección contra corrosión conforme a ISO 12944-2 para corrosión de tipo C5-M (fuera), C4-H dentro del buje y C3-H dentro de la Nacelle. A petición del cliente se puede suministrar una máquina para ambientes corrosivos, la cual dispone de protección C4-H también en los elementos no calientes del interior de la Nacelle.

1.4 CONEXIÓN CON LA RED ELÉCTRICA

El aerogenerador debe conectarse a una red de media tensión a 10-33 kV. El aerogenerador

The G87–2.0 MW wind turbine's design has been certified according to the IEC 61400 – 1, Ed. 2 Standard as Class II_A (67m and 78m) and according to DIBt Rules (for Germany) for Wind zone II (67m and 78m). In these days Gamesa is working on the Type Certificate.

The design assessment of the G90–2.0 MW wind turbine is currently being carried out according to the IEC 61400 – 1, Ed. 2, Standard as Class IIIA (67m and 78m) and DIBt WZ II (67m and 78m).

1.3 CLIMATIC CONDITIONS

The wind turbine is designed for ambient temperatures ranging from –20º C to +30º C. Under explicit request of the customer, the wind turbine can be supplied in High and Low temperature versions.

High Temperature Version.

- The operating rank of the High Temperature version increases temperature to -20º+40º

Low Temperature Version.

- The wind turbine is designed for operating at ambient temperatures ranging from –30º C to +30º C, with this range extended until –40º C with the machine stopped. If the operation of the machine starts after being stopped during long time at low temperatures, this lower temperature limit is –25º C.

The wind turbines should be placed in wind farms with a distance of at least 5 rotor diameters (400 m – 450m) between each other measured along the predominant wind direction. If wind turbines are placed along a row, perpendicularly to the predominant wind direction, the distance between them should be of at least 3 rotor diameters (240m – 270m).

The relative humidity can be 100 % (10% of time maximum). Corrosion protection for corrosion class C5-M (outside), C4-H inside the hub and C3-H inside the Nacelle according to ISO 12944-2 are provided. Under request of the customer a corrosive ambient version can be supplied, this machine has a C4-H corrosion class also on the non hot components inside the Nacelle.

1.4 GRID CONNECTION

The wind turbines must be connected to medium-voltage grid at 10-33 kV. The standard wind turbines

estándar se conecta a una red de 20 kV, otros niveles de tensión dentro del intervalo indicado pueden ser desarrollados a petición del cliente. El voltaje máximo del equipamiento es 36 kV (U_m). La conexión del cable de media tensión se realiza en la parte inferior de la torre.

is connected to a 20 kV grid, other voltage levels inside the indicated range can be developed when asked by the customer. The maximum voltage of the equipment is 36 kV (Um). The MV-cable connection is made in the bottom of the tower.

El transformador de la turbina debe estar ajustado a la tensión de la red eléctrica. Al realizar el pedido, Gamesa Eólica necesitará información precisa sobre la tensión de la red para elegir la tensión nominal del transformador y el tipo de conexión del devanado. Gamesa Eólica ofrece como opción las celdas de conexión.

The transformer in the turbine must be adjusted to the grid voltage. When ordering GAMESA EÓLICA S.A. will need precise information about grid voltage, as to choice the transformer's nominal voltage as well as the type of winding connection. GAMESA EÓLICA S.A. offers the switch gear as an option.

El aerogenerador puede generar energía reactiva. No obstante, en algunas ocasiones, el aerogenerador limitará la potencia reactiva para preservar su funcionamiento.

The wind-turbine may generate reactive. Nevertheless, in some occasions, the wind-turbine will limit the reactive power so as to preserve its operation.

El voltaje de la red de media tensión estará dentro del intervalo ± 5%. Variaciones entre +1/-3 Hz (50 Hz) son aceptables. Intermitentes o rápidas fluctuaciones de la frecuencia de la red eléctrica pueden causar serios problemas al aerogenerador.

The voltage of the medium voltage grid shall be within the range ± 5%. Variations within +1/-3 Hz (50 Hz) are acceptable. Intermittent or rapid grid frequency fluctuations may cause serious damage to the turbine.

Caídas de la red eléctrica solamente deberían ocurrir una vez por semana como promedio durante la vida del aerogenerador.

Grid dropouts must, as an average over the entire lifetime of the wind-turbine, only take place once a week.

Debe existir una conexión de tierra de máx. 10 Ω.

A ground connection of maximum 10 Ω must be present.

El sistema de tierra se deberá acomodar a las condiciones del terreno. La resistencia al neutro de la conexión a tierra deberá ser conforme a los requisitos de las autoridades locales.

The earthing system must be accommodated to local soil conditions. The resistance to neutral earth must be according to the requirements of the local authorities.

1.5 RESTRICCIONES GENERALES

1.5 GENERAL RESERVATIONS

Durante los periodos de vientos bajos, es de esperar un aumento del consumo de potencia para el calentamiento y la deshumidificación de la góndola.

During periods of low wind, an increased own consumption of power for heating and dehumidification of the nacelle must be expected.

Respecto a la acumulación de fuertes hielos, es de esperar interrupciones en la operación. En algunas combinaciones de vientos altos, altas temperaturas, temperatura baja del viento, baja densidad y/o bajo voltaje, puede ocurrir una disminución de la potencia nominal para asegurar que las condiciones térmicas de algunos componentes principales como la multiplicadora, generador, transformador, cables de potencia, etc. se mantengan dentro de los límites.

Regarding heavy icing up, interruptions in operation may be expected. In certain combinations of high wind speeds, high temperature, low air temperature, low air density and/or low voltage, power derating may happen to ensure that the thermal conditions of the main components such as gearbox, generator, transformer, power cables, etc, are kept within limits.

Generalmente se recomienda que el voltaje de red

It is generally recommended that the grid voltage is

eléctrica se mantenga tan cerca del nominal como sea posible. En caso de caída de la red eléctrica y muy bajas temperaturas, se debe esperar un cierto tiempo para el calentamiento antes de que el aerogenerador comience a operar.

Si el terreno, dentro de un radio de 100 m a partir de un aerogenerador, tiene una pendiente de más de 10º, pudieran ser necesarias consideraciones particulares.

Si el aerogenerador se sitúa a más de 1000 m sobre el nivel del mar, podría ocurrir una subida de temperatura mayor de lo normal en el generador, el transformador y otros componentes eléctricos. En dicho caso, podría suceder una reducción periódica de la potencia nominal, incluso si la temperatura ambiente está dentro de los límites especificados. Además en los emplazamientos situados a más de 1000 m sobre el nivel del mar el riesgo de congelación se verá aumentado.

Debido a los cambios y actualizaciones en nuestros productos, Gamesa Eólica S.A. se reserva el derecho a cambiar las especificaciones.

2 ELEMENTOS DEL AEROGENERADOR

La Figura 1 muestra la disposición de los diferentes elementos en la góndola del aerogenerador G8X – 2.0 MW.

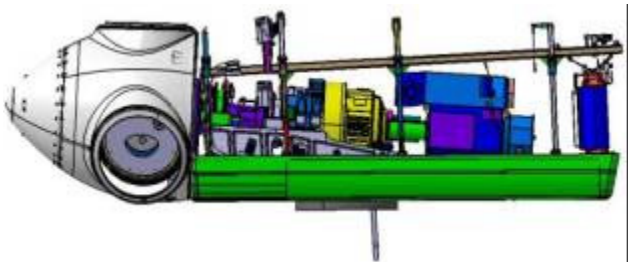

Figura 1 *Vista lateral de la del aerogenerador G8X-2.0 MW.*

2.1 ROTOR

2.1.1 General

El rotor del aerogenerador G8X-2.0 MW es un rotor de tres palas unidas a un buje esférico mediante los rodamientos de pala. El rotor está dotado de un ángulo de conicidad de 2º, que aleja la punta de las palas de la torre.

as close to nominal as possible. In case of grid dropout and very low temperatures, a certain time for heating must be expected before the wind turbine can start to operate.

If the terrain within a 100 m radius of the turbine has a slope of more than 10º, particular considerations may be necessary.

If the wind-turbine is placed in more that 1000 m above the sea level, a higher temperature rise than usual might occur in the generator, transformer and other electrical components. In this case a periodic reduction of rated power might occur, even if the ambient temperature is within the specified limits. Furthermore, also at sites in more than 1000 m above sea level, there will be an increased risk of icing-up.

Due to continuous updating of our products, Gamesa Eolica S.A. reserves the right to change these specifications.

2 WIND-TURBINE ELEMENTS

Figure 1 shows the location of the different elements in the nacelle of the G8X– 2.0 MW wind-turbine.

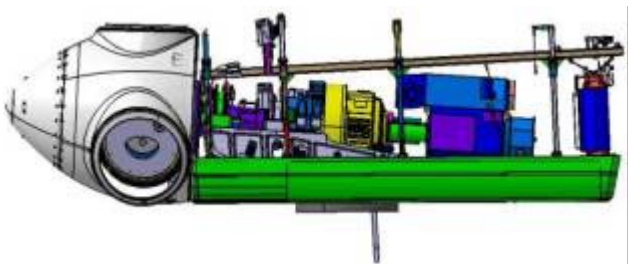

Figure 1 *Side view of G8X-2.0 MW wind-turbine.*

2.1 ROTOR

2.1.1 General

The rotor of G8X-2.0 MW consists of three blades attached to a cast iron hub through the blade bearings and the pitch regulation system. The blade coning is 2º so that, the blade tip is kept away from the tower

2.1.2 Palas

Las palas del aerogenerador G8X-2.0 MW tienen un sistema conductor de rayos que recoge las descargas eléctricas mediante receptores y las transmite, vía un cable de cobre que recorre la pala longitudinalmente hasta la raíz y que se transmiten a la nacelle. La distancia de la raíz de las palas hasta el centro del buje es de 1 m.

Las palas del aerogenerador G8X-2.0 MW están fabricadas en material compuesto, con resina epoxy y fibra de vidrio. En su fabricación se emplea la tecnología de los preimpregnados ("prepreg"), que permiten controlar de un modo muy preciso el volumen de fibra del material y, con él, las propiedades mecánicas de las palas. En el caso de G87 y G90 se ha optimizado el diseño mediante la utilización de un sistema híbrido (vidrio – carbono) en la viga. El método de fabricación de la viga es manual y por Tape Winding hasta ser automatizado en su totalidad, en G87 y G90, mediante la técnica de Tape Placement y Tape Winding. Esto repercute en la repetitividad de sus características mecánicas y por tanto aumenta la calidad respecto a otras tecnologías.

La estructura de las palas del aerogenerador G8X-2.0 MW está formada por un larguero interior alrededor del cual va pegado el revestimiento, formado por dos conchas fabricadas por separado. La misión del larguero es aportar resistencia estructural al conjunto, resistir las cargas propias de la pala y transmitir esfuerzos al buje.

El revestimiento tiene la forma aerodinámica adecuada para convertir la energía cinética del viento en par motor para la generación de electricidad.

El larguero es en sí mismo una viga de sección tubular cerrada con una geometría adaptada a la forma aerodinámica de los perfiles de la pala. El revestimiento es una estructura sándwich con núcleo de PVC y laminados de fibra de vidrio en resina epoxy.

Es en el larguero de G87 y G90 donde se introduce fibra de carbono. Esto provoca un aumento de rigidez y una disminución de peso respecto a las palas de fibra de vidrio. Las palas de fibra de vidrio están dimensionadas por deflexión máxima. En palas de gran longitud esto provocaría un gran aumento de peso. La introducción de fibra de carbono permite dimensionar las palas por tensión,

2.1.2 Blades

The blades of the G8X-2.0 MW are fitted with lightning receptors to ensure that lightning discharges are conducted via the cooper cable through the blade to the root and transmitted to the nacelle. The distance between the blade root and the centre of the hub is 1 m.

The blades of the G8X-2.0 MW windturbine are made of glass fibre reinforced epoxy. Their manufacture is based on the pre-preg moulding technology. This technique allows a very accurate control of the volume of material and, therefore, of the mechanical properties of the resulting blade. On G87 and G90 the design has been optimised using an hybrid system on the beam (glass – carbon). The fabrication method of the beam is manual and using Tape Winding until it's being totally automated on G87 and G90 with the Tape Placement and Tape Winding techniques. This processes increase the quality of the blades because the mechanical properties are highly controlled.

The structure of the G8X-2.0 MW is an internal spar and two shells -made separately- surrounding it.
The role of this spar is to provide structural resistance to the whole system, bear the own blade loads and transmit the stresses to the hub.

On the other hand, the shells have no structural mission but own the adequate aero-dynamical shape to convert the kinetic energy of the wind into drive torque to generate electricity.

The internal spar is essentially a closed beam of tubular cross-section and its geometry is adapted to the aero-dynamic profile of the blade at each station. The outer part (shells) is a sandwich-like construction formed by a PVC core and glass fibre-*epoxy* laminates.

The carbon – fibre is introduced on the internal spar of the G87 and G90. This increases the rigidity and reduces the total weight comparing to the glass – fibre. The glass – fibre blades are dimensioned by the maximum deflection. On high length blades this would increase the weight so much. The carbon – fibre permits to dimension the blades by the tension, optimising the amount of material. This fact, added

quedando por tanto la cantidad de material optimizada. Este hecho, unido a la sensiblemente mayor relación rigidez / peso de la fibra de carbono respecto de la fibra de vidrio, reduce considerablemente el peso final de la pala y, a la postre, las cargas del resto de componentes del aerogenerador.

with higher rigidity/weight relation of the carbon – fibre, reduces the total weight and as a result the loads of the rest of the components.

La unión de la pala al rodamiento de pala es atornillada. Se practican 90 agujeros en la sección de raíz del larguero en los que se introducen insertos metálicos roscados, para facilitar la unión atornillada.

The attachment of the blade to its bearing is bolted. This is attained by means of 90 steel threaded inserts embedded in the laminate of the blade root.

2.1.3 Buje

El buje es de forma esférica y está fabricado en fundición nodular. Está montado directamente en el eje principal. Posee una abertura en la parte frontal que permite el acceso al interior para realizar inspecciones y mantenimiento tanto de la hidráulica del buje como del par de apriete a los tornillos de las palas.

2.1.3 Hub

The hub is spherical and manufactured in nodular cast iron. It is directly mounted on the main shaft and has an frontal opening for internal inspections and maintenance of the hydraulic system of the hub and tightening the blade bolts.

2.1.4 Cono de la nariz

El cono de la nariz protege el buje y los rodamientos de pala del ambiente. El cono se atornilla a la parte frontal del buje.

2.1.4 Nose cone

The hub and the blade bearings are entirely enclosed and protected from the outside environmental conditions by the nose cone. It is bolted on front of the hub and supported by the blade bearings.

2.1.5 Rodamientos de pala

Los rodamientos de la pala son la interfaz entre la pala y el buje y permiten el movimiento de cambio de paso. Son rodamientos de bolas con doble hilera con juntas sellantes y agujeros pasantes en la pista exterior para la unión con el buje y en la pista interior para la unión a la pala.

2.1.5 Blade bearings

The blade bearings fasten the blade with a rotating connection to the hub. The bearing is a double row 4-point contact ball bearing with seals. It has through holes in the outer ring for connecting with the hub and in the inner ring for connecting with the blade.

2.2 SISTEMA DE CAMBIO DE PASO

El sistema de cambio de paso actúa durante todo el tiempo de funcionamiento del aerogenerador: (i) Cuando la velocidad del viento es inferior a la nominal el ángulo de paso seleccionado es aquel que maximiza la potencia eléctrica obtenida para cada velocidad del viento; (ii) Cuando la velocidad del viento es superior a la nominal el ángulo de paso es aquél que proporciona la potencia nominal de la máquina.

2.2 PITCH SYSTEM

The pitch system is working all the times of operation of the wind turbine: (i) When the wind speed is below the rated one the pitch angle is chosen so the electrical power output is maximised for each wind speed; (ii) When the wind speed is above the rated one the pitch angle is adjusted to yield the rated power.

El movimiento de cambio de paso de la pala es un giro alrededor de su eje longitudinal. Para conseguir este movimiento en el aerogenerador G8X-2.0 MW se utiliza un sistema hidráulico, que a través de un

The pitch movement of the blade is a rotation around its longitudinal axis. This movement in G8X-2.0 MW wind-turbine is attained by an hydraulic system, which set the three blades at the same pitch angle

cilindro independiente por pala, coloca las tres palas al mismo ángulo de paso en cada instante.

every time by means of an independent cylinder for each blade.

2.3 EJE PRINCIPAL

La transmisión del par motor que provoca el viento sobre el rotor hasta la multiplicadora se realiza a través del eje principal. El eje se une al buje con una brida atornillada y está apoyado sobre rodamientos alojados en soportes fundidos. Todas las cargas, excepto el par torsor, son transmitidas al bastidor a través de estos soportes. La unión con la entrada de baja velocidad de la multiplicadora se consigue con un disco cónico de apriete que transmite el par por fricción.

El eje está fabricado en acero forjado y tiene un orificio central longitudinal para alojar las mangueras hidráulicas y los cables de control del sistema de cambio de paso.

2.3 MAIN SHAFT

The main shaft transmits the drive torque from the rotor to the gearbox. The shaft is joined to the hub through a bolted flange and is supported by two bearings in cast main bearing houses. All loads, except the driving torque, are transmitted to the main frame through the supports. The main shaft is fixed to the low speed hollow shaft of the gearbox with a conical joint that transmits the torque by friction.

The main shaft is manufactured in forged alloy steel. It features a hole to house the hoses for hydraulic oil and cables for pitch control system.

2.4 BASTIDOR

El bastidor del aerogenerador G8X-2.0 MW se ha diseñado bajo los criterios de simpleza mecánica y robustez adecuada para soportar los elementos de la góndola y transmitir las cargas hasta la torre. La transmisión de estas cargas se realiza a través del cojinete de la corona de orientación.

El bastidor se divide en dos partes:

(i) El bastidor delantero es una pieza de fundición donde se fijan los soportes del eje principal y la corona de orientación.
(ii) El bastidor trasero está formado por dos vigas unidas por su parte delantera y trasera. Esta parte ha sido diseñada para soportar al generador (derecha), el controlador del *Top* (izquierda) y el transformador. Entre ellas el suelo de la góndola permite el acceso para la realización de tareas de reparación y mantenimiento.

2.4 MAIN FRAME

The machine main frame has been designed to result in a simple and robust foundation suitable for the nacelle components and machinery. It transmits the loads from these elements to the tower through the yaw bearing system.

The nacelle main frame is divided in two parts:

(i) The front foundation is a cast piece where the supports of the main shaft and the yaw ring are fixed.
(ii) The rear frame is composed by two beams joined both at their rear and front ends. This part has been designed as to support the generator (right), controller (left) and the transformer. Between them, the nacelle floor allows both repair and maintenance tasks to be done.

2.5 CARCASA

La carcasa es la cubierta que protege los componentes del aerogenerador que se encuentran en la góndola. Está fabricada en resina poliéster con fibra de vidrio.

En el interior de la góndola hay suficiente espacio

2.5 NACELLE COVER

The nacelle housing is the cover for the protection of the mechanical components from the actions of the environment. This cover is manufactured in glass fibre reinforced polyester. Sufficient standing and working area is provided in the inner of the nacelle for service and maintenance work.

A hatch at the front of the cabin gives access to the

para realizar las operaciones de reparación y mantenimiento del aerogenerador. Una trampilla en la parte frontal permite el acceso al interior del cono, y una trampilla en el suelo de la parte trasera permite operar con la grúa. Las 2 claraboyas del techo proporciona luz solar por el día, ventilación adicional y acceso al exterior, donde se encuentran los instrumentos de medida de viento y el pararrayos.

inside of the nose cone and the hub. A hatch in the ground of the rear part of the nacelle cover can be opened to operate the service crane. The 2 skylight hatches provide diurnal lighting and additional ventilation and enables easy access to the nacelle roof where the wind sensors and the lightning rods are placed.

Las partes giratorias están debidamente protegidas para garantizar la seguridad del personal de mantenimiento.

High-speed rotating parts are conveniently covered by protective screens providing adequate safety for maintenance personnel.

2.6 MEDIDA DE VIENTO

En el exterior de la capota, en la parte trasera, dos mástiles verticales sirven de soporte del anemómetro sónico y anemo+veleta para medida del viento.

2.6 WIND MEASUREMENT

Outside the nacelle, in the rear part, two vertical mast support the ultrasonic anemometer and the cup anemometer + windvane for measuring the wind speed and direction.

2.7 SISTEMA DE CONTROL

El sistema de control monitoriza y gobierna todas las funciones del aerogenerador G8X-2.0 MW de manera que las actuaciones sean óptimas en todo momento. El sistema de control registra continuamente las señales de los distintos sensores del aerogenerador, y cuando detecta algún error realiza las acciones oportunas para subsanarlo. El sistema de control detiene el aerogenerador si el error detectado así lo requiere.

Existe una pantalla táctil en la que se presentan datos de operación y que permite la interacción del usuario con el aerogenerador, y un sistema de control que está preparado para la monitorización y el control remoto si es necesario.

2.7 CONTROL SYSTEM

The controller monitors and controls all functions in the G8X wind-turbine to ensure that its performance is optimal at any wind speed. It continuously scans the signals from the sensors in the wind turbine so that as soon as an error is detected, the appropriate handling takes place. The controller will stop the turbine if the detected error requires so.

There exists a touch screen in which operational data are displayed. The controller is designed as to allow remote monitoring and control in case these features are required. It is also supervised by the system watchdog so that, its correct operation is permanently guaranteed

2.7.1 Disposición del sistema de control

El soporte físico del sistema de control se reparte en tres armarios:

1. Controlador de la “nacelle” situado en la nacelle.
2. Controlador “ground” situado en la base de la torre.
3. Controlador del buje situado en la parte giratoria del aerogenerador.

A su vez, el controlador de la “nacelle” se divide en tres partes:

1. Sección de control: se encarga de las tareas

2.7.1 Layout of the controller

The control system hardware is placed in three parts:

1. “Nacelle” controller, located at the nacelle.
2. “Ground” controller, located at the bottom of the tower.
3. “Hub” controller, located at the rotating element of the wind-turbine (inside the hub).

The “nacelle” controller is divided into three parts further:

1. Control section: It in charged of the proper

propias del gobierno de la góndola, i.e. monitorización del viento, cambio del ángulo de paso, orientación, control de la temperatura interior.

2. Convertidor de frecuencia: se encarga del control de potencia y de gestionar la conexión y desconexión del generador de la red.
3. Sección de embarrados y protecciones: en esta parte se encuentra la salida de la potencia producida con las protecciones eléctricas necesarias.

tasks of govern of the nacelle, i. e. wind monitoring, pitch angle change, orientation, inside temperature control.

2. Frequency converter: It is charged of the power control and generator-grid connection/disconnection management.

3. Bars and protection section: This is in charge of the power output yield with the necessary electrical protections.

2.7.2 Pantalla de control

Desde la pantalla táctil del "ground" se puede tanto observar algunos datos de la operación del aerogenerador como detener y arrancar la máquina, entre otras acciones. También se puede conectar una pantalla portátil al controlador de la "nacelle" para realizar estas tareas.

2.7.2 Control touch terminal

When an operator wants to look at operational data from the turbine, or to start or stop the turbine, he can use the operating panel in the "ground" controller or connect a service panel to the "nacelle" controller.

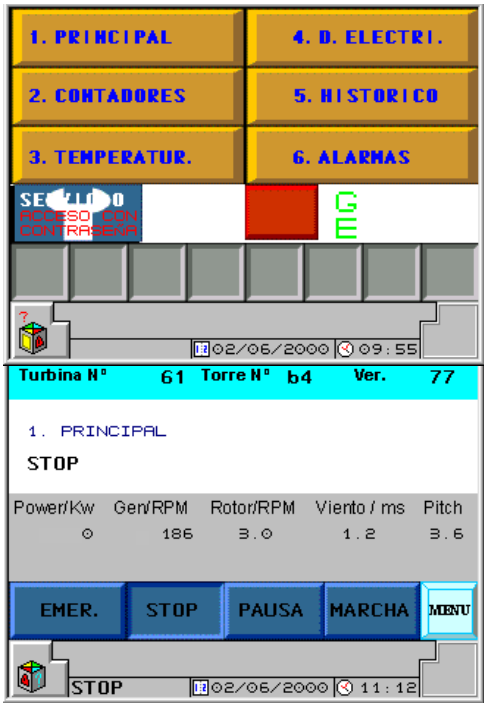

Figura 2. *Distintos modos de la pantalla de control.*

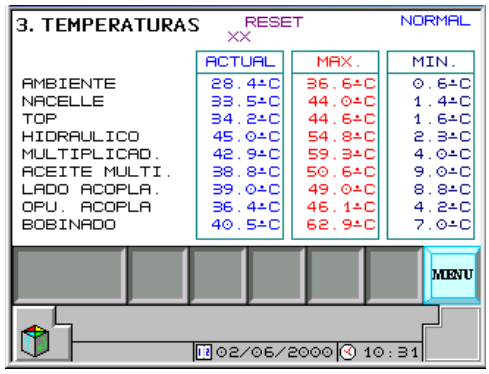

Figure 2. *Different operating panel modes.*

2.7.3 Control del aerogenerador

La velocidad de giro del aerogenerador y el ángulo de paso de las palas se modifican en cada instante dependiendo de la velocidad de viento que llega a la máquina. El sistema de control se encarga de elegir los valores adecuados de estas variables.

2.7.3 Wind-turbine control

The rotational speed and the pitch angle of the wind-turbine are modified at every instant depending on the existing wind-speed. The control system chooses the adequate values of these variables.

Atendiendo a la velocidad de viento se pueden establecer cuatro fases:

1. *Viento bajo*, con el generador desconectado de la red.
2. *Viento medio*, con el generador conectado, pero sin llegar a generar potencia nominal.
3. *Viento alto*, el generador produce potencia nominal.
4. *Viento muy alto*, el generador está desconectado y la turbina parada.

Viento bajo

Cuando la velocidad del viento es inferior a la velocidad de arranque de la máquina pero próxima a ésta, el sistema de control coloca las palas a un ángulo de paso cercano a 45º, que proporciona un par de arranque suficientemente alto.

A medida que la velocidad de viento aumenta la velocidad de rotación del rotor también aumenta, y el ángulo de paso se hace disminuir hasta que se alcanzan las condiciones adecuadas para que el generador se conecte.

Viento medio

A velocidades de viento por encima de la velocidad de arranque y por debajo de la velocidad nominal el sistema de control elige la velocidad de rotación y el ángulo de paso que proporcionan la máxima potencia para cada velocidad de viento.

Viento alto

Cuando la velocidad de viento es superior a la nominal, la energía contenida en el viento es suficiente para producir potencia nominal, y el ángulo de paso se incrementa para regular la potencia a su valor nominal.

Viento muy alto

Si la velocidad del viento es superior a la velocidad de parada, el generador se desconecta y el sistema de control lleva las palas a la posición de bandera (cercana a 90º) hasta que la velocidad de viento desciende por debajo de la velocidad de re-arranque y la máquina reanuda la generación de potencia.

Depending on the wind-speed 4 stages can be established:

1. *Low wind*, with the generator disconnected from the grid.
2. *Medium wind*, with the generator connected to the grid, but rated power is not accomplished.
3. *High wind*, the turbine produces rated power.
4. *Very high wind (stop wind)*, the generator is disconnected and the wind-turbine stopped.

Low wind

When the wind-speed is below, but close to, the start-wind-speed, the pitch angle will be approximately set equal to 45 degrees. This situation will give a sufficiently high start moment to the rotor.

As the wind-speed increases the rotational speed -rotor and generator- also increases, and the pitch angle is shifted down to small angles by the controller till the conditions to generator connection are achieved.

Medium wind

For wind speeds above the start-wind-speed and below the rated-wind-speed the control system works out the most suitable rotor speed -within a certain range of available operating speeds- and pitch angle so that the electrical power yield is maximum for each wind speed.

High wind

When the wind-speed exceeds the rated wind speed, the wind kinetic energy is sufficient for the turbine to produce rated power, and the pitch angle is increased to regulate the power to its rated value.

Very high wind

If the wind-speed is greater than the stop value the generator is disconnected and the control system pitches the blades to full feathered position (~ 90º). Then, the system will wait until the wind-speed has decreased below the re-start wind-speed to re-start the power generation.

2.8 COMUNICACIÓN DE TRANSFORMADOR, ARMARIO DE CONTROL Y CELDA

2.8.1 Alimentación del rotor del generador

La alimentación del rotor del generador se realiza a través de una salida del transformador principal 690V o a 480V dependiendo del convertidor.

2.8.2 Características de los cables del generador.

Estator: Los cables que unen tanto el estator del generador con el armario de control de potencia situado en la nacelle son cables 0.6/1kV 3x240 mm^2 y diseñados de acuerdo a la norma UNE 21150.

Rotor: Se utilizan cables 0.6/1kV 3x70 mm^2

Los cables que unen el armario de control de potencia con el transformador son cables de tipo 0.6/1kV 1x240 mm^2.

2.8.3 Fibra óptica

Pueden existir dos tipos de fibra óptica utilizadas para comunicaciones en el interior del aerogenerador. Una de ellas es de diámetro 200/230 μm, 4 hilos por manguera. Esta fibra óptica se utiliza para comunicaciones entre los distintos procesadores del aerogenerador y además está protegida contra humedad y roedores. La otra fibra óptica utilizada es de tipo HCS (200/230 μm) para la comunicación entre el autómata y los módulos de la góndola.

El sistema de telemando utiliza fibra de diámetro 62.5/125 μm, igualmente protegida contra la humedad y los roedores, para comunicar los distintos aerogeneradores.

2.9 CIMENTACIONES

A continuación se definen los datos principales de las cimentaciones estándar para el aerogenerador G8X – 2.0 MW con torres IEC IIA de 60, 67, 78 y 100 m y torres IEC IA de 60, 67 y 78m.

Estas cimentaciones se han calculado suponiendo cargas certificadas o en proceso de certificación y un terreno estándar.

En el caso de que las hipótesis manejadas sufran variaciones, los valores definidos no tendrán valor y será necesario un recálculo de la cimentaciones.

2.8 COMMUNICATION OF TRANSFORMER, CONTROL SYSTEM AND MEDIUM VOLTAGE SWITCH GEAR

2.8.1 Generator rotor supply

The power supply of the rotor of the generator is performed by means of an 690v or 480 V output of the main transformer depending on the converter.

2.8.2 Generator cables characteristics.

Stator: The generator stator and the power control board located in the nacelle are connected by means of DN-K 0.6/1kV 3 x 240 mm^2 cables which are designed according to the normative UNE 21150.

Rotor: As in the stator but with a section of 3 x 70 mm^2.

The power control board and the transformer are connected by means of 0.6/1kV 240 mm^2 cables

2.8.3 Optical fibre

There can be two kinds of optical fibre used for communications inside the turbine. One of these has a diameter of 200/230 μm, 4 wires per cable. This fibre is used for the communications between the different processors inside the turbine and besides, it is protected against the humidity and rodents action. The other optical fibre used is HCS (200/230 μm) for the communication between the PLC and the modules in the nacelle.

The remote control uses fibre of diameter 62.5/125 μm to communicate different wind-turbines. This fibre is also protected against the humidity and rodents action.

2.9 FOUNDATIONS

Below the main data of standard foundations of the G8X – 2.0 MW wind-turbine with 60 m, 67 m 78 m, and 100 m IEC IIA towers and 60, 67m and 78m IEC IA towers.

These foundations have been calculated using certified loads (or in certification process) and supposing a standard terrain.

In case these hypothesis change, the defined values will not be valid and a new calculation will be necessary.

Para cada emplazamiento, será necesario revisar las características del terreno junto con los datos de viento para seleccionar la cimentación más adecuada.

It will be necessary to revise the characteristics of the terrain and wind data to select the most convenient foundation for each site.

2.9.1 Datos principales:

- Dimensiones de las zapatas para torres IEC IIA:

Dimensión	**Dimensions**	**T60m**	**T67m**	**T78m**	**T100m**	**Unit**
Lado zapata, L	**Foundation length, L**	12.8	12.8	14.5	16	m
Canto exterior, h_e	**Exterior height, h_e**	1	1.5	1	1.6	m
Canto central, h_c	**Central height, h_c**	1.5	1.5	1.5	1.6	m
Diámetro virola cimentación	**Foundation belt diameter**	4.034	4.034	4.038	4038	m

- Mediciones de materiales para zapatas de torres IEC IIA:

Material	**Material**	**T60m**	**T67m**	**T78m**	**T100m**	**Unit**
Hormigón limpieza HM-20	**HM-20 concrete**	16.4	16.4	21	25.6	m^3
Hormigón estructural HA-30	**HA-30 structural concrete**	254.2	254.2	324	418	m^3
Acero armaduras B 500 S	**Steel reinforcement B 500 S**	22132	22132	35471	44100	kg

- Dimensiones de las zapatas para torres IEC IA:

Dimensión	**Dimensions**	**T60m**	**T67m**	**T78m**	**Unit**
Lado zapata, L	**Foundation length, L**	15	14.9	15.4	m
Canto exterior, h_e	**Exterior height, h_e**	1.5	1.5	1.5	m
Canto central, h_c	**Central height, h_c**	1.5	1.5	1.5	m
Diámetro virola cimentación	**Foundation belt diameter**	4.034	4.034	4.038	m

- Mediciones de materiales para zapatas de torres IEC IA:

Material	**Material**	**T60m**	**T67m**	**T78m**	**Unit**
Hormigón limpieza HM-15	**HM-15 concrete**	22.5	22.2	23.8	m^3
Hormigón estructural HA-30	**HA-30 structural concrete**	346	341.5	364.2	m^3
Acero armaduras B 500 S	**Steel reinforcement B 500 S**	40300	38100	40800	kg

2.9.1 Main data

- Dimensions of foundations of IEC IIA towers:

- Materials of foundations of IEC IIA towers::

- Dimensions of foundations of IEC IA towers:

- Materials of foundations of IEC IA towers:

3 PARÁMETROS DE DISEÑO.

3.1 CONDICIONES DEL VIENTO.

Las condiciones de viento para un emplazamiento se especifican normalmente por una distribución de Weibull. Esta distribución viene descrita por el factor de escala *A* y el factor de forma *k*. El factor *A* es proporcional a la velocidad media del viento y el factor *k* define la forma de la distribución para diferentes velocidades de viento. La turbulencia es el parámetro que describe las variaciones / fluctuaciones a corto plazo del viento.

Las condiciones de diseño de la máquina G8X-2.0 MW se indican a continuación:

3 DESIGN PARAMETERS.

3.1 WIND CONDITIONS.

The wind climate for a given site is normally specified by a Weibull distribution. The Weibull distribution is described by the scale factor A and the shape factor K. The A factor is proportional to the mean wind speed and the K factor defines the shape of the Weibull distribution for different wind speeds. Turbulence is the factor, which describes short-term wind variation/fluctuations.

The design conditions of G8X-2.0 MW are given below:

Tabla 4 Parámetros de diseño del aerogenerador G8X– 2.0 MW.
Table 4 Design parameters of G8X – 2.0 MW wind-turbine.

Class IEC	**DIBT II 60m**	**DIBT II 67m**	**DIBT II 78m**	**DIBT II 100m**	**DIBT III 67m**	**DIBT III 78m**	**II_A**	**I_A**	**Unidad /Unit**	**Comentarios Comments**
										IEC 61400-1 Ed. 2
Annual mean wind speed	5.9	6	6.2	6.4	8.4	8.6	8.5	10	m/s	Referred to hub height
Weibull* shape parameter, *K	2	2	2	2	2	2	2	2		
Turbulence intensity at 15 m/s, I_{15}	18	18	18	18	18	18	18	18		
Reference wind 10 min. averaged	36.7	37.4	38.3	39,9	43.4	44.5	42.5	50	m/s	Recurrente period 50 years
Reference wind 3 sec. averaged	-	-	-	-	-	-	59.5	70	m/s	Recurrente period 50 years
Stop / restart wind speed	25 / 20	25 / 20	25 / 20	25 / 20	25 / 20	25 / 20	25 / 20	25 / 20	m/s	-

Las curvas de potencia (calculadas para una turbulencia del 10 %) junto con las curvas C_p y C_t y la producción anual de cada aerogenerador se incluyen en los siguientes documentos:
G80 – 2.0 MW: **FT002002**
G83 – 2.0 MW: **FT002302**
G87 – 2.0 MW: **FT002404**
G90 – 2.0 MW: **FT002403**

The power curves (calculated for a turbulence of 10 %) together with the C_p and C_t curves and the annual production of each wind-turbine are included in the following documents:
G80 – 2.0 MW: **FT002002**
G83 – 2.0 MW: **FT002302**
G87 – 2.0 MW: **FT002404**
G90 – 2.0 MW: **FT002403**

3.2 VERIFICACIÓN DE LAS CONDICIONES DE VIENTO.

Los aerogeneradores se pueden colocar bajo diferentes y variadas condiciones climáticas: donde la densidad del aire, la intensidad de turbulencia, la velocidad media del viento y el parámetro de forma *k* son los parámetros a considerar. Si la intensidad de turbulencia es alta las cargas en el aerogenerador aumentan y su tiempo de vida disminuye. Por el contrario, las cargas se reducirán y su tiempo de vida aumentará si la velocidad media del viento o la intensidad de turbulencia o ambas son bajas. Por lo tanto, los aerogeneradores pueden colocarse en emplazamientos con alta intensidad de turbulencia si la velocidad media del viento es adecuadamente baja. Las condiciones climáticas han de examinarse si lo prescrito es excedido.

El valor característico, a altura de buje, de la intensidad de turbulencia I_{15} a la velocidad de viento media *diez-minutal* de 15 m/s se calcula sumando la desviación estándar medida de la intensidad de turbulencia a su valor medio medido o estimado.

En terreno complejo las condiciones de viento serán verificadas sobre la base de medidas realizadas en el emplazamiento. Además, habrá que considerar el efecto de la topografía en la velocidad y perfil del viento, la intensidad de turbulencia y la inclinación del flujo de viento sobre cada aerogenerador.

4 ESPECIFICACIONES TÉCNICAS.

A continuación se detallan las especificaciones técnicas de los diferentes componentes del aerogenerador G8X – 2.0 MW.

3.2 WIND CONDITION ASSESSMENT.

The turbines can be placed under various climatic conditions: where the air density, the turbulence intensity, the mean wind speed and the shape factor K are the parameters to be considered. If the turbulence intensity is high the turbine loading increases and the turbine lifetime decreases. On the contrary, the loading will be reduced and the lifetime extended if the mean wind speed or the turbulence intensity, or both, are low. Therefore, the wind-turbines can be placed on sites with high turbulence intensity if the mean wind speed is appropriately low. The climatic conditions have to be examined if the prescribed is exceeded

The characteristic value of hub-height turbulence intensity, I_{15}, at a min. average wind speed of 15 m/s is calculated by adding the measured standard deviation of the turbulence intensity to the measured or estimated mean value.

For complex terrain, the wind conditions shall be assessed from measurements made at the site. In addition, consideration shall be given to the effect of topography on the wind speed, wind profile, turbulence intensity and flow inclination at each turbine location.

4 TECHNICAL SPECIFICATIONS.

The technical specifications of the different components of the G8X – 2.0 MW wind-turbine are listed below:

4.1 CONO / NOSE CONE

Dimensiones	Distancia punta-base: 4237 mm Ø max. 3957 mm / Ø base 3300 mm
Material	Fibra de vidrio y resina de poliéster
Peso	310 kg

Dimensions	Tip-base distance: 4237 mm Ø max. 3957 mm; Ø base 3300 mm
Material	Glass fibre and polyester resin
Weight	310 kg

4.2 ROTOR / ROTOR

Diámetro	G80 D 80000mm G83 D 83000mm G87 D 87000mm G90 D 90000mm
Área barrida	G80 5026,5 m2 G83 5410,6 m2 G87 5944,7 m2 G90 6361,7 m2
Velocidad de rotación de operación	9.0 : 19.0 rpm
Sentido de rotación	Sentido agujas de reloj (vista frontal)
Orientación	Barlovento
Ángulo de inclinación	6º
Conicidad del rotor	2º
Número de palas	3
Freno aerodinámico	Puesta en bandera de palas

Diameter	G80 D 80000mm G83 D 83000mm G87 D 87000mm G90 D 90000mm
Swept Area	G80 5026,5 m2 G83 5410,6 m2 G87 5944,7 m2 G90 6361,7 m2
Rotational Speed Operation Interval	9.0 : 19.0 rpm
Sense of Rotation	Clockwise (front view)
Rotor Orientation	Upwind
Tilt angle	6º
Blade coning	2º
Number of blades	3
Aero-dynamic brake	Full feathering

4.3 PALAS / BLADES

Concepto estructural	Conchas pegadas a viga soporte principal
Material	- G80/83 Pre-impregnados de fibra de vidrio – epoxy - G87/G90 Pre-impregnados de fibra de carbono - epoxy y fibra de vidrio - epoxy
Conexión de palas	Insertos de acero en raíz
Perfiles aerodinámicos	- G80/83 NACA 63.XXX + FFA – W3 - G87/G90 DU-WX + FFA – W3
Longitud	- G80 39m - G83 40,5m - G87 42,5m - G90 44m
Cuerda de la pala (máxima / mínima)	- G80 3,36m / 0.48 m - G83 3,36m / 0.48 m - G87 3,36m / 0,013m - G90 3,36m / 0,013m
Torsión	- G80 18,74º - G83 18,74º - G87 15,74º - G90 15,74º
Masa nominal	- G80 6719 Kg - G83 7274 kg 8656 Kg (extender metálico) - G87 5981 Kg - G90 5983 Kg

Principle	Shells bonded to supporting beam
Material	- G80/83 Glass fibre reinforced epoxy - G87/G90 Carbon and glass fibre reinforced epoxy
Blade connection	Steel root inserts
Airfoils	- G80/83 NACA 63.XXX + FFA – W3 - G87/G90 DU-WX + FFA – W3
Length	- G80 39m - G83 40,5m - G87 42,5m - G90 44m
Chord (root/ tip)	- G80 3,36m / 0.48 m - G83 3,36m / 0.48 m - G87 3,36m / 0,013m - G90 3,36m / 0,013m
Max. Twist	- G80 18,74º - G83 18,74º - G87 15,74º - G90 15,74º
Weight	- G80 6719 Kg - G83 7274 kg; 8656 Kg (metallic extender) - G87 5981 Kg - G90 5983 Kg

4.4 RODAMIENTO DE PALA / BLADE BEARING

Tipo	Rodamiento de bola en doble fila 4 puntos de contacto
Dimensiones	ø2120 mm / ø1700 mm x 192 mm
Peso	1475 kg
Lubricación	Grasa Aeroshell 14

Type	Double row 4 point contact ball bearing
Dimensions	ø2120 mm / ø1700 mm x 192 mm
Weight	1475 kg
Lubrication	Grease Aeroshell 14

4.5 CARCASA / NACELLE COVER

Dimensiones	10050x1050x3300 mm
Material	Fibra de vidrio y resina de poliéster
Peso	2000 kg

Dimensions	10050x1050x3300 mm
Material	Glass fibre and polyester resin
Weight	2000 kg

4.6 BUJE DE PALA / ROTOR HUB

Tipo	Esférico
Material	Fundición nodular

Type	Spherical
Material	Nodular Cast Iron
Material specifications	EN-GJS-400-18U-LT per EN 1563

4.7 EJE PRINCIPAL / MAIN SHAFT

Tipo	Eje forjado
Dimensiones	Ø630 mm / brida ø1500 mm / longitud 2690 mm
Material	Acero templado y revenido
Especificación de material	42CrMo4 ó 34CrNiMo6 EN10083
Peso	6100 kg

Type	Forged shaft
Dimensions	Ø630 mm / flange ø1500 mm / length 2690 mm
Material	Quenched and tempered steel
Material specification	42CrMo4 or 34CrNiMo6 EN10083
Weight	6100 kg

4.8 SOPORTE DEL EJE / MAIN SHAFT SUPPORT

Tipo	Soporte de fundición
Material	Fundición nodular
Especificación de material	EN-GJS-400-18U-LT según EN 1563
Peso	1600 kg

Type	Cast
Material	Nodular Cast Iron
Material specification	EN-GJS-400-18U-LT per EN 1563
Weight	1600 kg

4.9 RODAMIENTOS DEL EJE / MAIN SHAFT BEARING

4.9.1 Rodamiento delantero del eje principal / Front main shaft bearing

Tipo	Rodamientos de rodillos a rótula. 230 / 630
Dimensiones	Ø920 mm / ø630 mm x 212 mm
Peso	485 kg
Lubricación	Grasa LG WM1

Type	Spherical Roller Bearings. 230 / 630
Dimensions	Ø920 mm / ø630 mm x 212 mm
Weight	485 kg
Lubrication	Grease LG WM1

4.9.2 Rodamiento trasero del eje principal / Rear main shaft bearing

Tipo	Rodamientos de rodillos a rótula. 24188
Dimensiones	Ø720 mm / ø440 mm x 280 mm
Peso	460 kg
Lubricación	Grasa LG WM1

Type	Spherical Roller Bearings. 24188
Dimensions	Ø720 mm / ø440 mm x 280 mm
Weight	460 kg
Lubrication	Grease LG WM1

4.10 BASTIDOR DELANTERO / FRONT MAIN FRAME

Material	Fundición nodular
Especificación de material	EN-GJS-400-18U-LT según EN 1563

Material	Nodular Cast Iron
Material specification	EN-GJS-400-18U-LT per EN 1563

4.11 SISTEMA DE GIRO / YAW SYSTEM

Tipo	Corona de orientación con cojinete de fricción
Materiales	
Corona de orientación	Forjado. 34CrNiMo 6 / 42CrMo4 EN10083
Elemento de fricción	PETP
Velocidad de orientación	< 0.5º/s
Freno de yaw	Activo hidráulico + Pasivo

Type	Plain bearing system with built-in friction
Materials	
Yaw ring	Forged. 34CrNiMo 6 / 42CrMo4 EN10083
Plain bearing	PETP
Yawing speed	< 0.5º/s.
Yaw brake	Hydraulic active + Passive

4.12 MECANISMO DE GIRO. MOTORREDUCTORAS / YAW GEARS

Tipo	3 etapas epicicloidales
	1 etapa sinfín (ratio máximo 1:10)
Motor	2.2 kW, motor asíncrono de 6 polos con freno

Type	3 planetary stages
	1 worm gear non – locking stage (maximum ratio 1:10)
Motor	2.2 kW, 6 pole asynchronous motor with brake.

4.13 TORRE / TOWER

Tipo	Tronco-cónica tubular
Material	Acero al carbono estructural
Especificación material	
Virolas	S235 JO / S235 JRG2 / S275J2G3/ S355J2G3 / S235 J2G3 / S355 NL
Bridas	S355 NL
Tratamiento superficial	Pintada
Tipo de corrosión, exterior / interior	C5-H (ISO 12944-2) / C3-H (ISO 12944-2)
Diámetro en parte superior	2.3 m (todas las alturas)
Diámetro en parte inferior	4.0 m (todas las alturas)
Altura del buje	
Torre modular de 3 tramos IEC (60 m)	60 m
Torre modular de 3 tramos IEC (67 m)	67 m
Torre modular de 4 tramos IEC (78 m)	78 m
Torre modular de 5 tramos IEC (100m)	100 m

Características de los tramos de torres IEC IIA / DIBT II				
	Longitud [mm]	**Ø Inferior Externo [mm]**	**Ø Superior Externo [mm]**	**Peso [kg]**
Torre IEC IIA / DIBT II 60 m				
Inferior	10391	4034	3490	34000
Intermedio	23822	3490	2778	56000
Superior	24367	2778	2314	43000
Torre IEC IIA/ DIBT II 67 m				
Inferior	16665	4034	3490	52000
Intermedio	23822	3490	2780	56000
Superior	24367	2780	2314	43000
Torre IEC IIA / DIBT II 78 m				
Inferior	11100	4038	3810	54000
Intermedio 1	16980	3810	3494	62000
Intermedio 2	23822	3494	2781	56000
Superior	24367	2781	2314	43000
Torre IEC IIA / DIBT II 100m				
Inferior	15619	4038	3855	65000
Intermedio 1	16961	3855	3810	65000
Intermedio 2	16980	3810	3494	58000
Intermedio 3	23822	3494	2781	56000
Superior	24367	2781	2314	52000

Características de los tramos de torres IEC IA /DIBT III				
	Longitud [mm]	**Ø Inferior Externo [mm]**	**Ø Superior Externo [mm]**	**Peso [kg]**
Torre IEC IA / DIBT III 60 m				
Inferior	10391	4034	3492	31400
Intermedio	23822	3492	2778	51600
Superior	24367	2778	2314	40000
Torre IEC IA / DIBT III 67 m				
Inferior	16665	4034	3492	49400
Intermedio	23822	3492	2781	51600
Superior	24367	2781	2314	40000
Torre IEC IA / DIBT III 78 m				
Inferior	11100	4038	3810	45200
Intermedio 1	16980	3810	3494	55200
Intermedio 2	23847	3494	2781	55700
Superior	24392	2781	2314	41200

(*) La altura exacta del buje incluye 0.60 m de distancia desde la brida de cimentación al suelo y 1.7 m desde la parte más alta de la torre hasta el centro del buje.

Type	Trunk-conical Tubular
Material	Non-alloy structural steel
Material specification	
Shells	S235 JO / S235 JRG2 / S275J2G3 / S355J2G3 / S235 J2G3 / S355 NL
Flanges	S355 NL
Surface treatment	Painted
Corrosion class, outside / inside	C5-M (ISO 12944-2) / C3 (ISO 12944-2)
Top diameter	2.3 m (all heights)
Bottom diameter	4.0 m (all heights)
Hub height	
3 parted modular tower IEC (60 m)	60 m
3 parted modular tower IEC (67 m)	67 m
4 parted modular tower IEC (78 m)	78 m
5 parted modular tower IEC (100 m)	100 m

Characteristics of the IEC IIA / DIBT II tower sections				
	Length [mm]	**Outer Ø at Bottom [mm]**	**Outer Ø at Top [mm]**	**Weight [kg]**
Tower IEC IIIA/ DIBT II 60 m				
Bottom	10391	4034	3490	34000
Intermediate	23822	3490	2778	56000
Top	24367	2778	2314	43000
Tower IEC IIA/ DIBT II 67 m				
Bottom	16665	4034	3490	52000
Intermediate	23822	3490	2780	56000
Top	24367	2780	2314	43000

Tower IEC IIA / DIBT II 78 m				
Bottom	11100	4038	3810	54000
Intermediate 1	16980	3810	3494	62000
Intermediate 2	23822	3494	2781	56000
Top	24367	2781	2314	43000
Tower IEC IIA / DIBT II 100 m				
Bottom	15619	4038	3855	65000
Intermediate 1	16961	3855	3810	65000
Intermediate 2	16980	3810	3494	58000
Intermediate 3	23822	3494	2781	56000
Top	24367	2781	2314	52000

Characteristics of the IEC IA / DIBT III tower sections				
	Length [mm]	**Outer Ø at Bottom [mm]**	**Outer Ø at Top [mm]**	**Weight [kg]**
Tower IEC IA / DIBT III 60 m				
Bottom	10391	4034	3492	31400
Intermediate	23822	3492	2778	51600
Top	24367	2778	2314	40000
Tower IEC IA / DIBT III 67 m				
Bottom	16665	4034	3492	49400
Intermediate	23822	3492	2781	51600
Top	24367	2781	2314	40000
Tower IEC IA / DIBT III 78 m				
Bottom	11100	4038	3810	45200
Intermediate 1	16980	3810	3494	55200
Intermediate 2	23847	3494	2781	55700
Top	24392	2781	2314	41200

(*) The exact hub height includes 0.7 m (distance from the foundation section to ground level) and 1.7 m (distance from top flange to hub).

4.14 MULTIPLICADORA / GEARBOX

Tipo	1 etapa planetaria / 2 paralelas
Ratio	1 : 100.5 (50 Hz) 1 : 120,5 (60Hz)
Refrigeración	Bomba de aceite con intercambiador.
Calentador de aceite	2.25 kW a 690V
Filtro de aceite	3 µm / 10 µm
Proveedor	Varios.
Dimensiones (aprox.)	2 x 2.2 x 2.2 m^3
Peso (max.)	16500 kg

Type	1 planetary stage / 2 palrallel stages
Ratio	1 : 100.5 (50 Hz) 1 : 120,5 (60Hz)
Cooling system	Oil pump with oil cooler; Aux. pump
Oil heater power	2.25 kW, 690V
Oil filter	3 μm / 10 μm
Supplier	Several
Dimensions (approx.)	2 x 2.2 x 2.2 m^3
Weight (max.)	16500 kg

4.15 ACOPLAMIENTO EJE DE ALTA / HIGH SPEED SHAFT COUPLING

Eje principal – multiplicadora	Disco cónico de apriete
Multiplicadora – generador	Acoplamiento flexible

Main shaft – gearbox	Shrink Disc Conical
Gearbox – generador	Flexible joint

4.16 GENERADOR CON CONVERTIDOR / GENERATOR WITH CONVERTER

Tipo	Doblemente alimentado con rotor devanado y anillos deslizantes
Potencia nominal	2000 kW (estátor + rotor)
Voltaje	690 Vac
Frecuencia	50 Hz / 60 Hz
Nº de polos	4
Clase de protección	IP54 (IP 23 para anillos rozantes)
Velocidad nominal de rotación	1680 rpm
Intensidad nominal	
Estator	1500 A @ 690 V
Rotor	260 A @ 480 V / 167 A @ 690 V
Factor de potencia	1.0
Intervalo de factor de potencia (*)	0.98_{CAP} – 0.96_{IND} (opción 1)
	0.95_{CAP} – 0.95_{IND} (opción 2)
Dimensiones	3224mm x 1883 mm x 1310 mm
Pesos	7100 kg
Rodamiento DE	6330 M / C3
Rodamiento NDE	6330 M / C3
	Ver sección 1.5

(*) En bornas de baja tensión del transformador.

Type	Doubly fed machine with wound rotor and slip-rings
Rated power	2000 kW (stator + rotor)
Voltage	690 Vac
Frequency	50 Hz / 60 Hz
Number of poles	4
Class of protection	IP54(IP23 for slip rings)
Rated speed	1680 rpm
Nominal current	
Stator	1500 A @ 690 V
Rotor	260 A @ 480 V / 167 A @ 690 V
Default power factor	1.0
Power factor range (*)	0.98_{CAP} – 0.96_{IND} (option 1)
	0.95_{CAP} – 0.95_{IND} (option 2)
Dimensions	3224mm x 1883 mm x 1310 mm
Weight	7100 kg
DE Bearing	6330 M / C3
NDE Bearing	6330 M / C3
	Ver sección 1.5

(*) At Low Voltage tranformer side.

4.17 FRENO DE APARCAMIENTO / PARKING BRAKE

Tipo	Freno de disco
Diámetro	600 mm
Material	EN-GJV-300-LT

Type	Disc brake
Diameter	600 mm
Material	EN-GJV-300-LT

4.18 GRUPO HIDRÁULICO / HYDRAULIC UNIT

Capacidad de la bomba	44 l/min
Presión máxima	200 bar
Contenido de aceite	300 l
Motor	18.5 kW / 22kW

Pump capacity	44 l/min
Maximum pressure	200 bar
Oil quantity	300 l
Motor	18.5 kW / 22kW

4.19 SENSORES DE VIENTO / WIND SENSORS

Tipo	1 anemómetro ultrasónico 2D con medida de velocidad y dirección simultánea + 1 anemómetro de cazoletas y veleta
Número	1 + 1

Type	1 ultrasonic anemometer 2D with simultaneous measurement of wind speed and direction + 1 cup anemometer and windvane
Number	1 + 1

4.20 UNIDAD DE CONTROL / CONTROL UNIT

Alimentación		
Frecuencia	50 Hz / 60 Hz	
Voltaje	3 x 690 Vca o 3 x 690 Vca +3 x 480 Vca	
Potencia para iluminación	1 x 10 A, 230 Vac (50Hz) / 1 x 10 A, 110 Vca (60Hz)	
PLC	Sisteam A / RFC 430 ETH-IB (Phoenix Contact)	
Comunicación	CAN / DDCS /Interbus	
Memoria de programa	EPROM (flash)	
Lenguaje de programación	ST (IEC-1131)	
Configuración	Módulos a un rack frontal	
Operación	Pantalla táctil	
Pantallas	Terminales táctiles, 320 x 240 pixels, 5,7 pulg.	
Supervisión / control		
	Potencia activa	Ambiente (temperatura del aire)
	Potencia reactiva	Rotación
	Orientación	Generador
	Hidráulicos	Sistema de cambio de paso
	Red eléctrica	Monitorización remota
Información		
		Datos de operación
		Producción
		Listado de operación
		Listado de alarmas
Ordenes		
	Arranque / pausa	
	Inicio / parada de orientación manual	
	Tests de mantenimiento	
Supervisión remota		
	Posibilidad de conexión a comunicación serie (para PLC Sistema A) o Ethernet (para PLC Phoenix Contact)	

Datos de controladores Nacelle, Buje, Ground		
Grado de protección		
	Nacelle	IP-43
	Buje	IP-54
	Ground	IP-54
Dimensiones aprox.	Nacelle	4000 x 2200 x 500 mm^3
	Buje	800 x 800 x 400 mm^3
	Ground	800 x 1600 x 400 mm^3
Tipo de alojamiento	Acero: chapa de 3 mm (armario y pedestal) y de 1,5 mm (puerta)	
Protección personas	UNE 60439-1; UNE 60204	

Power supply		
Frequency	50 Hz / 60 Hz	
Voltage	3 x 690 Vca or 3 x 690 Vac + 3 x 480 Vac	
Illumination	1 x 10 A, 230 Vac (50Hz) or (1 x 10 A, 110 Vca) (60Hz)	
PLC	Sisteam A / RFC 430 ETH-IB (Phoenix Contact)	
Communication	CAN / DDCS / Interbus	
Program memory	EPROM (flash)	
Programming language	ST (IEC-1131)	
Configuration	Modules to a front rack	
Operation	Touch terminal	
Display	Touch terminal, 320 x 240 pixels, 5,7 inch	
Supervision / control		
	Active power	Ambient (air temperature)
	Reactive power	Rotation
	Yawing	Generator
	Hydraulics	Pitch system
	Grid	Remote monitoring
Information		
	Operating data	Operation log
	Production	Alarm log
Commands		
	Run /pause	
	Start / Stop. Manual yaw	
	Maintenance tests	
Remote supervision		
	Possibility of connection of serial communication (for PLC Ssiteam A) or Ethernet (for PLC Phoenix Contact).	

Nacelle, hub and ground controller data		
Protection level		
	Nacelle	IP-43
	Hub	IP-54
	Ground	IP-54
Dimensions aprox		
	Nacelle	4000 x 2200 x 500 mm^3
	Hub	800 x 800 x 400 mm^3
	Ground	800 x 1600 x 400 mm^3
Type of enclosure	Steel. Thickness 3 mm (cabinet, pedestal); 1,5 mm (door)	
Method of protection of persons	UNE 60439-1; UNE 60204	

4.21 CELDA DE MEDIA TENSIÓN / MEDIUM VOLTAGE SWITCH GEAR

La celda de conexión del aerogenerador a la red eléctrica en Media Tensión se incluye en el suministro de Gamesa Eólica de forma opcional. La elección de esta celda debe ser realizada de acuerdo a las características eléctricas de la red de conexión, a continuación se muestran las características básicas de una celda-tipo.
Esta celda corresponde al aerogenerador G8X 2MW estándar para una red de conexión de 20kV. Para otros niveles de tensión de la red de conexión, es necesario consultar con Gamesa Eólica.

Tipo	Aparamenta Blindada aislada SF6
Servicio	Continuo
Instalación	Interior
Nº de fases	3
Nº embarrados	1
Tensión nominal asignada	24 kV
Tensión del servicio	20 kV
Frecuencia nominal	50 Hz
Intensidad nominal	
Función de protección (P)	200 A
Función de conexión a red (L)	400 A
Nivel de aislamiento	
A tierra, entre polos y entre bornas (frecuencia industrial / tipo rayo))	50 kV / 125 kV
Intensidad de cortocircuito	
Admisible de corta duración (1 s)	16 kA
Nominal cresta	40 kA
Resistencia arcos internos	
Intensidad	16 kA-0,5 s (UNE 20099-CEI 298
Voltaje	24 kV
Dimensiones (aprox.) (*)	1200 x 800 x 2090 (alto) mm^3
Peso (aprox.) (*)	415 kg

(*) Celda mayor
(**) El tipo de celda depende de las características del puerto de conexión del aerogenerador. Los datos indicados corresponden a una de las situaciones posibles.

The switch gear of the windturbine is included in the supply of Gamesa Eólica, S. A. as an option. This gear has to be chosen according to the electrical characteristics of the grid connection. Below, characteristics of one type of gear are shown. This gear corresponds to the G8X-2.0 MW standard for a grid connection of 20 kV. For other voltage levels, it is necessary to contact Gamesa Eólica, S. A.

Type	Armored isolated SF6
Service	Continuous
Installation	Inside
Number of phases	3
Busbar number	1
Assigned nominal voltage	24 kV
Service voltage	20 kV
Nominal frequency	50 Hz /
Nom. Intensity, Protection function (P)	200 A
Nom. Intensity, Grid connection function (L)	400 A
Insulation level	
Ground, between poles and between terminals	50 kV (industrial freq.) / 125 kV (peak freq.)
Short-circuit intensity	
Permissible of short duration (1 s)	16 kA
Nominal pulse	40 kA
Resistance	
Intensity	16 kA-0.5 s (UNE 20099-CEI 298)
Voltage	24 kV
Dimensions (approx. for larger unit)	1200 x 800 x 2090 (height) mm^3
Weight (approx. for larger unit)	415 kg

(*) Biggest gear
(**) The switch gear depends on the characteristics of the connection port of the generator. The indicated data correspond to one of the possible situations.

4.22 TRANSFORMADOR / TRANSFORMER

Tipo	Trifásico, seco encapsulado
Relación de transformación	6,6 kV ~ 34,4 kV / 690 V o 690 V + 480 V
Potencia nominal	2100 kVA / 2500 kVA (opción)
Frecuencia	50 Hz / 60Hz
Grupo de conexión	Dyn11
Clase de aislamiento	F
Nivel de aislamiento (kV)	24 kV
Peso (aprox.)	<5000 kg

Type	3 phase, dry-encapsulated
Transformation relation	6,6 kV ~ 34,4 kV / 690 V or 690 V + 480 V
Nominal power	2100 kVA / 2500 kVA (option)
Frequency	50 Hz / 60Hz
Connection group	Dyn11
Insulation class	F
Insulation level (kV)	24 kV.
Weight (approx.)	< 5000 kg

4.23 PESOS / WEIGHTS

PESO TORRES / TOWER WEIGHT	60 m	67 m	78 m	100 m
Torres IEC IIA (*)	127 t	145 t	201 t	283 t
Torres DIBt Zona II (*)			201 t	283 t
Torres IEC IA / DIBt Zona III (*)	136 t	153 t	203 t	

(*) Estos pesos no incluyen la celda de media tensión y el *ground*.
(*) It does not include the switch gear and the ground controller.

PESO NACELLE / NACELLE WEIGHT	70 t

PESO ROTOR / ROTOR WEIGHT	G80	G83 EXTENDER MECANOSOLDADO	G83 EXTENDER ROOT BLADE	G87	G90
	38,6 t	45,0 t	40,7 t	36,4 t	38,0 t

PESO TOTAL NACELLE /NACELLE TOTAL WEIGHT		G80	G83 EXTENDER MECANOSOLDADO	G83 EXTENDER ROOT BLADE	G87	G90
Towers IEC IIA (*)	**60 m**	235,6 t	242 t	237,7 t	233,4 t	234,9 t
	67 m	253,6 t	260 t	255,7 t	251,4 t	252,9 t
	78 m	309,6 t	316 t	311,7 t	307,4 t	308,9 t
	100 m	391,6 t	398 t	393,7 t	389,4 t	390,9 t
Towers DIBt Zone II (*)	**78 m**	309,6 t	316 t	311,7 t	307,4 t	308,9 t
	100 m	391,6 t	398 t	393,7 t	389,4 t	390,9 t
Towers IEC IA / DIBt Zone III (*)	**60 m**	244,6 t	233 t	246,7 t	242,4 t	243,9 t
	67 m	261,6 t	268 t	263,7 t	259,4 t	260,9 t
	78 m	311,6 t	318 t	313,7 t	309,4 t	310,9 t

Título:
Análisis de ruido aerogenerador G90 - 2 MW

Title:
Noise analysis for the G90-2 MW wind turbine

Confidencialidad: 3

Doc VWS: FT002413.R2

AUTOR/ AUTHOR: NCD

REVISADO/CHECKED: AMG

APROBADO/APPROVED: JMY

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REGISTRO DE CAMBIOS/ RECORD OF CHANGES

Rev.	Fecha/ Date	Autor/ Author	Descripción	Description
B	06/08/03	BML	Versión Inicial	Initial Version
2	16/04/04	NCD	Versión con actualización de formato y con tablas de valores	Initial Version with new format and including tables with numerical values

Título: **Análisis de ruido aerogenerador G90 - 2 MW**
Title: **Noise analysis for the G90-2 MW wind turbine**

1 OBJETO

El presente documento da una estimación del nivel de emisión de ruido del aerogenerador G90 – 2MW de Gamesa Eólica.

2 ALCANCE

El alcance del cálculo presentado es aplicable en las condiciones indicadas en **4 Descripción**

3 DEFINICIONES Y ACRÓNIMOS

-

4 DESCRIPCIÓN

Hay que hacer notar que las expresiones empleadas en el cálculo de la emisión de ruido son aproximadas.

5 RESULTADOS

La Figura 1 muestra el nivel de ruido ocasionado por el aerogenerador G90 para diferentes alturas de torre en función de la velocidad del viento medido a una altura de 10m.

1 AIM

This document provides an estimate of the noise associated to the G90-2MW wind turbine.

2 SCOPE

The calculation scope only apply in the terms described in **4 Description**

3 DEFINITIONS AND ACRONYMS

-

4 DESCRIPTION

Methods used to carry out this estimate are based on semiempirical correlations.

5 RESULTS

Figure 1 shows noise level generated by the G90 wind turbine for different tower heights and wind velocities measured at 10 meters above ground.

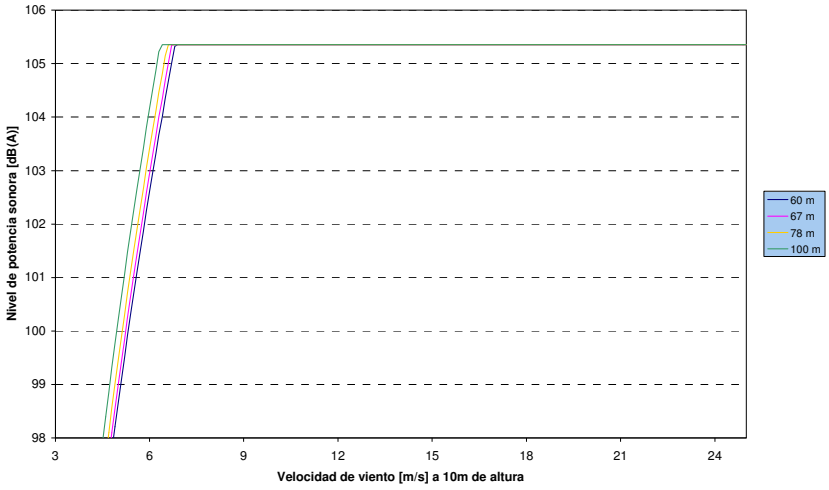

Figura 1. Nivel de ruido del aerogenerador G90 – 2 MW en función de la altura de torre y de la velocidad del viento a 10m sobre el nivel del suelo. $\lambda = 9.0$

Figure 1. Noise level of G90 – 2MW wind turbine for different tower heights and wind velocities measured at 10 meters above ground.

La Tabla 1 muestra los valores numéricos de nivel de ruido en dB(A) para las distintas velocidades de viento, desde 3m/s hasta la velocidad de corte.

Table 1 shows noise numerical values in dB(A) for different wind velocities, from 3m/s to cut wind speed.

v_{wind} [m/s]	dB(A) H= 60m	dB(A) H= 67m	dB(A) H= 78m	dB(A) H= 100m
3	91.86	91.86	91.86	91.86
4	93.80	94.14	94.60	95.36
5	98.65	98.99	99.45	100.2
6	102.6	102.9	103.4	104.2
7	105.3	105.3	105.3	105.3
8	105.3	105.3	105.3	105.3
9	105.3	105.3	105.3	105.3
10	105.3	105.3	105.3	105.3
11	105.3	105.3	105.3	105.3
12	105.3	105.3	105.3	105.3
13	105.3	105.3	105.3	105.3
14	105.3	105.3	105.3	105.3
15	105.3	105.3	105.3	105.3
16	105.3	105.3	105.3	105.3
17	105.3	105.3	105.3	105.3
18	105.3	105.3	105.3	105.3
19	105.3	105.3	105.3	105.3
20	105.3	105.3	105.3	105.3
21	105.3	105.3	105.3	105.3

Tabla 1. Nivel de ruido del aerogenerador G90 – 2MW para diferentes velocidades de viento y distintas alturas de torre

Table 1. Noise level of G90 – 2MW wind turbine for different wind velocities and tower heights

La velocidad máxima de punta de pala para este aerogenerador es 78.7 m/s. El nivel estimado máximo* de emisión de ruido en estas condiciones es 105.3 dB(A).

Wingtip maximum velocity is 78.7 m/s . Estimated maximum noise level is 105.3 dB (A).

6 DOCUMENTOS Y ARCHIVOS APLICABLES

7 ANEXOS

8 APPLICABLE DOCUMENTATION AND FILES

9 ANNEXES

(*) Estudio de ruido de los aerogeneradores V80, G83, G87 y G90. Ref: GAMESA A1.aero.002.03, 21/07/03.

Gamesa Eólica

INSTRUCCIÓN DE TRABAJO WORK INSTRUCTION	Nº: 1.941654 Revisión: 03

Título: Title:	CARTA DE LUBRICACION LUBRICATION CHART				Ref. VWS Nº: 941654 R02 Dr./Plano-Instrucción Supl: 942288
Realizado		**Revisado**	**Aprobado**		
RSL	Fecha: 01/07/03	R.Z.	Ingeniería: JPT	Fecha Aprobación:	Pág. 1 De 2

POS	PUNTO DE LUBRICACIÓN / LUBRICATION POINT	LUBRICANTE	CANTIDAD	INTERVALO	FECH
1	Rodamiento de pala / *Blade bearings*	*AeroShell Calsium Grease 14 (149047)*	*3 x 400 g*	*6 months*	*24/09/*
2	Rótulas bielas / *Connecting rod joints*	*SKF LGWM1 (149139)*	*3 x 25 g*	*6 months*	*08/08/*
3	Eje antirotación / *Traverse anti rotation device*	*SKF LGWM1(149139) + Teflón Líquido (3003001)*	*As Required*	*6 months*	*13/08/*
4	Eje soporte estrella, casquillo frontal,*Casquillo glicodour / Traverse tube, front bushing, glicodour bushing* → Eje soporte estrella superficie del eje / *Traverse tube, visible part* →	→ *SKF LGWM1 (149139)* → *SKF LGWM1 + Teflón líquido(3003001)*	*100 g* *Lo necesario*	*6 months* *6 months*	*08/08/* *13/08/*
5	Rodamiento caballete, frente / *Main bearing, front* → Rodamiento caballete, trasera / *Main bearing rear* →	→ *SKF LGWM1 (149139)* → *SKF LGWM1 (149139)*	*400 g* *400 g*	*6 months* *6 months*	*08/08/*
6	Multiplicadora / *Gear box, Flender* Multiplicadora / *Gear box, Hansen* Multiplicadora / *Gear box, Valmet* Multiplicadora / *Gear box Fellar* Multiplicadora / *Gear box Lohman* *Multiplicadora / Gear box Echesa*	*Texaco Meropa 320 (149092)* *Texaco Meropa 320 (149092)* *Texaco Meropa 320 (149092)* *Texaco Meropa 320 (149092)* *Texaco Meropa 320 (149092)* *Texaco Meropa 320 (149092)*	*125 l* *130 l* *125 l* *135 l* *125 l* *110 l*	*18 months* *18 months* *18 months* *18 months ** *18 months* *18 months*	*10/02*
7	Cardan / *Cross cardan shaft*	*Beslux Liplex H-1/2-S (9002601)*	*300 g*	*6 months*	*09/05*
8	Anillos deslizantes / *Guide rings, pitch bearing housing*	*SKF LGWM1 (149139)*	*10 g*	*6 months*	*08/08*
9	Rodamiento de Pitch / *Pitch bearing*	*SKF LGWM1 (149139)*	*50 g*	*6 months*	*08/08*
10	Arrastrador del pitch / *Link bearing: Pitch bearing housing - cylinder*	*AeroShell Calsium Grease 14 (149047)*	*25 g*	*6 months*	*24/09*
11	Montaje cilindro hidraúlico / *Hydraulic cylinder mounting*	*SKF LGWM1 (149139)*	*10 g*	*6 months*	*08/08*
12	Amortiguador multiplicadora / *Gear mounting, disc springs*	*Shell Stamina Grease HDS 2(1.094161)*	*100 g*	*6 months*	*09/05/*
13	PETP de corona / *Yaw bearing (Slide blocks)*	*Shell Stamina HDS 2 (1.094161))*	*200 g*	*6 months*	*10/02*

14	Dientes de corona / *Yaw gear (Yaw teeth)*	*Kluber Grafloscon A-G1 Ultra(149187)*	*100 g*	*6 months*	*10/02/*
15	Reductoras de giro / *Yaw drive gears: Worm gear* *Planetary gear*	*Shell Tivela SC (149107)* *Shell Tivela SC (149107)*	*2,7 l* *6 l*	*5 years* *5 years*	*08/08/*
16	Rodamientos frontales Generador de 660 Kw / *Big Gen: Front bearing* *ABB (660 Kw)* *Leroy Somer (660 kW)* *Weier (660 kW)* *INDAR (660 Kw)*	*Arcanol FAG (3003002)* *Arcanol FAG (3003002)* *Arcanol FAG 3003002))* *Beslux Liplex H-1/2-S (9002601)*	*40 g* *60 g* *72 g* *55 g*	*6 months*	*09/05/*
17	Rodamientos traseros Generador de 660 Kw / *Big Gen: rear bearings* *ABB (660 Kw)* *Leroy Somer (660 kW)* *Weier (660 kW)* *INDAR (660 Kw)*	*Arcanol FAG (3003002))* *Arcanol FAG (3003002))* *Arcanol FAG (3003002)* *Beslux Liplex H-1/2-S (9002601)*	*40 g* *60 g* *83 g* *55 g*	*6 months*	*09/05/*
18	Rodamientos frontales Generador de 200 Kw / *Small Gen.: Front bearing ABB (200 Kw)*	*Arcanol FAG (3003002))*	*25 g*	*6 months*	*13/08/*
19	Rodamientos traseros Generador de 660 Kw / *Small Gen.: Rear bearing ABB (200 Kw)*	*Arcanol FAG (3003002)*	*25 g*	*6 months*	*13/08/*
20	Grupo Hidraúlico / *Hydraulic unit*	*Texaco Rando HDZ 32 (149115)*	*60 l*	*5 years*	*08/08/*
21	Polipasto / *Crane*	*Mobilgear 630*	*Lubricated for life*		*08/08/*

* En las multiplicadoras Fellar, el primer cambio de aceite se hará a los 6 meses de la puesta en funcionamiento / In Fellar gear-boxes, the first change of oil will be performed at 6 months.

MATERIAL SAFETY DATA SHEET

"READ AND UNDERSTAND MATERIAL SAFETY DATA SHEET
BEFORE HANDLING OR DISPOSING OF PRODUCT"

02324 MEROPA 320

1. PRODUCT AND COMPANY NAME

PRODUCT CODE AND NAME
02324 MEROPA 320
DESCRIPTION
Gear Lubricant
COMPANY
TEXACO PETROLIFERA S.A.
C.Villa de Madrid 34
Pol. Ind. Fuente del Jarro
46988 Paterna (Valencia)
SPAIN
Tel : 0034/96132 2361
Fax : 0034/96132 3704
Emergency Phone Number : 0044/(0)18 65 407 333

2. COMPOSITION/INFORMATION ON INGREDIENTS

Name	% Wt	CAS No.	EC No.
Mineral oil	95 - 99,99	*	*
Olefin sulphide	< 5	CBI	CBI
R 53	May cause long-term adverse effects in the aquatic environment.		
Phosphoric acid ester amine salt	< 2,5	CBI	CBI
N R 51/53	Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.		

(IP 346 DMSO extract < 3%)
* : EC-Nrs.: 278-012-2 ; 295-426-9 ; 265-169-7 ; 265-101-6

3. HAZARDS IDENTIFICATION

Product classification
Product is not classified as dangerous according to Directive 1999/45/EC.

Acute effects of exposure to man

Inhalation
Vapours or mist in unusually high concentrations, as from exposure in poorly ventilated areas or confined spaces, may cause irritation of the nose and throat, headache, nausea, and drowsiness.

Skin contact
Brief contact is not irritating. Prolonged contact, as with clothing wetted with material, may cause defatting of skin or irritation, seen as local redness with possible mild discomfort.

Eye contact
May cause minimal irritation, experienced as temporary discomfort.

Ingestion
No adverse effects expected. If more than several mouthfuls are swallowed, abdominal discomfort, nausea, and diarrhoea may occur.

Chronic effects of exposure to man	
Medical conditions aggravated by exposure	Because of its defatting properties, prolonged and repeated skin contact may aggravate an existing dermatitis (skin condition).
Effects of exposure to the environment	May form an oil film leading to deoxygenation of water and possible harmful effects on aquatic life.

4. FIRST AID MEASURES

Route of exposure	
Inhalation	If irritation, headache, nausea, or drowsiness occurs, remove to fresh air. Get medical attention if breathing becomes difficult or symptoms persist.
Skin contact	Wash skin with plenty of soap and water for several minutes. Get medical attention if skin irritation develops or persists.
Eye contact	Flush eyes with plenty of water for several minutes. Get medical attention if eye irritation persists.
Ingestion	Do not induce vomiting. Get medical attention. Never give anything by mouth to an unconscious or convulsing person.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	Use water fog, dry powder, foam or carbon dioxide. Use water to cool fire-exposed containers. If a leak or spill has not ignited, use water fog to disperse the vapours and to provide protection for personnel attempting to stop the leak.
Extinguishing media which must not be used for safety reasons	Water jet
Special exposure hazards arising from the substance or preparation itself, combustion products, resulting gases	None
Special protective equipment for firefighters	The nature of special protective equipment required will depend upon the size of the fire, the degree of confinement of the fire and the natural ventilation available. Fire-resistant clothing and self-contained breathing apparatus is recommended forfires in confined spaces and poorly-ventilated areas. Full fire-proof clothing is recommended for any large fires involving this

	product. In case of fire - Always call the fire brigade. Small fires, such as those capable of being fought with ahand-held extinguisher, can normally be fought by a person who has received instruction on the hazards of flammable liquid fires. Fires that are beyond that stage should only be tackled by people who have received hands-on training. Ensure escape pathis available.

6. ACCIDENTAL RELEASE MEASURES

Procedures in case of accidental release or leakage	Contain spill if possible. Wipe up or absorb on suitable material and shovel up. Prevent liquid or runoff from entering waterways and sewer systems.

7. HANDLING AND STORAGE

Handling	Avoid prolonged or repeated contact with skin. Avoid breathing vapours.
Storage	Store in the original container securely closed and at room temperature.
Specific use (s)	For intended product uses please refer to the Product Information Leaflet (PIL)

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Respiratory protection	Airborne concentrations should be kept to lowest levels possible. If vapour or mist is generated, use approved respirator as appropriate. Supplied air respiratory protection should be used for cleaning large spills or upon entry into tanks, vessels, or other confined spaces.
Hand and skin protection	Exposed employees should exercise reasonable personal cleanliness. This includes cleansing exposed skin areas several times daily with soap and water, and laundering or dry cleaning soiled work clothing.
Eye protection	Chemical type goggles or face shield recommended to prevent eye contact.
Exposure limit for the product	Oil mist, mineral (excluding metalworking fluids) : TWA : 5 mg/m3 ; STEL : 10 mg/m3

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	Clear liquid
Odour	Mineral oil
Flash point (ASTM D92), °C	> 222
Relative density	min 0,893 kg/L @ 15 °C
Viscosity	304 - 336 mm2/s @ 40°C

10. STABILITY AND REACTIVITY

Materials to avoid	Strong oxidising agents.
Hazardous decomposition products	Oxides of carbon, aldehydes and ketones.

11. TOXICOLOGICAL INFORMATION

Acute

Inhalation	High concentrations of vapours or mist are likely to be irritating to the respiratory tract and may cause nausea, dizziness, headaches and drowsiness.
Skin contact	Slightly irritating to the skin.
Eye contact	Unlikely to cause more than transient stinging or redness if accidental eye contact occurs.
Ingestion	Unlikely to cause harm if accidentally swallowed in small doses, though larger quantities may cause nausea and diarrhoea.
Chronic	Repeated skin contact may cause a persistent irritation or dermatitis.

12. ECOLOGICAL INFORMATION

Mobility	Spillages may penetrate the soil causing ground water contamination.
Persistence and degradability	According to EC criteria : Not readily biodegradable
Potential to bioaccumulate	Considered unlikely to bioaccumulate.
Aquatic toxicity	Not classified as toxic.
Remarks	Believed not to represent a long-term danger to the aquatic environment. WGK=1

13. DISPOSAL CONSIDERATIONS

Disposal	Dispose in accordance with local laws and regulations governing disposal of waste oil. EWC-Nr : 13 02 05

14. TRANSPORT INFORMATION

transport	Not regulated

15. REGULATORY INFORMATION

Classification/Labelling information	Under the criteria of Directive EEC/67/548 (dangerous substances) and EEC/1999/45 (dangerous preparations) : Not classified

16. OTHER INFORMATION

Full text of risk phrases	R 53 May cause long-term adverse effects in the aquatic environment. N R 51/53 Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
Changes were made in sections :	2, 3, 7, 9, 15, 16

DATE ISSUED : 07/01/2004 Supersedes : 07/01/2004

All information contained in this Material Safety Data Sheet and, in particular, the health and safety and environmental information is accurate to the best of our knowledge and belief as at the date of issue specified. However, the Company makes no warranty or representation, express or implied, as to the accuracy or completeness of such information.

The provision of this Material Safety Data Sheet is not intended, of itself, to obviate the need for all users to satisfy themselves that the product described is suitable for their individual purposes and that the safety precautions and environmental advice are adequate for their individual purposes and situation. Further, it is the user's obligation to use this product safely and to comply with all applicable laws and regulations concerning the use of the product.

The company accepts no responsibility for any injury, loss or damage, consequent upon any failure to follow the safety and other recommendations contained in this Material Safety Data Sheet, nor from any hazards inherent in the nature of the material, nor from any abnormal use of the material.

"Data sheet prepared by TEXACO BELGIUM N.V.

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Fax : +/32/9/240 7340"

Version nr : 1.10

MATERIAL SAFETY DATA SHEET

"READ AND UNDERSTAND MATERIAL SAFETY DATA SHEET
BEFORE HANDLING OR DISPOSING OF PRODUCT"

33115 MEROPA WM 320

1. PRODUCT AND COMPANY NAME

PRODUCT CODE AND NAME
33115 MEROPA WM 320
DESCRIPTION
Gear Lubricant
COMPANY
TEXACO PETROLIFERA S.A.
C.Villa de Madrid 34
Pol. Ind. Fuente del Jarro
46988 Paterna (Valencia)
SPAIN
Tel : 0034/96132 2361
Fax : 0034/96132 3704
Emergency Phone Number : 0044/(0)18 65 407 333

2. COMPOSITION/INFORMATION ON INGREDIENTS

Name	% Wt	CAS No.	EC No.
Residual oils (petroleum), solvent-dewaxed	65 - 79,99	64742-62-7	265-166-0
Distillates (petroleum), solvent-dewaxed heavy paraffinic	20 - 34,99	64742-65-0	265-169-7
Olefin sulphide	< 2	CBI	CBI
R 53 May cause long-term adverse effects in the aquatic environment.			
Phosphoric acid ester amine salt	< 2,5	CBI	CBI

N R 51/53 Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

(IP 346 DMSO extract < 3%)

3. HAZARDS IDENTIFICATION

Product classification
Product is not classified as dangerous according to Directive 1999/45/EC.

Acute effects of exposure to man

Inhalation
Vapours or mist in unusually high concentrations, as from exposure in poorly ventilated areas or confined spaces, may cause irritation of the nose and throat, headache, nausea, and drowsiness.

Skin contact
Brief contact is not irritating. Prolonged contact, as with clothing wetted with material, may cause defatting of skin or irritation, seen as local redness with possible mild discomfort.

Eye contact
May cause minimal irritation, experienced as temporary discomfort.

Ingestion
No adverse effects expected. If more than

	several mouthfuls are swallowed, abdominal discomfort, nausea, and diarrhoea may occur.
Chronic effects of exposure to man	
Medical conditions aggravated by exposure	Because of its defatting properties, prolonged and repeated skin contact may aggravate an existing dermatitis (skin condition).
Effects of exposure to the environment	May form an oil film leading to deoxygenation of water and possible harmful effects on aquatic life.

4. FIRST AID MEASURES

Route of exposure	
Inhalation	If irritation, headache, nausea, or drowsiness occurs, remove to fresh air. Get medical attention if breathing becomes difficult or symptoms persist.
Skin contact	Wash skin with plenty of soap and water for several minutes. Get medical attention if skin irritation develops or persists.
Eye contact	Flush eyes with plenty of water for several minutes. Get medical attention if eye irritation persists.
Ingestion	Do not induce vomiting. Get medical attention. Never give anything by mouth to an unconscious or convulsing person.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	Use water fog, dry powder, foam or carbon dioxide. Use water to cool fire-exposed containers. If a leak or spill has not ignited, use water fog to disperse the vapours and to provide protection for personnel attempting to stop the leak.
Extinguishing media which must not be used for safety reasons	Water jet
Special exposure hazards arising from the substance or preparation itself, combustion products, resulting gases	None
Special protective equipment for firefighters	The nature of special protective equipment required will depend upon the size of the fire, the degree of confinement of the fire and the natural ventilation available. Fire-resistant clothing and self-contained breathing apparatus is recommended forfires in confined spaces and

	poorly-ventilated areas. Full fire-proof clothing is recommended for any large fires involving this product. In case of fire - Always call the fire brigade. Small fires, such as those capable of being fought with ahand-held extinguisher, can normally be fought by a person who has received instruction on the hazards of flammable liquid fires. Fires that are beyond that stage should only be tackled by people who have received hands-on training. Ensure escape pathis available.

6. ACCIDENTAL RELEASE MEASURES

Procedures in case of accidental release or leakage	Contain spill if possible. Wipe up or absorb on suitable material and shovel up. Prevent liquid or runoff from entering waterways and sewer systems.

7. HANDLING AND STORAGE

Handling	Avoid prolonged or repeated contact with skin. Avoid breathing vapours.
Storage	Store in the original container securely closed and at room temperature.
Specific use (s)	For intended product uses please refer to the Product Information Leaflet (PIL)

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Respiratory protection	Airborne concentrations should be kept to lowest levels possible. If vapour or mist is generated, use approved respirator as appropriate. Supplied air respiratory protection should be used for cleaning large spills or upon entry into tanks, vessels, or other confined spaces.
Hand and skin protection	Exposed employees should exercise reasonable personal cleanliness. This includes cleansing exposed skin areas several times daily with soap and water, and laundering or dry cleaning soiled work clothing.
Eye protection	Chemical type goggles or face shield recommended to prevent eye contact.
Exposure limit for the product	Oil mist, mineral (excluding metalworking fluids) : TWA : 5 mg/m3 ; STEL : 10 mg/m3

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	Clear liquid
Odour	Mineral oil
Flash point (ASTM D92), °C	250
Relative density	0.895 kg/L @ 15 °C
Viscosity	min 300 mm2/s @ 40 °C

10. STABILITY AND REACTIVITY

Materials to avoid	Strong oxidising agents.
Hazardous decomposition products	Oxides of carbon, aldehydes and ketones.

11. TOXICOLOGICAL INFORMATION

Acute

Inhalation	High concentrations of vapours or mist are likely to be irritating to the respiratory tract and may cause nausea, dizziness, headaches and drowsiness.
Skin contact	Slightly irritating to the skin.
Eye contact	Unlikely to cause more than transient stinging or redness if accidental eye contact occurs.
Ingestion	Unlikely to cause harm if accidentally swallowed in small doses, though larger quantities may cause nausea and diarrhoea.
Chronic	Repeated skin contact may cause a persistent irritation or dermatitis.

12. ECOLOGICAL INFORMATION

Mobility	Spillages may penetrate the soil causing ground water contamination.
Persistence and degradability	According to EC criteria : Not readily biodegradable
Potential to bioaccumulate	Considered unlikely to bioaccumulate.
Aquatic toxicity	Not classified as toxic.
Remarks	Believed not to represent a long-term danger to the aquatic environment. WGK=1

13. DISPOSAL CONSIDERATIONS

Disposal	Dispose in accordance with local laws and regulations governing disposal of waste oil. EWC-Nr. : 13 02 05

14. TRANSPORT INFORMATION

transport	Not regulated

15. REGULATORY INFORMATION

Classification/Labelling information	Under the criteria of Directive EEC/67/548 (dangerous substances) and EEC/1999/45 (dangerous preparations) : Not classified

16. OTHER INFORMATION

Full text of risk phrases	R 53 May cause long-term adverse effects in the aquatic environment. N R 51/53 Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
Changes were made in sections :	2, 3, 7, 9, 15, 16

DATE ISSUED : 07/01/2004 Supersedes : 07/01/2004

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The provision of this Material Safety Data Sheet is not intended, of itself, to obviate the need for all users to satisfy themselves that the product described is suitable for their individual purposes and that the safety precautions and environmental advice are adequate for their individual purposes and situation. Further, it is the user's obligation to use this product safely and to comply with all applicable laws and regulations concerning the use of the product.

The company accepts no responsibility for any injury, loss or damage, consequent upon any failure to follow the safety and other recommendations contained in this Material Safety Data Sheet, nor from any hazards inherent in the nature of the material, nor from any abnormal use of the material.

"Data sheet prepared by TEXACO BELGIUM N.V.

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Version nr : 1.12

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MATERIAL IDENTITY
Product code and name:
2324M MEROPA 320
Chemical name and/or family or decription:
Gear Oils
Manufacturer's name and address:
PRODUCTOS TEXACO S.A. de C.V.

Oriente 171-401, Aragon Inguaran
07820, Mexico D.F., Mexico
Telephone numbers:
Transportation emergency:
525-751-0600
CHEMTREC (USA): (800) 424-9300
Health emergency-Company: (504) 680-1900
MSDS Assistance (USA):(845)838-7204
Technical Information - Fuels, Fuel Additives: (845) 838-7611
Technical Information - Coolants: (845) 838-7444

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2. COMPOSITION/INFORMATION ON INGREDIENTS

Product and/or component(s)
Carcinogenic According to:

NONE

-

Name	Cas nr	Range in %
Solvent-dewaxed heavy paraffinic petroleum distillates	64742-65-0	20 - 34.99

5.00 mg/m3 TWA-OSHA (MINERAL OIL MIST)

5.00 mg/m3 TWA-ACGIH (MINERAL OIL MIST)
10.00 mg/m3 STEL ACGIH (MINERAL OIL MIST)

64742-62-7 65 - 79.99

Solvent-dewaxed petroleum residual oil

5.00 mg/m3 TWA-OSHA (MINERAL OIL MIST)
5.00 mg/m3 TWA-ACGIH (MINERAL OIL MIST)
10.00 mg/m3 STEL ACGIH (MINERAL OIL MIST)

PRODUCT IS NON-HAZARDOUS ACCORDING TO OSHA (1910.1200).

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3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW
WARNING STATEMENT
NONE CONSIDERED NECESSARY
PRECAUTIONARY MEASURES:
-Avoid prolonged breathing of vapor, mist, or gas.
-Workers should wash exposed skin several times daily with soap and water.
HMIS

Health:	0
Flammability:	1
Reactivity:	0
Special:	-

NFPA

Health:	0
Flammability:	1
Reactivity	0
Special:	-

Primary Route of Exposure:
EYES
SKIN
INHALATION
EFFECTS OF OVEREXPOSURE
Acute:
Eyes:
May cause minimal irritation, experienced as temporary discomfort.
Skin:
Brief contact is not irritating. Prolonged contact, as with clothing wetted with material, may cause defatting of skin or irritation, seen as local redness with possible mild discomfort.
Other than the potential skin irritation effects noted above, acute (short term) adverse effects

are not expected from brief skin contact, see other effects, below, and Section 11 for information regarding potential long term effects.
Inhalation:
Vapors or mist, in excess of permissible concentrations, or in unusually high concentrations generated from spraying, heating the material or as from exposure in poorly ventilated areas or confined spaces, may cause irritation of the nose and throat, headache, nausea, and drowsiness.
Ingestion:
If more than several mouthfuls are swallowed, abdominal discomfort, nausea, and diarrhea may occur.
Sensitization Properties:
Unknown.
Chronic:
No adverse effects have been documented in humans as a result of chronic exposure. Section 11 may contain applicable animal data.
Medical Conditions Aggravated by Over Exposure:
Because of its defatting properties, prolonged and repeated skin contact may aggravate an existing dermatitis (skin condition).
Other Remarks:
When overheated, product may release hydrogen sulfide (H2S) gas. H2S concentrations above permissible concentrations can cause irritation of the eyes and respiratory tract, headache, dizziness, nausea, vomiting, diarrhea and pulmonary edema. At concentrations above 300 ppm, respiratory paralysis, causing unconsciousness and death, can occur.

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4. FIRST AID MEASURES

Eyes:
Flush eyes with plenty of water for several minutes. Get medical attention if eye irritation persists.
Skin:
Wash skin with plenty of soap and water for several minutes. Get medical attention if skin irritation develops or persists.
Ingestion:
If more than several mouthfuls of this material are swallowed, give two glasses of water (16 oz.). Get medical attention.
Inhalation:
If irritation, headache, nausea, or drowsiness occurs, remove to fresh air. Get medical attention if breathing becomes difficult or respiratory irritation persists.
Other Instructions:
Remove and dry-clean or launder clothing soaked or soiled with this material before reuse. Dry cleaning of contaminated clothing may be more effective than normal laundering. Inform individuals responsible for cleaning of potential hazards associated with handling contaminated clothing.
Note to Physician:
None

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5. FIRE-FIGHTING MEASURES

Ignition Temperature - AIT (degrees C):
Not determined.
Flash Point (degrees C):
238 (COC)
Flammable Limits (%):
Recommended Fire Extinguishing Agents and Special Procedures:

Use water spray, dry chemical, foam, or carbon dioxide to extinguish flames. Use water spray to cool fire-exposed containers. Water or foam may cause frothing.
Unusual or Explosive Hazards:
Hydrogen sulfide (H2S) may be released if overheated.
Extinguishing Media Which Must Not be Used:
Not evaluated.
Special Protective Equipment for Firefighters:
Other than normal protective fire-fighting equipment, no special equipment or procedures required.
FIRE:
In case of fire, use water spray, dry chemical, foam or carbon dioxide. Water may cause frothing. Use water spray to cool fire-exposed containers.

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6. ACCIDENTAL RELEASE MEASURES

Procedures in Case of Accidental Release, Breakage or Leakage:
Ventilate area. Avoid breathing vapor. Wear appropriate personal protective equipment, including appropriate respiratory protection. Contain spill if possible. Wipe up or absorb on suitable material and shovel up. Prevent entry into sewers and waterways. Avoid contact with skin, eyes or clothing.

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7. HANDLING AND STORAGE

Precautions to be Taken in
Handling:
Minimum feasible handling temperatures should be maintained.
Storage:
Periods of exposure to high temperatures should be minimized. Water contamination should be avoided.

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8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Protective Equipment (Type)
Eye/Face Protection:
Safety glasses, chemical type goggles, or face shield recommended to prevent eye contact.
Skin Protection:
Workers should wash exposed skin several times daily with soap and water. Soiled work clothing should be laundered or dry-cleaned.
Respiratory Protection:
Airborne concentrations should be kept to lowest levels possible. If vapor, mist or dust is generated and the occupational exposure limit of the product, or any component of the product, is exceeded, use appropriate NIOSH or MSHA approved air purifying or air supplied respirator after determining the airborne concentration of the contaminant. Air supplied respirators should always be worn when airborne concentration of the contaminant or oxygen content is unknown.
Ventilation:
Adequate to meet component occupational exposure limits (see Section 2).
Exposure Control for Total Product:
None established for product, refer to Section 2 for component exposure limits.

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9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Dark red liquid
Odor:	Petroleum odor
Boiling Point (degrees C):	Not determined.
Melting/Freezing point (degrees C):	Not determined.
Specific Gravity (water=1):	.9045
pH of undiluted product:	Not applicable.
Vapor Pressure:	Not determined.
Viscosity (degrees C):	329 cSt (40)
VOC Content:	Not determined.
Vapor Density (air=1):	Not determined.
Solubility in Water (%):	Not determined.
Other:	None

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10. STABILITY AND REACTIVITY

This material reacts violently with:
Strong Oxidizers
Comments:
Under extreme temperatures or extended storage periods, hydrogen sulfide (H2S) gas may accumulate in the head-space of container.
Products Evolved When Subjected to Heat or Combustion:
Toxic levels of carbon monoxide, carbon dioxide, irritating aldehydes and ketones, and combustion products or compounds of
sulfur (may include hydrogen sulfide)
Hazardous Polimerizations:
No

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11. TOXICOLOGICAL INFORMATION

TOXICOLOGICAL INFORMATION (ANIMAL TOXICITY DATA)
Median Lethal Dose
Oral:

LD50 Believed to be > 5.00 g/kg (rat) practically non-toxic
Inhalation:
Not determined.
Dermal:
LD50 Believed to be > 2.00 g/kg (rabbit) practically non-toxic
Irritation Index, Estimation of Irritation (Species)
Skin:
(Draize) Believed to be < .50 /8.0 (rabbit) no appreciable effect
Eyes:
(Draize) Believed to be < 15.00 /110 (rabbit) no appreciable effect
Sensitization:
Not determined.
Other:
None

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12. DISPOSAL CONSIDERATIONS

Waste Disposal Methods:
Dispose of this product in accordance with local and/or national regulations.
US/RCRA Waste Disposal Methods:
Not evaluated.
Remarks:
None

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13. TRANSPORT INFORMATION

DOT:	Not regulated
IMDG:	Not regulated
ICAO:	Not evaluated
TDG:	Not evaluated

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14. REGULATORY INFORMATION

Regulatory Information:
SARA 311 Hazard Categorization:
N/A
WHMIS:
Not determined
Regulatory Comments:
None.

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15. ENVIROMENTAL INFORMATION

Aquatic Toxicity:
Not determined.
Mobility:
Not determined.
Persistence and Biodegradability:
Not determined.
Potential to Bioaccumulate:
Not determined.
Remarks:
None

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16. OTHER INFORMATION

Other Information:
Definitions of Terms: OSHA - Occupational Safety and Health Administration (a regulatory and enforcement agency of safety and health in most United States industrial sectors, part of the United States Department of Labor. PEL - Permissible Exposure Limit, OSHA workplace exposure limits for hazardous materials. IARC - International Agency for Research on Cancer (part of the World Health Organization). NTP - National Toxicology Program (overseen by the United States Department of Health and Human Services), develops tests for public health regulation of toxic chemicals. ACGIH - American Conference of Government Industrial Hygienists, develops recommended exposure limits for chemical substances and physical agents. TLV - Threshold Limit Value, ACGIH term for the airborne concentration of a material to which nearly all healthy workers can be exposed without adverse effects. TLV-STEL- Short-term exposure limit, for brief exposure. (15 minutes) TLV-TWA- Time weighted average concentration, for longer exposure.(8 hours) HMIS - Hazardous Materials Identification System, developed by the National Paint and Coatings Association, numbers assigned to indicate the degree of hazard, with 0 for least severe to 4 for most severe. NFPA - National Fire Protection Association (an international organization to promote fire prevention), a hazard rating system similar to HMIS.

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17. PRODUCT LABEL

MATERIAL IDENTITY
Product code and name:
2324M MEROPA 320
-

Name	Cas nr	Range in %
Solvent-dewaxed heavy paraffinic petroleum distillates	64742-65-0	20 - 34.99
Solvent-dewaxed petroleum residual oil	64742-62-7	65 - 79.99

PRODUCT IS NON-HAZARDOUS ACCORDING TO OSHA (1910.1200).
WARNING STATEMENT
NONE CONSIDERED NECESSARY
PRECAUTIONARY MEASURES:
-Avoid prolonged breathing of vapor, mist, or gas.
-Workers should wash exposed skin several times daily with soap and water.
HMIS

Health:
0
Flammability:
1
Reactivity:
0
Special:
-

NFPA

Health:
0
Flammability:
1
Reactivity
0
Special:
-

Eyes:
Flush eyes with plenty of water for several minutes. Get medical attention if eye irritation persists.

Skin:
Wash skin with plenty of soap and water for several minutes. Get medical attention if skin irritation develops or persists.

Ingestion:
If more than several mouthfuls of this material are swallowed, give two glasses of water (16 oz.). Get medical attention.

Inhalation:
If irritation, headache, nausea, or drowsiness occurs, remove to fresh air. Get medical attention if breathing becomes difficult or respiratory irritation persists.

Note to Physician:
None

FIRE:
In case of fire, use water spray, dry chemical, foam or carbon dioxide. Water may cause frothing. Use water spray to cool fire-exposed containers.

DOT:
Not regulated

Manufacturer's name and address:
PRODUCTOS TEXACO S.A. de C.V.

Oriente 171-401, Aragon Inguaran
07820, Mexico D.F., Mexico

Telephone numbers:
Transportation emergency:
525-751-0600
Health emergency-Company:(504) 680-1900

Product Code :

Date Issued : 11/05/1999

CAUTION: Misuse of empty containers can be hazardous. Empty containers can be hazardous if used to store toxic, flammable, or reactive materials. Cutting or welding of empty containers might cause fire, explosion or toxic fumes from residues. Do not pressurize or expose to open flame or heat. Keep container closed and drum bungs in place.

THE INFORMATION CONTAINED HEREIN IS BELIEVED TO BE ACCURATE. IT IS PROVIDED INDEPENDENTLY OF ANY SALE OF THE PRODUCT FOR PURPOSE OF HAZARD COMMUNICATION AS PART OF THE COMPANY'S PRODUCT STEWARDSHIP PROGRAM. IT IS NOT INTENDED TO CONSTITUTE PERFORMANCE INFORMATION CONCERNING THE PRODUCT. NO EXPRESS WARRANTY, OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE IS MADE WITH RESPECT TO THE PRODUCT OR THE INFORMATION CONTAINED HEREIN. DATA SHEETS ARE AVAILABLE FOR ALL THE COMPANY'S PRODUCTS. YOU ARE URGED TO OBTAIN DATA SHEETS FOR ALL THE COMPANY'S PRODUCTS YOU BUY, PROCESS, USE OR DISTRIBUTE AND YOU ARE ENCOURAGED AND REQUESTED TO ADVISE THOSE WHO MAY COME IN CONTACT WITH SUCH PRODUCTS OF THE INFORMATION CONTAINED HEREIN. TO DETERMINE APPLICABILITY OR EFFECT OF ANY LAW OR REGULATION WITH RESPECT TO THE PRODUCT, USER SHOULD CONSULT HIS LEGAL ADVISOR OR THE APPROPRIATE GOVERNMENT AGENCY. THE COMPANY DOES NOT UNDERTAKE TO FURNISH ADVICE ON SUCH MATTERS.

TEXACO MEROPA®

68, 100, 150, 220, 320, 460, 680, 1000, 1500, 3200

CUSTOMER BENEFITS

Texaco Meropa oils deliver value through:

- **Gear set efficiencies** — High thermal stability EP system maintains clean gear and bearing surfaces, minimizing deposits which interfere with effective lubrication. High oxidation stability limits in-service viscosity increases, which lead to energy losses.
- **Extended equipment life** — Extremely effective EP system forms a protective film in areas of metal-to-metal contact, minimizing wear rates and maintaining efficient transfer of power. Good water separation and effective rust inhibitors protect surfaces against rust and corrosion. High thermal stability additive system reduces the formation of high temperature compounds which can be corrosive to bearing materials. The effective corrosion inhibitor provides additional protection for metal components.
- **Long oil life** — Effective oxidation inhibitors and copper passivator minimize oil oxidation, limiting viscosity increase and extending oil drain intervals.

FEATURES

Texaco Meropa oils are high performance, multipurpose gear lubricants designed for industrial gear lubrication services where loads and shock loadings are high.

When used in misting systems, Texaco Meropa provides excellent oxidation stability to prevent oil mist deposits. They will form a high volume of mist droplets for transmission to the point of application. Texaco Meropa oils have minimal stray mist (fog).

APPLICATIONS

Texaco Meropa oils are recommended for:

- all industrial enclosed gearing and wherever an AGMA extreme pressure lubricant is specified
- all mist oil application systems
- general industrial plant lubrication where the performance properties of this type of lubricant are required

Texaco Meropa meet the requirements of:

- **U.S. Steel** 224 (ISO 68, 100, 150, 220, 320, 460, 680)
- **AGMA** 9005 (ISO 68, 100, 150, 220, 320, 460, 680, 1000, 1500)
- **Cincinnati Machine** P 63 (ISO 68), P 76 (ISO 100), P 77 (ISO 150), P 74 (ISO 220), P-59 (ISO 320), P-35 (ISO 460), P 78 (ISO 1000)

Texaco Meropa oils (ISO 68, 100, 150, 220, 320, 460) are suitable for use in **Bijur** oil application equipment.

For customers wishing to extend drain intervals and further reduce gear wear, and where water contamination is minimal, Texaco Meropa oils is recommended. Texaco Meropa oils can be used in industrial applications where overloading, severe operating conditions, high lubricant operating temperatures, or other problems are encountered. Texaco Meropa oils have been shown to reduce operating temperatures, power consumption/energy requirements, and failure rates in industrial operating environments.

A ChevronTexaco Company

2 October 2002

GL-2240

Typical Test Data

ISO Grade	68	100	150	220	320
CPS Number	*222319*	*222601*	*222320*	*222321*	*222324*
MSDS Number	*8642*	*8642*	*8642*	*8642*	*8642*
AGMA Grade	2 EP	3 EP	4 EP	5 EP	6 EP
API Gravity	31.0	30.6	29.7	28.4	27.3
Viscosity, Kinematic cSt at 40°C cSt at 100°C	 64.6 8.6	 95.0 11.0	 142 14.4	 209 18.8	 304 23.2
Viscosity, Saybolt SUS at 100°F SUS at 210°F	 334 55	 495 64	 744 77	 1102 96	 1618 116
Viscosity Index	104	100	100	100	95
Flash Point,°C(°F)	225(437)	225(437)	240(464)	245(473)	245(473)
Pour Point,°C(°F)	-33(-27)	-30(-22)	-30(-22)	-21(-5)	-18(0)
Timken OK Load, lb	65	65	65	65	65
FZG Pass Stage, ASTM D 5182	12	12	12	12	12

ISO Grade	460	680	1000	1500	3200
CPS Number	*222325*	*222342*	*222343*	*222344*	*222349*
MSDS Number	*8642*	*8642*	*8642*	*8642*	*8642*
AGMA Grade	7 EP	8 EP	8A EP	9 EP	10
API Gravity	26.3	26.0	25.9	25.7	25.3
Viscosity, Kinematic cSt at 40°C cSt at 100°C	 437 29.4	 646 39.8	 950 53.9	 1425 74.0	 3200 84.2
Viscosity, Saybolt SUS at 100°F SUS at 210°F	 2341 144	 3467 194	 5115 262	 7699 359	 18,040 411
Viscosity Index	95	100	107	114	77
Flash Point,°C(°F)	245(473)	260(500)	260(500)	260(500)	141(286)
Pour Point,°C(°F)	-15(+5)	-12(+10)	-12(+10)	-12(+10)	0(+18)
Timken OK Load, lb	65	65	65	65	65
FZG Pass Stage, ASTM D 5182	12	> 12	> 12	> 12	> 12

Typical test data are average values only. Minor variations which do not affect product performance are to be expected in normal manufacturing.

MATERIAL SAFETY DATA SHEET

"READ AND UNDERSTAND MATERIAL SAFETY DATA SHEET
BEFORE HANDLING OR DISPOSING OF PRODUCT"

02081 PINNACLE EP 320

1. PRODUCT AND COMPANY NAME

PRODUCT CODE AND NAME
02081 PINNACLE EP 320
DESCRIPTION
Gear Lubricant
COMPANY
TEXACO PETROLIFERA S.A.
C.Villa de Madrid 34
Pol. Ind. Fuente del Jarro
46988 Paterna (Valencia)
SPAIN
Tel : 0034/96132 2361
Fax : 0034/96132 3704
Emergency Phone Number : 0044/(0)18 65 407 333

2. COMPOSITION/INFORMATION ON INGREDIENTS

Name	% Wt	CAS No.	EC No.
Olefin sulphide	< 25	CBI	CBI
R 53 May cause long-term adverse effects in the aquatic environment.			
Phosphoric acid ester amine salt	< 2,5	CBI	CBI
N R 51/53 Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.			

3. HAZARDS IDENTIFICATION

Product classification
Product is not classified as dangerous according to Directive 1999/45/EC.

Acute effects of exposure to man

Inhalation
Vapours or mist in unusually high concentrations, as from exposure in poorly ventilated areas or confined spaces, may cause irritation of the nose and throat, headache, nausea, and drowsiness.

Skin contact
Brief contact is not irritating. Prolonged contact, as with clothing wetted with material, may cause defatting of skin or irritation, seen as local redness with possible mild discomfort.

Eye contact
May cause minimal irritation, experienced as temporary discomfort.

Ingestion
No adverse effects expected. If more than several mouthfuls are swallowed, abdominal discomfort, nausea, and diarrhoea may occur.

Chronic effects of exposure to man

Medical conditions aggravated by exposure
Because of its defatting properties, prolonged and repeated skin contact may aggravate an existing dermatitis (skin condition).

Effects of exposure to the environment	May form an oil film leading to deoxygenation of water and possible harmful effects on aquatic life.

4. FIRST AID MEASURES

Route of exposure	
Inhalation	If irritation, headache, nausea, or drowsiness occurs, remove to fresh air. Get medical attention if breathing becomes difficult or symptoms persist.
Skin contact	Wash skin with plenty of soap and water for several minutes. Get medical attention if skin irritation develops or persists.
Eye contact	Flush eyes with plenty of water for several minutes. Get medical attention if eye irritation persists.
Ingestion	Do not induce vomiting. Get medical attention. Never give anything by mouth to an unconscious or convulsing person.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	Use water fog, dry powder, foam or carbon dioxide. Use water to cool fire-exposed containers. If a leak or spill has not ignited, use water fog to disperse the vapours and to provide protection for personnel attempting to stop the leak.
Extinguishing media which must not be used for safety reasons	Water jet
Special exposure hazards arising from the substance or preparation itself, combustion products, resulting gases	None
Special protective equipment for firefighters	The nature of special protective equipment required will depend upon the size of the fire, the degree of confinement of the fire and the natural ventilation available. Fire-resistant clothing and self-contained breathing apparatus is recommended forfires in confined spaces and poorly-ventilated areas. Full fire-proof clothing is recommended for any large fires involving this product. In case of fire - Always call the fire brigade. Small fires, such as those capable of being fought with ahand-held extinguisher, can normally be fought by a person who has received instruction on the hazards of

	flammable liquid fires. Fires that are beyond that stage should only be tackled by people who have received hands-on training. Ensure escape pathis available.

6. ACCIDENTAL RELEASE MEASURES

Procedures in case of accidental release or leakage	Contain spill if possible. Wipe up or absorb on suitable material and shovel up. Prevent liquid or runoff from entering waterways and sewer systems.

7. HANDLING AND STORAGE

Handling	Avoid prolonged or repeated contact with skin. Avoid breathing vapours.
Storage	Keep containers closed when not in use. Store at ambient temperature.
Specific use (s)	For intended product uses please refer to the Product Information Leaflet (PIL)

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Respiratory protection	Airborne concentrations should be kept to lowest levels possible. If vapour, mist or dust is generated, use approved respirator as appropriate. Supplied air respiratory protection should be used for cleaning large spills or upon entry into tanks,vessels, or other confined spaces.
Hand and skin protection	Exposed employees should exercise reasonable personal cleanliness. This includes cleansing exposed skin areas several times daily with soap and water, and laundering or dry cleaning soiled work clothing.
Eye protection	Chemical type goggles or face shield recommended to prevent eye contact.
Exposure limit for the product	None established for product.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	Clear liquid
Odour	Mineral oil
Flash point (ASTM D92), °C	240
Relative density	0.855 kg/L @ 15 °C
Viscosity	288 mm2/s @ 40 °C

10. STABILITY AND REACTIVITY

Materials to avoid	Strong oxidising agents.
Hazardous decomposition products	Oxides of carbon, aldehydes and ketones.

11. TOXICOLOGICAL INFORMATION

Acute

Inhalation	High concentrations of vapours or mist are likely to be irritating to the respiratory tract and may cause nausea, dizziness, headaches and drowsiness.
Skin contact	Slightly irritating to the skin.
Eye contact	Unlikely to cause more than transient stinging or redness if accidental eye contact occurs.
Ingestion	Unlikely to cause harm if accidentally swallowed in small doses, though larger quantities may cause nausea and diarrhoea.
Chronic	Repeated skin contact may cause a persistent irritation or dermatitis.

12. ECOLOGICAL INFORMATION

Mobility	Spillages may penetrate the soil causing ground water contamination.
Persistence and degradability	According to EC criteria : Not readily biodegradable
Potential to bioaccumulate	Considered unlikely to bioaccumulate.
Aquatic toxicity	Not classified as toxic.

13. DISPOSAL CONSIDERATIONS

Disposal	Dispose in accordance with local laws and regulations governing disposal of waste oil.

14. TRANSPORT INFORMATION

transport	Not regulated

15. REGULATORY INFORMATION

Classification/Labelling information	Under the criteria of Directive EEC/67/548 (dangerous substances) and EEC/1999/45 (dangerous preparations) :

Not classified

16. OTHER INFORMATION

Full text of risk phrases	R 53 May cause long-term adverse effects in the aquatic environment. N R 51/53 Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
Changes were made in sections :	2, 3, 7, 9, 15, 16

DATE ISSUED : 07/01/2004 Supersedes : 07/01/2004

All information contained in this Material Safety Data Sheet and, in particular, the health and safety and environmental information is accurate to the best of our knowledge and belief as at the date of issue specified. However, the Company makes no warranty or representation, express or implied, as to the accuracy or completeness of such information.

The provision of this Material Safety Data Sheet is not intended, of itself, to obviate the need for all users to satisfy themselves that the product described is suitable for their individual purposes and that the safety precautions and environmental advice are adequate for their individual purposes and situation. Further, it is the user's obligation to use this product safely and to comply with all applicable laws and regulations concerning the use of the product.

The company accepts no responsibility for any injury, loss or damage, consequent upon any failure to follow the safety and other recommendations contained in this Material Safety Data Sheet, nor from any hazards inherent in the nature of the material, nor from any abnormal use of the material.

"Data sheet prepared by TEXACO BELGIUM N.V.

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B-9052 Gent / Zwijnaarde (Belgium)
Tel. : +/32/9/240 7352
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Version nr : 1.09

MATERIAL SAFETY DATA SHEET

Revision Date: 10/23/2003

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT: AEROSHELL® Grease 14

MSDS NUMBER: 56200E - 9

PRODUCT CODE(S): 70014

MANUFACTURER ADDRESS:SOPUS Products, P.O. Box 4453, Houston, TX. 77210-4453

TELEPHONE NUMBERS

Spill Information: (877) 242-7400

Health Information: (877) 504-9351

MSDS Assistance Number: (877) 276-7285

MILSPEC: MIL-G-25537C

SECTION 2 PRODUCT/INGREDIENTS

CAS#	CONCENTRATION	INGREDIENTS
		Aviation Grease
Mixture	85 - 94.99 %weight	Highly refined petroleum oils
Proprietary	5 - 14.99 %weight	Grease Thickener
Mixture	1 - 2.99 %weight	Additives

SECTION 3 HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Appearance & Odor: Tan grease. Slight Hydrocarbon Odor.

Health Hazards: No known immediate health hazards. High-pressure injection under the skin may cause serious damage.

Physical Hazards: No known physical hazards.

NFPA Rating (Health, Fire, Reactivity): 0, 1, 0

Hazard Rating:Least - 0 Slight - 1 Moderate - 2 High - 3 Extreme - 4

Inhalation:
Inhalation of vapors (generated at high temperatures only) or oil mist may cause mild irritation of the nose, throat, and respiratory tract.

Eye Irritation:
Lubricating greases are generally considered no more than minimally irritating to the eyes.

Skin Contact:
Lubricating greases are generally considered no more than minimally irritating to the skin. Prolonged and repeated contact may result in defatting and drying of the skin that may cause various skin disorders such as dermatitis, folliculitis or oil acne. Release of the material during high-pressure applications may result in injection under the skin causing possible extensive tissue damage which is difficult to heal.

Ingestion:
Lubricating greases are generally no more than slightly toxic if swallowed.

Signs and Symptoms:
Local necrosis is evidenced by delayed onset of pain and tissue damage a few hours following injection.

Aggravated Medical Conditions:
Pre-existing eye, skin and respiratory disorders may be aggravated by exposure to this product.

For additional health information, refer to section 11.

SECTION 4 FIRST AID MEASURES

Inhalation:
Remove victim to fresh air and provide oxygen if breathing is difficult. Get medical attention.

Skin:
Remove contaminated clothing and shoes and wipe excess from skin. Flush skin with water, then wash with soap and water. If irritation occurs, get medical attention. Do not reuse clothing until cleaned. If material is injected under the skin, transport to the nearest medical facility for additional treatment.

Eye:

Flush with water. If irritation occurs, get medical attention.

Ingestion:
DO NOT induce vomiting. In general no treatment is necessary unless large quantities are swallowed, however, get medical advice.

SECTION 5 FIRE FIGHTING MEASURES

Flash Point [Method]: >590 ºF/>310 ºC [Pensky-Martens Closed Cup]

Extinguishing Media:
Material will float and can be re-ignited on surface of water. Use water fog, 'alcohol foam', dry chemical or carbon dioxide (CO2) to extinguish flames. Do not use a direct stream of water.

Fire Fighting Instructions:
Material will not burn unless preheated. Do not enter confined fire space without full bunker gear (helmet with face shield, bunker coats, gloves and rubber boots), including a positive pressure, NIOSH approved, self-contained breathing apparatus.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Protective Measures:
May burn although not readily ignitable.

Spill Management:
Scoop up excess grease. Clean area with appropriate cleaner.

Reporting:
CERCLA: Product is covered by EPA's Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) petroleum exclusion. Releases to air, land, or water are not reportable under CERCLA (Superfund).

CWA: This product is an oil as defined under Section 311 of EPA's Clean Water Act (CWA). Spills into or leading to surface waters that cause a sheen must be reported to the National Response Center, 1-800-424-8802.

SECTION 7 HANDLING AND STORAGE

Precautionary Measures:
Avoid heat, open flames, including pilot lights, and strong oxidizing agents. Use explosion-proof ventilation to prevent vapor accumulation. Ground all handling equipment to prevent sparking.

Handling:
Wash with soap and water before eating, drinking, smoking, applying cosmetics, or using toilet. Launder contaminated clothing before reuse. Properly dispose of contaminated leather articles such as shoes or belts that cannot be decontaminated. Contaminated leather articles including shoes cannot be decontaminated and should be destroyed to prevent reuse.

Storage:
Store in a cool, dry place with adequate ventilation. Keep away from open flames and high temperatures.

Container Warnings:
Keep containers closed when not in use. Containers, even those that have been emptied, can contain explosive vapors. Do not cut, drill, grind, weld or perform similar operations on or near containers.

SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION

EXPOSURE CONTROLS

Adequate ventilation to control airborne concentrations below the exposure guidelines/limits.

PERSONAL PROTECTION

Personal protective equipment (PPE) selections vary based on potential exposure conditions such as handling practices, concentration and ventilation. Information on the selection of eye, skin and respiratory protection for use with this material is provided below.

Eye Protection:
Safety glasses with side shields

Skin Protection:
Use protective clothing which is chemically resistant to this material.
Selection of protective clothing depends on potential exposure conditions and

may include gloves, boots, suits and other items. The selection(s) should take into account such factors as job task, type of exposure and durability requirements.

Published literature, test data and/or glove and clothing manufacturers indicate the best protection is provided by:
Neoprene, or Nitrile Rubber

Respiratory Protection:
If engineering controls do not maintain airborne concentrations to a level which is adequate to protect worker health, an approved respirator must be worn. Respirator selection, use and maintenance should be in accordance with the requirements of the OSHA Respiratory Protection Standard, 29 CFR 1910.134.

Types of respirator(s) to be considered in the selection process include:
For Vapors: Air Purifying, R or P style prefilter & organic cartridge, NIOSH approved respirator. Self-contained breathing apparatus for use in environments with unknown concentrations or emergency situations.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Appearance & Odor: Tan grease. Slight Hydrocarbon Odor.
Substance Chemical Family: Lubricants
Appearance: Tan grease.

Density: 7.3 lb/gal

Drop Point: 284 ºF

Flash Point: > 590 ºF [Pensky-Martens Closed Cup]

Penetration Unworked: 200 - 267

Specific Gravity: 0.876

SECTION 10 REACTIVITY AND STABILITY

Stability:
Material is stable under normal conditions.

Conditions to Avoid:

Avoid heat and open flames.

Materials to Avoid:
Avoid contact with strong oxidizing agents.

Hazardous Decomposition Products:
Thermal decomposition products are highly dependent on combustion conditions.
A complex mixture of airborne solids, liquids and gases will evolve when this
material undergoes pyrolysis or combustion. Carbon Monoxide, Carbon Dioxide,
Nitrogen Oxides
and other unidentified organic compounds may be formed upon combustion.

SECTION 11 TOXICOLOGICAL INFORMATION

Acute Toxicity
  Dermal LD50 >5 g/kg(Rat) OSHA: Non-Toxic Based on components(s)
  Oral LD50 3.16 g/kg(Rabbit) OSHA: Non-Toxic Based on components(s)
Carcinogenicity Classification
Aviation Grease
  NTP: No IARC: Not Reviewed by IARC ACGIH: No OSHA: No

SECTION 12 ECOLOGICAL INFORMATION

Environmental Impact Summary:
There is no ecological data available for this product. However, this product is an oil. It is persistent and does not readily biodegrade. However, it does not bioaccumulate.

SECTION 13 DISPOSAL CONSIDERATIONS

RCRA Information:

Under RCRA, it is the responsibility of the user of the material to determine, at the time of the disposal, whether the material meets RCRA criteria for hazardous waste. This is because material uses, transformations, mixtures, processes, etc. may affect the classification. Refer to the latest EPA, state and local regulations regarding proper disposal.

SECTION 14 TRANSPORT INFORMATION

US Department of Transportation Classification
This material is not subject to DOT regulations under 49 CFR Parts 171-180.

Oil: This product is an oil under 49CFR (DOT) Part 130. If shipped by rail or highway in a tank with a capacity of 3500 gallons or more, it is subject to these requirements. Mixtures or solutions containing 10% or more of this product may also be subject to this rule.

International Air Transport Association
Not regulated under IATA rules.

International Maritime Organization Classification
Not regulated under International Maritime Organization rules.

SECTION 15 REGULATORY INFORMATION

FEDERAL REGULATORY STATUS

OSHA Classification:
Under normal conditions of use or in a foreseeable emergency, this product does not meet the definition of a hazardous chemical when evaluated according to the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

Ozone Depleting Substances (40 CFR 82 Clean Air Act):
This material does not contain nor was it directly manufactured with any Class I or Class II ozone depleting substances.

Superfund Amendment & Reauthorization Act (SARA) Title III:

There are no components in this product on the SARA 302 list.

SARA Hazard Categories (311/312):
Immediate Health:NO Delayed Health:NO Fire:NO Pressure:NO
Reactivity:NO

SARA Toxic Release Inventory (TRI) (313):
There are no components in this product on the SARA 313 list.

Toxic Substances Control Act (TSCA) Status:
All component(s) of this material is(are) listed on the EPA/TSCA Inventory of Chemical Substances.

Other Chemical Inventories:
Component(s) of this material is (are) listed on the Australian AICS, Canadian DSL, Chinese Inventory, European EINECS, Korean Inventory, Philippines PICCS,

State Regulation
This material is not regulated by California Prop 65, New Jersey Right-to-Know Chemical List or Pennsylvania Right-To-Know Chemical List. However for details on your regulation requirements you should contact the appropriate agency in your state.

SECTION 16 OTHER INFORMATION

Revision#: 9

Revision Date: 10/23/2003

Revisions since last change (discussion): This Material Safety Data Sheet (MSDS) has been newly reviewed to fully comply with the guidance contained in the ANSI MSDS standard (ANSI Z400.1-1998). We encourage you to take the opportunity to read the MSDS and review the information contained therein.

SECTION 17 LABEL INFORMATION

READ AND UNDERSTAND MATERIAL SAFETY DATA SHEET BEFORE HANDLING OR DISPOSING OF PRODUCT. THIS LABEL COMPLIES WITH THE REQUIREMENTS OF THE OSHA HAZARD COMMUNICATION STANDARD (29 CFR 1910.1200) FOR USE IN THE WORKPLACE. THIS LABEL IS NOT INTENDED TO BE USED WITH PACKAGING INTENDED FOR SALE TO CONSUMERS AND MAY NOT CONFORM WITH THE REQUIREMENTS OF THE CONSUMER PRODUCT SAFETY ACT OR OTHER RELATED REGULATORY REQUIREMENTS.

PRODUCT CODE(S): 70014

AEROSHELL® Grease 14

ATTENTION!

PROLONGED OR REPEATED SKIN CONTACT MAY CAUSE OIL ACNE OR DERMATITIS.
HIGH-PRESSURE INJECTION UNDER SKIN MAY CAUSE SERIOUS DAMAGE.

Precautionary Measures:
Avoid prolonged or repeated contact with eyes, skin and clothing. Wash thoroughly after handling.

FIRST AID

Inhalation: Remove victim to fresh air and provide oxygen if breathing is difficult. Get medical attention.
Skin Contact: Remove contaminated clothing and shoes and wipe excess from skin. Flush skin with water, then wash with soap and water. If irritation occurs, get medical attention. Do not reuse clothing until cleaned. If material is injected under the skin, transport to the nearest medical facility for additional treatment.
Eye Contact: Flush with water. If irritation occurs, get medical attention.
Ingestion: DO NOT induce vomiting. In general no treatment is necessary unless large quantities are swallowed, however, get medical advice.

FIRE

In case of fire, Use water fog, 'alcohol foam', dry chemical or carbon dioxide (CO2) to extinguish flames. Do not use a direct stream of water. Material will float and can be re-ignited on surface of water.

SPILL OR LEAK

Scoop up excess grease. Clean area with appropriate cleaner.

CONTAINS: Highly refined petroleum oils, Mixture; Grease Thickener, Proprietary; Additives, Mixture

NFPA Rating (Health, Fire, Reactivity): 0, 1, 0

TRANSPORTATION

US Department of Transportation Classification

This material is not subject to DOT regulations under 49 CFR Parts 171-180.

Oil: This product is an oil under 49CFR (DOT) Part 130. If shipped by rail or highway in a tank with a capacity of 3500 gallons or more, it is subject to these requirements. Mixtures or solutions containing 10% or more of this product may also be subject to this rule.

CAUTION: Misuse of empty containers can be hazardous. Empty containers can be hazardous if used to store toxic, flammable, or reactive materials. Cutting or welding of empty containers might cause fire, explosion or toxic fumes from residues. Do not pressurize or expose to open flames or heat. Keep container closed and drum bungs in place.

Name and Address

SOPUS Products
P.O. Box 4453
Houston, TX 77210-4453

ADMINISTRATIVE INFORMATION

MANUFACTURER ADDRESS: SOPUS Products, P.O. Box 4453, Houston, TX. 77210-4453

Company Product Stewardship & Regulatory Compliance Contact: Timothy W Childs

Phone Number: (281) 874-7708

THE INFORMATION CONTAINED IN THIS DATA SHEET IS BASED ON THE DATA AVAILABLE TO US AT THIS TIME, AND IS BELIEVED TO BE ACCURATE BASED UPON THAT : IT IS PROVIDED INDEPENDENTLY OF ANY SALE OF THE PRODUCT, FOR PURPOSE OF HAZARD COMMUNICATION. IT IS NOT INTENDED TO CONSTITUTE PRODUCT PERFORMANCE INFORMATION, AND NO EXPRESS OR IMPLIED WARRANTY OF ANY KIND IS MADE WITH

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22440-11134-100R-10/23/2003

SHELL STAMINA® GREASE HSX 2

Polyurea grease for lubrication of bearings under extreme pressure

Product Description

Stamina® Grease HSX 2 is a specially formulated polyurea grease containing a synthetic base oil and high performance corrosion and oxidation inhibitors. In addition, it also contains molybdenum disulfide ("moly") as a lubricity adjunct. This grease is especially suitable for lubrication of bearings under extreme temperature conditions.

Recommendations/Applications

Stamina Grease HSX 2 is recommended for the lubrication of bearings in equipment under adverse conditions. It is especially successful in high temperature service such as those found in dryer sections of paper machines and slow moving equipment such as stokers, coal burning boilers and municipal waste boilers. **Stamina Grease HSX 2** is also suitable for the lubrication of furnace door bearings, kiln car wheel bearings and shafts extending through furnaces. The presence of "moly" provides added lubricity protection. **Stamina Grease HSX 2** is formulated to perform well in conditions of temperature extremes.

Features

Stamina Grease HSX 2 is formulated using a polyurea thickener, special additives, and an ISO 460 synthetic base oil. It contains molybdenum disulfide and is characterized by a high dropping point (above 450°F). Stamina HSX Grease 2 exhibits excellent resistance to water, corrosion, and oxidation. It offers outstanding performance over a wide range of operating temperatures and is able to withstand extended high operating temperatures. This grease will allow bearings to start and run even at low ambient temperatures and is especially recommended where frequent equipment relubrication may be difficult or impossible to achieve in service. The combination of the synthetic base oil and the polyurea thickener reduces service hardening of the greases at prolonged elevated temperatures.

The presence of "moly" provides an extra measure of protection in shock loading situations. During heavy shock loading, the lubricant film between metal surfaces can be temporarily ruptured or squeezed out. By using a "moly" grease, a film remains to prevent metal-to-metal contact which could cause equipment damage. The presence of "moly" is also valuable in dirty environments or when proper re-greasing intervals are not followed. Some "moly" tends to stay in place and protect metal surfaces even when insufficient grease is used.

Benefits

- long bearing life
- excellent high temperature properties and oxidation stability
- superior water resistance and corrosion protection
- excellent heavy and shock loading protection

Recommendations and Approvals

Stamina Grease HSX 2 is recommended in high temperature applications, where conventional greases tend to harden such as stokers, coal burning boilers and municipal waste boilers. It is also recommended for use in heavy duty industrial applications especially where excessive exposure to high loading is problematic. Because of this **Stamina Grease HSX 2** is particularly suited in stoker and paper mill applications.

SOC: 02546-12/02

Product Maintenance

Maintaining a clean work environment is critical when equipment greasing is performed. Grease fittings should be wiped clean prior to grease injection to prevent contaminants from entering the equipment. Bearing housings should be maintained one-third to one-half full of grease. Over-greasing should be avoided as excessive heat buildup can result. Periodic relubrication via grease gun or centralized system should be supplemented by complete cleaning and packing with fresh grease on an appropriate schedule. Shell greases are available with or without drum liners to facilitate disposal in compliance with local regulations.

Typical Properties for Shell Stamina Grease HSX 2

Code No.	Test Method	71224
NLGI Grade		2
Appearance		Dark Gray
Texture		Smooth
Polyurea Thickener, Wt %	(Calc)	15.0
PAO Base Fluid Viscosity		
@ 40°C, cSt	D 445	460
@ 100°C, cSt	D 445	41.5
Penetration	D 217	
Worked, 60X		280
Worked 10,000X, % Change		20
Dropping Point, °F	Mettler	500+
Oil Separation, wt%	D 1742	0.2
Evaporation Loss, wt%	D 972	0.4
Rust Protection	D 1743	Pass
Copper Corrosion	D 4048	1b
Water Washout	D 1264	
wt% loss at 175°F		1.0
Wheel Bearing Life	D 3527	
B50, hours		300+
Guide to Usable Temperature		
Min, °F		-40
Continuous Service, Max, °F		350
Short Exposure, Max, °F		450

Handling Practices

For information on the safe handling and use of these products, refer to their Material Safety Data Sheets at **http://www.equivashellmsds.com.** For more information and availability, call **1+800-782-7852.**

Material Safety Data Sheet

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

Havoline® XLC (CL00)

Product Use: Antifreeze/Coolant
Product Number(s): 32619
Company Identification
ChevronTexaco Global Lubricants
6001 Bollinger Canyon Road
San Ramon, CA 94583
United States of America

Transportation Emergency Response
CHEMTREC: (800) 424-9300 or (703) 527-3887
Health Emergency
ChevronTexaco Emergency Information Center: Located in the USA. International collect calls accepted. (800) 231-0623 or (510) 231-0623
Product Information
email : lubemsds@chevrontexaco.com
Product Information: 800-LUBE-TEK
MSDS Requests: 800-414-6737

SECTION 2 COMPOSITION/ INFORMATION ON INGREDIENTS

COMPONENTS	CAS NUMBER	AMOUNT
Ethylene Glycol	107-21-1	80 - 95 %weight
Sodium 2-ethylhexanoate	19766-89-3	1 - 5 %weight

SECTION 3 HAZARDS IDENTIFICATION

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****
EMERGENCY OVERVIEW

- HARMFUL OR FATAL IF SWALLOWED
- CONTAINS MATERIAL THAT MAY CAUSE ADVERSE REPRODUCTIVE EFFECTS BASED ON ANIMAL DATA
- POSSIBLE BIRTH DEFECT HAZARD - CONTAINS MATERIAL THAT MAY CAUSE BIRTH DEFECTS BASED ON ANIMAL DATA
- MAY CAUSE DAMAGE TO:
- KIDNEY

****
****

IMMEDIATE HEALTH EFFECTS
Eye: Not expected to cause prolonged or significant eye irritation.
Skin: Contact with the skin is not expected to cause prolonged or significant irritation. Not expected to be harmful to internal organs if absorbed through the skin.

Ingestion: Toxic; may be harmful or fatal if swallowed.
Inhalation: The vapor or fumes from this material may cause respiratory irritation. Symptoms of respiratory irritation may include coughing and difficulty breathing. Breathing this material at concentrations above the recommended exposure limits may cause central nervous system effects. Central nervous system effects may include headache, dizziness, nausea, vomiting, weakness, loss of coordination, blurred vision, drowsiness, confusion, or disorientation. At extreme exposures, central nervous system effects may include respiratory depression, tremors or convulsions, loss of consciousness, coma or death.

DELAYED OR OTHER HEALTH EFFECTS:
Reproduction and Birth Defects: Contains material that may cause adverse reproductive effects based on animal data. Contains material that may cause birth defects based on animal data.
Target Organs: Contains material that may cause damage to the following organ(s) following repeated ingestion based on animal data: Kidney
See Section 11 for additional information. Risk depends on duration and level of exposure.

SECTION 4 FIRST AID MEASURES

Eye: No specific first aid measures are required. As a precaution, remove contact lenses, if worn, and flush eyes with water.
Skin: No specific first aid measures are required. As a precaution, remove clothing and shoes if contaminated. To remove the material from skin, use soap and water. Discard contaminated clothing and shoes or thoroughly clean before reuse.
Ingestion: If swallowed, get immediate medical attention. Do not induce vomiting. Never give anything by mouth to an unconscious person.
Inhalation: Move the exposed person to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if breathing difficulties continue.

SECTION 5 FIRE FIGHTING MEASURES

FIRE CLASSIFICATION:
OSHA Classification (29 CFR 1910.1200): Not classified by OSHA as flammable or combustible.

NFPA RATINGS: Health: 2 Flammability: 1 Reactivity: 0

FLAMMABLE PROPERTIES:
Flashpoint: (Pensky-Martens Closed Cup) 127 °C (260 °F)
Autoignition: No Data Available
Flammability (Explosive) Limits (% by volume in air): Lower: 3.2 Upper:

EXTINGUISHING MEDIA: Dry Chemical, CO2, AFFF Foam or alcohol resistant foam.

PROTECTION OF FIRE FIGHTERS:
Fire Fighting Instructions: This material will burn although it is not easily ignited. For fires involving this material, do not enter any enclosed or confined fire space without proper protective equipment, including self-contained breathing apparatus.
Combustion Products: Highly dependent on combustion conditions. A complex mixture of airborne solids, liquids, and gases including carbon monoxide, carbon dioxide, and unidentified organic compounds will be evolved when this material undergoes combustion.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Protective Measures: Eliminate all sources of ignition in vicinity of spilled material.
Spill Management: Stop the source of the release if you can do it without risk. Contain release to prevent further contamination of soil, surface water or groundwater. Clean up spill as soon as

possible, observing precautions in Exposure Controls/Personal Protection. Use appropriate techniques such as applying non-combustible absorbent materials or pumping. Where feasible and appropriate, remove contaminated soil. Place contaminated materials in disposable containers and dispose of in a manner consistent with applicable regulations.
Reporting: Report spills to local authorities and/or the U.S. Coast Guard's National Response Center at (800) 424-8802 as appropriate or required.

SECTION 7 HANDLING AND STORAGE

Precautionary Measures: Do not breathe vapor or fumes. Wash thoroughly after handling.
General Handling Information: Do not taste or swallow antifreeze or solution. Keep out of the reach of children and animals.
Static Hazard: Electrostatic charge may accumulate and create a hazardous condition when handling this material. To minimize this hazard, bonding and grounding may be necessary but may not, by themselves, be sufficient. Review all operations which have the potential of generating and accumulating an electrostatic charge and/or a flammable atmosphere (including tank and container filling, splash filling, tank cleaning, sampling, gauging, switch loading, filtering, mixing, agitation, and vacuum truck operations) and use appropriate mitigating procedures. For more information, refer to OSHA Standard 29 CFR 1910.106, 'Flammable and Combustible Liquids', National Fire Protection Association (NFPA 77, 'Recommended Practice on Static Electricity', and/or the American Petroleum Institute (API) Recommended Practice 2003, 'Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents'.
General Storage Information: Do not store in open or unlabeled containers.
Container Warnings: Container is not designed to contain pressure. Do not use pressure to empty container or it may rupture with explosive force. Empty containers retain product residue (solid, liquid, and/or vapor) and can be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, static electricity, or other sources of ignition. They may explode and cause injury or death. Empty containers should be completely drained, properly closed, and promptly returned to a drum reconditioner or disposed of properly.

SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION

GENERAL CONSIDERATIONS:
Consider the potential hazards of this material (see Section 3), applicable exposure limits, job activities, and other substances in the work place when designing engineering controls and selecting personal protective equipment. If engineering controls or work practices are not adequate to prevent exposure to harmful levels of this material, the personal protective equipment listed below is recommended. The user should read and understand all instructions and limitations supplied with the equipment since protection is usually provided for a limited time or under certain circumstances.

ENGINEERING CONTROLS:
Use process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below the recommended exposure limits.

PERSONAL PROTECTIVE EQUIPMENT
Eye/Face Protection: No special eye protection is normally required. Where splashing is possible, wear safety glasses with side shields as a good safety practice.
Skin Protection: No special protective clothing is normally required. Where splashing is possible, select protective clothing depending on operations conducted, physical requirements and other substances in the workplace. Suggested materials for protective gloves include: Natural rubber, Neoprene, Nitrile Rubber, Polyvinyl Chloride (PVC or Vinyl).
Respiratory Protection: Determine if airborne concentrations are below the recommended occupational exposure limits for jurisdiction of use. If airborne concentrations are above the acceptable limits, wear an approved respirator that provides adequate protection from this material, such as: Air-Purifying Respirator for Organic Vapors, Dusts and Mists.
Use a positive pressure air-supplying respirator in circumstances where air-purifying respirators may not provide adequate protection.
Occupational Exposure Limits:

Component	Agency	TWA	STEL	Ceiling	Notation
Ethylene Glycol	ACGIH	--	--	100 mg/m3	--

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Attention: the data below are typical values and do not constitute a specification.

Color: Colorless
Physical State: Liquid
Odor: Faint or Mild
pH: 8.4
Vapor Pressure: <0.01 mmHg @ 20 °C (68 °F)
Vapor Density (Air = 1): 2.1
Boiling Point: 108.9°C (228°F) (Typical)
Solubility: Miscible
Freezing Point: -36.7°C (-34°F)
Specific Gravity: 1.11 @ 15.6°C (60.1°F) / 15.6°C (60.1°F)
Viscosity: No data available

SECTION 10 STABILITY AND REACTIVITY

Chemical Stability: This material is considered stable under normal ambient and anticipated storage and handling conditions of temperature and pressure.
Incompatibility With Other Materials: May react with strong acids or strong oxidizing agents, such as chlorates, nitrates, peroxides, etc.
Hazardous Decomposition Products: Aldehydes (Elevated temperatures), Ketones (Elevated temperatures)
Hazardous Polymerization: Hazardous polymerization will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION

IMMEDIATE HEALTH EFFECTS
Eye Irritation: The eye irritation hazard is based on evaluation of data for similar materials or product components.
Skin Irritation: The skin irritation hazard is based on evaluation of data for similar materials or product components.
Skin Sensitization: No product toxicology data available.
Acute Dermal Toxicity: The acute dermal toxicity hazard is based on evaluation of data for similar materials or product components.
Acute Oral Toxicity: The acute oral toxicity hazard is based on evaluation of data for similar materials or product components.
Acute Inhalation Toxicity: The acute inhalation toxicity hazard is based on evaluation of data for similar materials or product components.

ADDITIONAL TOXICOLOGY INFORMATION:
This product contains ethylene glycol (EG). The toxicity of EG via inhalation or skin contact is expected to be slight at room temperature. The estimated oral lethal dose is about 100 cc (3.3 oz.) for an adult human. Ethylene glycol is oxidized to oxalic acid which results in the deposition of calcium oxalate crystals mainly in the brain and kidneys. Early signs and symptoms of EG poisoning may resemble those of alcohol intoxication. Later, the victim may experience nausea, vomiting, weakness, abdominal and muscle pain, difficulty in breathing and decreased urine output. When EG was heated above the boiling point of water, vapors formed which reportedly caused unconsciousness, increased lymphocyte count, and a rapid, jerky movement of the eyes in persons chronically exposed. When EG was administered orally to pregnant rats and mice, there was an increase in fetal deaths and birth defects. Some of these effects occurred at doses that had no toxic effects on the mothers. We are not aware of any reports that EG causes reproductive toxicity in human beings.

2-Ethylhexanoic acid (2-EXA) caused an increase in liver size and enzyme levels when repeatedly administered to rats via the diet. When administered to pregnant rats by gavage or in

drinking water, 2-EXA caused teratogenicity (birth defects) and delayed postnatal development of the pups. Additionally, 2-EXA impaired female fertility in rats. Birth defects were seen in the offspring of mice who were administered sodium 2-ethylhexanoate via intraperitoneal injection during pregnancy.

SECTION 12 ECOLOGICAL INFORMATION

ECOTOXICITY
The toxicity of this material to aquatic organisms has not been evaluated. Consequently, this material should be kept out of sewage and drainage systems and all bodies of water.

ENVIRONMENTAL FATE
This material is expected to be readily biodegradable.

SECTION 13 DISPOSAL CONSIDERATIONS

Use material for its intended purpose or recycle if possible. Oil collection services are available for used oil recycling or disposal. Place contaminated materials in containers and dispose of in a manner consistent with applicable regulations. Contact your sales representative or local environmental or health authorities for approved disposal or recycling methods.

SECTION 14 TRANSPORT INFORMATION

The description shown may not apply to all shipping situations. Consult 49CFR, or appropriate Dangerous Goods Regulations, for additional description requirements (e.g., technical name) and mode-specific or quantity-specific shipping requirements.

DOT Shipping Description: Anti-freeze Preparations, Proprietary
Additional Information: Bulk shipments with a reportable quantity (5000 pounds) of ethylene glycol are a hazardous material. The Proper Shipping Name is: Environmentally Hazardous Substance, Liquid, N.O.S. (ethylene glycol), 9, UN3082, III, RQ (ethylene glycol).

IMO/IMDG Shipping Description: NOT REGULATED AS DANGEROUS GOODS FOR TRANSPORTATION UNDER THE IMDG CODE

ICAO/IATA Shipping Description: Anti-freeze Preparations, Proprietary; NOT REGULATED AS DANGEROUS GOODS FOR TRANSPORT UNDER ICAO

SECTION 15 REGULATORY INFORMATION

EPCRA 311/312 CATEGORIES: 1. Immediate (Acute) Health Effects: YES
2. Delayed (Chronic) Health Effects: YES
3. Fire Hazard: NO
4. Sudden Release of Pressure Hazard: NO
5. Reactivity Hazard: NO

REGULATORY LISTS SEARCHED:

01-1=IARC Group 1	03=EPCRA 313
01-2A=IARC Group 2A	04=CA Proposition 65
01-2B=IARC Group 2B	05=MA RTK

02=NTP Carcinogen 06=NJ RTK
07=PA RTK

The following components of this material are found on the regulatory lists indicated.
Ethylene Glycol 03, 05, 06, 07

CHEMICAL INVENTORIES:
All components comply with the following chemical inventory requirements: DSL (Canada), EINECS (European Union), TSCA (United States).

NEW JERSEY RTK CLASSIFICATION:
Refer to components listed in Section 2.

WHMIS CLASSIFICATION:
Class D, Division 1, Subdivision B: Toxic Material - Acute Lethality
Class D, Division 2, Subdivision A: Very Toxic Material - Teratogenicity and Embryotoxicity
Reproductive Toxicity

SECTION 16 OTHER INFORMATION

NFPA RATINGS: Health: 2 Flammability: 1 Reactivity: 0

HMIS RATINGS: Health: 2* Flammability: 1 Reactivity: 0
(0-Least, 1-Slight, 2-Moderate, 3-High, 4-Extreme, PPE:- Personal Protection Equipment Index recommendation, *- Chronic Effect Indicator). These values are obtained using the guidelines or published evaluations prepared by the National Fire Protection Association (NFPA) or the National Paint and Coating Association (for HMIS ratings).

LABEL RECOMMENDATION:
Label Category : ANTIFREEZE/COOLANT 3

REVISION STATEMENT: This revision updates the following sections of this Material Safety Data Sheet: 3,4,5,8,9,10,14,15,16
Revision Date: 02/23/2005

ABBREVIATIONS THAT MAY HAVE BEEN USED IN THIS DOCUMENT:

TLV - Threshold Limit Value	TWA - Time Weighted Average
STEL - Short-term Exposure Limit	PEL - Permissible Exposure Limit
	CAS - Chemical Abstract Service Number
ACGIH - American Conference of Government Industrial Hygienists	IMO/IMDG - International Maritime Dangerous Goods Code
API - American Petroleum Institute	MSDS - Material Safety Data Sheet
CVX - ChevronTexaco	NFPA - National Fire Protection Association (USA)
DOT - Department of Transportation (USA)	NTP - National Toxicology Program (USA)
IARC - International Agency for Research on Cancer	OSHA - Occupational Safety and Health Administration

Prepared according to the OSHA Hazard Communication Standard (29 CFR 1910.1200) and

the ANSI MSDS Standard (Z400.1) by the ChevronTexaco Energy Research & Technology Company, 100 Chevron Way, Richmond, California 94802.

The above information is based on the data of which we are aware and is believed to be correct as of the date hereof. Since this information may be applied under conditions beyond our control and with which we may be unfamiliar and since data made available subsequent to the date hereof may suggest modifications of the information, we do not assume any responsibility for the results of its use. This information is furnished upon condition that the person receiving it shall make his own determination of the suitability of the material for his particular purpose.