



Fire Safety

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This document describes the fire safety measures of the Lagerwey LP2 and LP4 product range.

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1 Introduction

This document is a global presentation of the fire safety measures of the Lagerwey product range.

Lagerwey turbines are designed according to the IEC 61400 2005 edition 3 and underlying standards. According to the Machine Directive a Risk assessment and evaluation has been carried out for Personal safety (including fire safety) which is obligated for all phases from assembly to service.

Potential fire hazardous situations might occur in two locations within the turbine and one outside.

1. Inside:
 - Turbine head (Nacelle and Hub)
 - Tower base platform
2. Outside (LP2 only):
 - Transformer / switchgear housing which usually is placed near the turbine foundation

2 Design principle of the turbine

The Lagerwey turbines are designed according to the permanent magnet direct drive principle. The concept is based on the gearless principle achieved by a direct drive generator and full IGBT power converter.

One of the benefits of the direct drive principle is that there is no gearbox. A conventional wind turbine gearbox is lubricated by hundreds litres of oil. Additional systems are needed to condition the gearbox lubricants. Such as; oil filtration, heating and cooling systems. Lagerwey turbines are designed to have a minimum of flammable liquids.

Turbines with geared solutions use isolation material in their gearboxes to reduce noise. The isolation material is polluted by oil during years of operation. This gives these solutions a higher fire risk.

The direct drive generator has an outside stator and an inside rotor structure which does not carry the main turbine loads but only carries the torque and 'internal' generator loads. The generator rotor has fully encapsulated permanent magnets to avoid any pollution or deterioration. The stator has stiff copper windings and are vacuum impregnated with high quality resin ensuring durability of the machine. The inside of the generator is disconnected from the outside environment while the excellent, by natural air flow, outside cooling takes care of the heat transfer without any active cooling system. With the windings mounted on the outer part of the generator short circuiting of the windings will reduce the risk of any hazard inside the nacelle significantly. The operating temperature of the windings is 100°C. There is no contact between GFRP covers and the stator of the turbine.

The power conversion is located in the bottom of the tower. The power conversion consist off a fully non-flammable liquid cooled back to back converter running by IGBT's. All functions and sensors of the turbine will be monitored and controlled by the Lagerwey Control System. The main control system is located in the nacelle and connected to power converter by glass fibres.

3 Fluids

Lagerwey turbines operate with a minimum amount of potential flammable liquids. These liquids are used in different systems in the turbine.

3.1 Main bearing assembly

Lagerwey lubricates its main bearing assembly with an oil bath. There is no pressure in this system and it only contains approximately 60 litres of low flammable oil.

3.2 Yaw system

Electrical yaw motors and hydraulic yaw brakes take care of the automatic yaw control. The yaw brake callipers are actuated by a standalone hydraulic system which is controlled by the PLC. Depending on the platform, the amount of hydraulic oil varies between 19 and 28 litres.

The yaw drives contain 17 litres of oil each. The amount of yaw drives varies between 4 and 12 depending on the platform and rotor diameter.

3.3 Pitch system

The blades are pitched automatically in the right pitch angle by means of electrical pitch drives.

The pitch drives contain between 9 and 29 litres of oil each. There are always 3 pitch drives: one per blade.

3.4 Parking brake / Rotor Lock

The turbine can stop by three fully independently working blades. For service purposes the rotor can be locked in several positions. By means of the manually operated hydraulic parking brake the rotor can be stopped in any position. It must be noted that this brake is only used for holding the rotor for a certain time and is not used for regular turbine operation. Before access is allowed to the rotor the mechanical double locking pins have to be in position to lock the rotor.

Many turbines use hydraulic cylinders to lock the generator rotor. Lagerwey chose a simple mechanical solution that does not require hydraulics.

3.5 Transformer

The main transformer of the LP2 platform, which transforms the voltage from 690V to e.g. 10kV is placed in a cabinet outside the turbine, usually in the vicinity of the turbine foundation. In conventional turbines the transformer is placed in the nacelle. By placing the main transformer outside the turbine Lagerwey eliminates a potential hazard with fire risk.

The LP4 platform provides room for the transformer in the bottom of the tower. The transformer is filled with MIDELOIL, which is low flammable. On top of that the transformer room is a closed fire resistant compartment for 90 minutes.

4 Escape routes

In case of an emergency the turbine offers various escape routes.

4.1 Tower base platform door

The Tower base platform door is the main entrance of the turbine. It is equipped with a panic lock so it is always possible to open the door from the inside without a key.

4.2 Escape hatch in the nacelle

In the rear side of the nacelle cover an escape hatch is placed. A rescue device for emergency descent is placed in the vicinity of the escape hatch.

4.3 Elevator / ladder

The tower is equipped with a service elevator. The elevator is ladder guided. The same ladder can be used to climb or descent inside the turbine in case of an emergency.

In case of grid loss the elevator can be lowered manually. By malfunction of the service elevator the top hatch and bottom hatch can be opened and the crew can climb through the elevator. The ladder is equipped with a fall arrest system.

5 Fire extinguishers

The LP2 platform is equipped with two fire extinguishers. One in the nacelle and the other in the bottom of the tower. The LP4 platform additionally has an fire extinguishers in the MVSG compartment.

6 Smoke detection

Smoke detectors are located in the Nacelle and in the different compartments in the bottom tower section.

7 Risk assessment

Fire hazard might occur due electrical or mechanical or lightning strike fault at the turbine. Failure might cause fire inside the nacelle or hub at the top of the turbine or downstairs at the tower base platform where converters are situated. Outside the turbine fire hazard might occur in the transformer house due to electrical failure.

8 Mitigation strategies

8.1 Lightning strike

The turbine is equipped with lightning protection system which will pass all lightning strikes from the turbine straight to ground earthing around the turbine. Also personal protection the nacelle is covered with a faraday cage.

8.2 Fire

In case of fire several sensors will give alarm to the control system which then will automatically shut down the turbine operation. In normal situation sensors will stop the turbine before fire can occur, because most of electrical and mechanical components are monitored by temperature sensors which detect over heating of the components and prevent further damage. The shutdown system is executed in a fail safe manner, meaning that the turbine will be stopped if one of the sensors or its cables fails.

Regular turbine maintenance will reduce potential fire risk and will ensure that the turbine is in good working order.

9 Alarm list

Emergency phone number: 112

Location:

Coordinates:

Site layout:

9.1 Contact list

	Contact name	Phone number / e-mail
Emergency phone number		112
Wind farm owners:		
Grid connection control:		
Lagerwey Service Control Center		+31 646 041 313 +31 859 022 700 service@lagerwey.nl
Responsible persons	Wim Robbertsen	+31 630 056 381 wr@lagerwey.nl

10 In case of fire

In case of fire at the turbine, or near the site:

1. Push the emergency stop button and exit the turbine immediately. People outside should not try to enter the turbine to push emergency button.
2. Only use firefighting equipment to ensure a safe escape route from the turbine.
3. Call 112 and notify the fire department.
4. Establish a temporary clearance area of 600m diameter around the turbine and move upwind outside the clearance area.
5. Notify the owners and turbine operator.
6. Allow the turbine to "burn out"
7. If possible wet down the surrounding area to limit the possibility of fire spreading to surrounding vegetation.