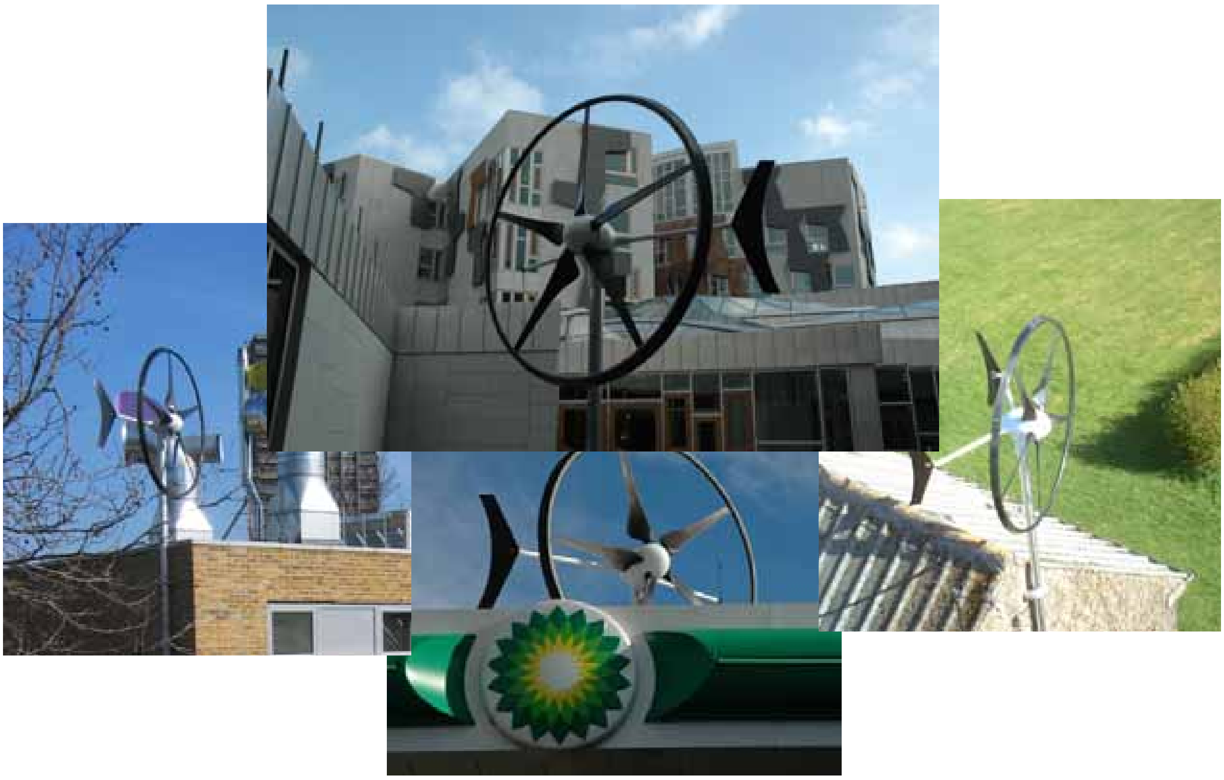
SWIFT

Rooftop Wind Energy System™
Technical & Planning Information



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1. Swift Rooftop Wind Energy System™

1.1 Introduction

This document is intended to provide guidance to engineers, architects and specifiers when considering the installation of a Swift Rooftop Wind Energy System™. It is not intended as an Installation Manual and does not contain information suitable for the maintenance, installation or decommissioning of the Swift Rooftop Wind Energy System™.

The system must only be installed by trained and approved installers.

The information contained in this document is subject to periodic review and it is the specifiers responsibility to ensure that the most recent version is used.

1.2 Product Description

As part of its mission to provide accessible renewable technologies, Swift Turbines Ltd (STL) has produced the world's feasibly rooftop-mountable wind turbine, capable of providing a cost effective renewable energy source for domestic, community and industrial use. The Swift Rooftop Wind Energy System™ is grid connected for "beyond the meter" generation.

The emphasis of the design process has focused on safety, reliability and ease of operation, alongside high performance. The turbine uses unique patented technologies, which allow:

- Wide ranging application
- Vibration-isolated rooftop mounting
- Quiet operation through acoustic suppression aerodynamics
- Safe, efficient & autonomous operation
- Visually appealing design
- Environmentally sustainable "harm neutral" design
- Sophisticated electronic control system

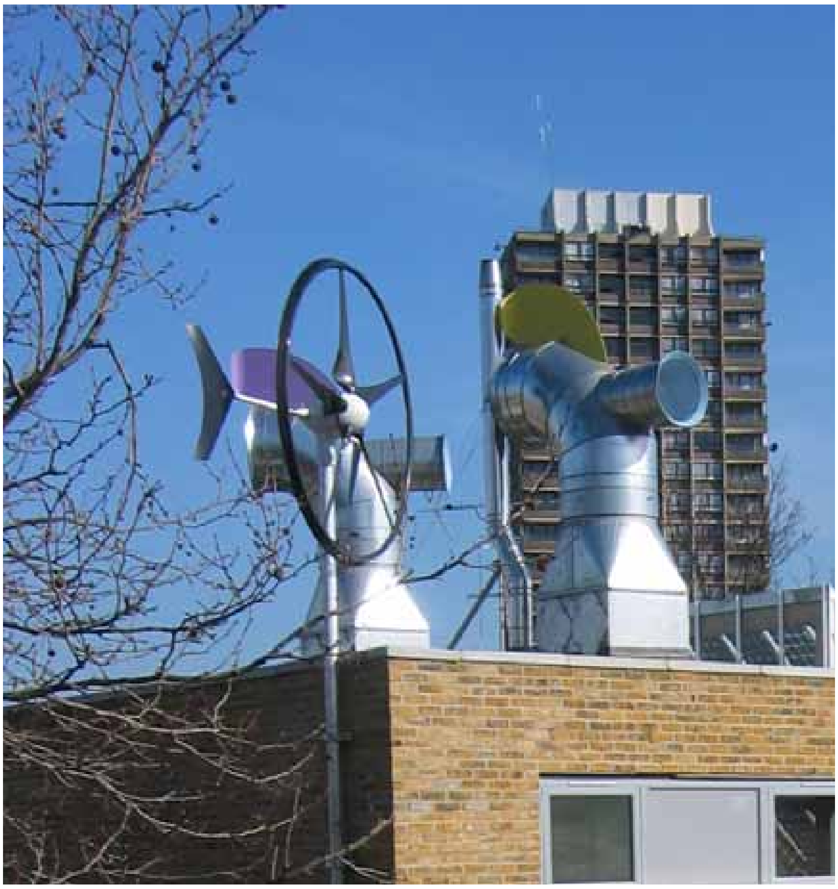

Figure 1 - Installed Swift Rooftop Wind Energy System

The Swift™ turbine is mounted on a bespoke aluminium mast with a minimum blade-roof clearance of 0.5 metres. It is usually optimally mounted at the highest point of a roof in a position that benefits from prevailing wind. The Swift™ is designed to be aesthetically pleasing.

To ensure minimal transmission of oscillations from the turbine to the building there are damping systems, designed to isolate a wide range of frequencies. The patented ring diffuser minimises turbine noise. The five-bladed design allows for a slower speed of rotation to further reduce noise, making the Swift Rooftop Wind Energy System™ a truly building-mountable wind system.

The Swift™ turbine has a unique over-power regulation mechanism to control rotation speed and maintain system integrity and safety in high winds. This consists of a innovative twin-vane progressive mechanical furling mechanism, coupled with a sophisticated electronic control system. This allows the optimum amount of power to be taken from the turbine under varying wind and loading conditions without stalling, and represents a step change in the accurate and safe control of small wind turbines. In environmental terms, each unit of electricity generated from a Swift Rooftop Wind Energy System™ displaces one unit generated from fossil fuels, with the added benefit that the electricity is consumed on-site, thus negating losses from transmission. This can amount to a displacement of up to 1.6 tonnes of CO_2 per year – a significant environmental contribution.

2. Planning Policy

2.1 Policy and legislative context

The Scottish Executive's policy for renewable energy is described in PAN 45 and is set out in "NPPG6, Renewable Energy Developments".

2.2 Technology Overview

The need for increased use of renewable energy is well established. Opportunities to generate 'bulk' electricity from renewable resources are currently being exploited throughout Scotland, including the development of wind, hydro and other technologies.

It is recognised, however, that in order meet objectives for CO_2 reductions and reduction of dependency on fossil fuels, the domestic and commercial application of renewable technologies must be increased. Small-scale wind turbines have the potential to contribute towards this need, providing electricity or hot water heating in both domestic and commercial applications. The associated CO_2 savings per turbine are small, but longer term cost savings per household or business could be significant. Wide deployment of turbines will lead to significant CO_2 savings in the longer term and will increase levels of 'embedded' generation.

This planning advice note focuses on the installation of small wind turbines on rooftops but can also apply to mast or pole mounted turbines up to a height of 15m.

2.3 Visual impact

Rooftop-mounted small wind turbines are likely to increase the overall height of a building to take advantage of higher wind speeds (with the exception of 'building integrated' designs) and will be comparable in height to a large television arial or chimney stack. Rooftop wind turbines will at first be unusual in their appearance, as were satellite dishes when first deployed in the early 1980's. In sensitive areas (Conservation Areas and Listed Buildings), development should be controlled by relevant legislation.

Elsewhere, applications should be assessed on a case-by-case basis, taking account of the existing building and structures, it's scale, the nature of the setting and the benefits of renewable energy generation. Computer generated photo montages of the building with the turbine in-situ will assist decision making. The colour and finish of the wind turbine is appropriate to setting and designed to minimise visual impact and reflection of light. Different colours of turbine could be considered appropriate for different roof coverings.

Due to the fact that Swift turbines will be located on or near existing commercial/domestic buildings, they are unlikely to add a new element to the local landscape. Unlike large wind farms installation, a full landscape and visual impact assessment is not required.

Free standing wind turbines mounted on masts have the potential to have greater impact, depending on the height of the mast and the diameter of the turbine. Proposals for free standing turbines should be assessed on a case-by-case basis, in accordance with guidance contained in the main planning annex on wind energy and any additional structural/engineering issues.

2.4 Noise

The need to control noise emission from a small-scale wind turbine is critical in domestic settings. In commercial/light industrial settings, where there are no residential properties in the immediate vicinity, the control of noise is important, but less critical. Detailed discussion of noise from wind turbines is contained in the main wind energy appendix to "PAN 45 (revised 2002): Renewable Energy Technologies", and wider discussion of planning and noise can be found in PAN 56.

Some older models of wind turbines (large and small) have emitted significant noise levels, which would be unacceptable in a domestic setting. New, near-silent design of the Swift turbine has greatly reduced sound power levels due to improved blade design and reduced mechanical noise. Modern turbines are also easier to control and can be shut down at very high wind speeds when levels of noise emission may be unacceptable.

In the absence of specific guidance on noise, all small-scale wind turbines should meet the criteria identified by the DTI/ETSU report: 'The Assessment and Rating of noise from wind farms.'[1]. As a general rule, noise emitted from the turbine should not exceed 5dB(a) above background. A fixed limit of 43dB(A) is recommended for nighttimes. Both daytime and nighttimes, noise limits can be increased to 45dB(A) where the owner of the property benefits form the operation of the turbine. The Swift Rooftop Wind Energy System™ meets all of these criteria.

Comparison of a predicted noise curve (from 0-10m/s wind speed) for the proposed turbine to background noise levels should enable adequate assessment of whether noise will cause disturbance. A detailed noise assessment is not required where the noise emitted from the turbine falls between 35-40dB(A) over the full range of wind speeds – as is the case with the Swift™ turbine. There is no evidence to suggest that noise form wind turbines can have a significant effect on wildlife.

2.5 Reflectivity

Rotating wind turbine blades can occasionally be seen to 'flash', when a combination of certain conditions coincide in specific locations at particular times of the day and year. Whilst this is not thought to be an issue in North America, it is considered to be a potential 'nuisance' within Northern Europe. To minimise the occurrence of 'flash' the Swift's rotor is comprised of moulded carbon fibre, with a matt black surface. Matt is specifically chosen to avoid highlights or bright reflections from rotor surfaces, during rotation, in either natural or artificial street light. The black colour allows for minimal reflectivity (the ratio of the total amount of white light diffusely reflected by the surface to the amount falling on the surface) as it is extremely absorptive over a wide range of wavelengths.

The small diameter and likely location of the Swift rooftop turbine greatly reduces the probability of reflection occurring. However, where turbines are located in such a position that reflection may occur (see guidance in wind power annex), the frequency

[1] ETSU (1996) 'The Assessment and Rating of noise from wind farms.' DTI Noise Working Group, Energy Technology Support Unit.

of the turbine should be below 2.5 or above 20 hertz (the frequencies between which disturbance to humans can occur[2]). Where the turbine is greater than 10 rotor diameters distance from the potential receptor reflection should not represent a problem[3]. Reflection is therefore not considered to be a significant issue for the Swift Rooftop Wind Energy System™.

2.6 Electromagnetic Interference

Aircraft, Military Low Flying, Aerodromes and technical sites:

Unlike large wind turbines and wind farms, small rooftop wind turbines of the size of the Swift turbine are extremely unlikely to have any detrimental effects on aviation and associated radar/navigation systems.

Television / radio reception:

The small diameter of the Swift turbine will limit any potential effects on television and radio reception. If this occurs it is likely to be highly localised and technically easy to overcome. The Swift Rooftop Wind Energy System meets all of the necessary UK and EU Electro-Magnetic Compatibility (EMC) standards.

Effect on mobile phone and telecommunications links:

It is unlikely that small rooftop wind turbines will effect either mobile phone reception or fixed radio/microwave communications links. The Swift Rooftop Wind Energy System meets all of the necessary UK and EU Electro-Magnetic Compatibility (EMC) standards.

Emission of electromagnetic radiation:

Wind turbines, like any electrical equipment, will emit electromagnetic radiation. Small rooftop wind turbines will generate electricity at low voltage and typically have a power output of 100watts to several kilowatts. It is therefore unlikely that turbines of this size will emit levels of radiation greater than common household goods. The Swift Rooftop Wind Energy System™ has been fully EMC tested for electro-magnetic compatibility and exceeds all of the relevant UK and European standards.

2.7 Bird Strike

Species of birds known to be sensitive to the operation of large wind turbines (Golden Eagles, Geese, Swans, Harriers, Owls and divers) are less likely to fly near to industrial or domestic properties where small rooftop turbines will be located. The small diameter of the Swift turbines (< 2m) makes them comparable, as an obstacle, to a rooftop television arial, mobile phone mast or large satellite dish. It is extremely unlikely, therefore, that the location of a rooftop turbine will cause a significant increase in bird strike, beyond the rates already caused by existing buildings, windows and other obstacles. Larger, mast-mounted turbines may pose an increased threat, depending on location. Studies have shown that birds will adapt their flight patterns to take account of the presence of wind turbines and that well located turbines are unlikely to pose a significant threat to local populations.

[2] Burton et. al. (2001) ‘Wind Energy Handbook’. Wiley.
[3] PAN45 and Taylor and Rand (1991) ‘Planning for wind energy in Dyfed.’ EERU 065. Energy and Environment Research Unit, Open University, UK.

2.8 Safety

Structural safety:
Small wind turbines should comply with IEC 16400 and, in particular, BS EN 61400-2: 1995 "Wind turbine generator systems - safety requirements".

The Swift wind turbine is designed to withstand extremely high winds and will typically shut down or 'furl out' in high wind strengths to protect the turbine from damage. It is extremely unlikely that a turbine meeting the standards described above and correctly installed in accordance with manufacturers guidelines could cause human injury. The Swift Rooftop Wind Energy System™ is designed (and has been independently verified) to meet and exceed all of the structural and safety constraints required by BS EN 61400-2 and all other UK safety standards for machines of this type.

Electrical connections and/or an associated hot water system should be installed in accordance with appropriate building standards.

Electro-magnetic compatibility:
Domestic, commercial and light industrial premises EN50081-1
Industrial premises BS EN 50081-2
Mains frequency BS EN 61000
(power quality) effects including flicker and harmonic distortion

Electrical safety:
The Swift Rooftop Wind Energy System™ meets all of the electrical safety criteria set out in EN 50178 and the 16th Edition of the UK Wiring Regulations.

Grid monitoring:
The Swift Rooftop Wind Energy System™ meets all of the grid-monitoring criteria set out in VDE 126, including Anti-Islanding Protection.

G83 compliance
The Swift Rooftop Wind Energy System™ has been independently verified to ensure that it meets the G83 standard for the grid-connection of small-scale generators.

Figure 2 – A typical Swift turbine installation in a residential block

Renewable Device's Swift wind turbine has been designed to be planning compliant and can be installed safely and simply into almost any building design.

Figure 3 – Swift turbine domestic installations

3. Installation summary

For information only, below are the steps required to achieve a safe and effective installation of the Swift™ Rooftop Wind Energy System:

- Transportation and receipt of Swift™ Rooftop Wind Energy System.
- Preparation of walls and installation of mounting brackets.
- Installation of turbine mounting mast.
- Installation of electronic control system and grid-tie inverter.
- Installation of Swift™ turbine.
- Electrical connection of system.
- Testing.
- Commissioning.
- Completion of test certificates and commissioning documentation.

The Swift turbine is typically wall-mounted at the gable end of a building using the bespoke brackets supplied. For information, the bracket spacing is as shown in Figure 5, below.

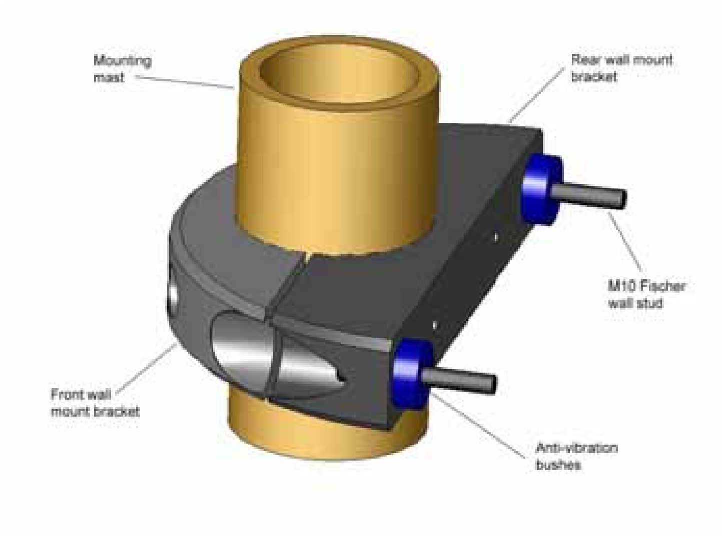

Figure 4 - Correctly assembled & installed mast mounting brackets

The pitch of the holes required to mount there brackets to the wall or any reinforcing structure is 254.0mm.

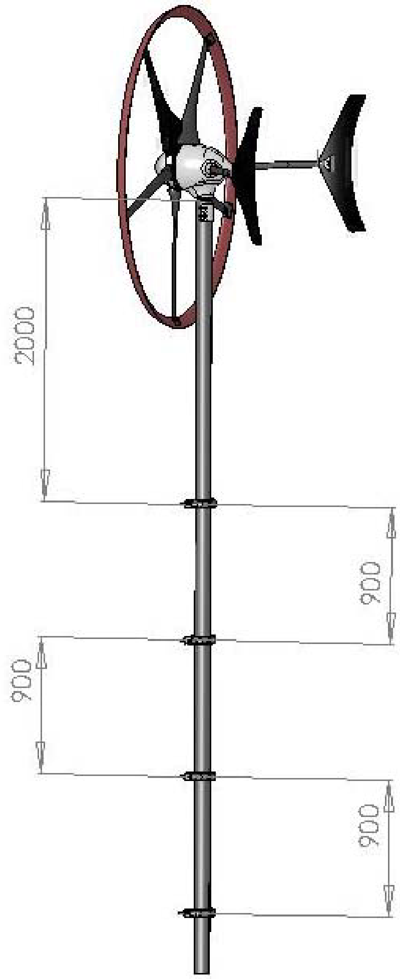

Figure 5 - Swift™ wind turbine assembly showing bracket spacings

In some circumstances it may be necessary to mount the Swift™ wind turbine mounting mast onto the exterior, and through the overhanging eaves of a building. In this instance, sealing roof glands will be required. The mounting mast is located by sliding it up through these rubber glands.

Figure 6 - Typical installation of rubber roof gland seal.

3.1 Flat Roof Installation

The Swift Rooftop Wind Energy System™ can be installed on a flat roof. In this type of installation, the mounting mast described above is replaced with a bespoke mounting stand. The installation of this stand is site-specific and may require additional engineering work to be carried out in order to assess the structural suitability of the building.

The most common type of flat roof installation uses a bespoke stand, as shown in Figure 7.

Figure 7 - a typical flat roof installation configuration

The height of the flat roof mounting mast will vary as some sites may have a parapet. The flat roof mounting mast will be between 1.5m and 3.5m in height (from the base plate to the turbine hub height) and will typically be 2.0m

For reference, the approximate mass of the Swift turbine components are as follows:

Mass of Swift turbine:	50 kg
Mass of mounting mast:	40 kg

3.2 Loadings

In all installation configurations, the wall mounting anchors or the flat roof stand will transmit the aerodynamic thrust from the rotor to the mounting structure. The amount of mechanical stress imposed on the anchors will depend on the height of the mounting mast – each installation is different. As a guide, when designing the mounting structure, the stress at the anchor points should be considered to be induced by an axial thrust (acting horizontally at the rotor hub height) of 7kN, plus the loads due to the mass of the turbine and mounting masts.

4. Electrical & electronic controller connections

The Swift Rooftop Wind Energy System™ will be supplied with two electronic components: an electronic control system and a grid-tie inverter.

The electronic control system provides sophisticated electronic control of the turbine and the grid-tie inverter is used to synchronise the power output with the consumers electricity supply.

Figure 8 - Installed Swift™ Electronic Control System

5. Performance

The power curve for the Swift wind turbine is shown in Figure 9, below.

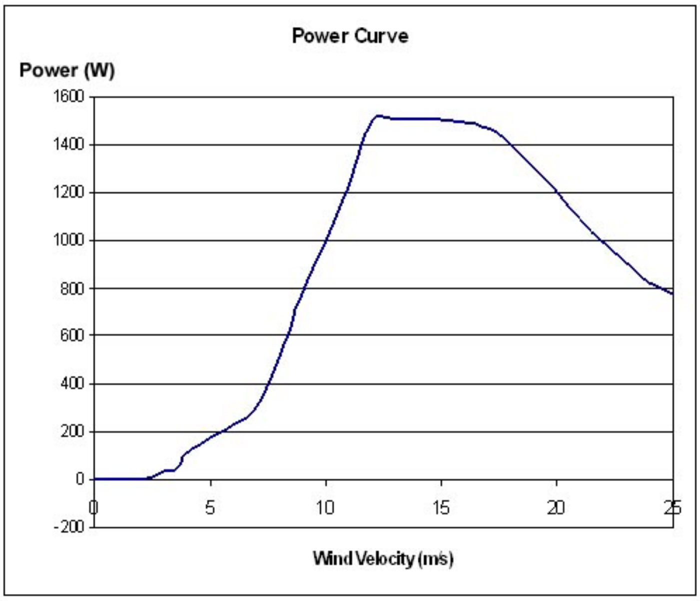

Figure 9 - Swift wind turbine power curve

6. Compliance

The Swift Rooftop Wind Energy System has been independently tested or certified to comply with the following standards and directives:

EN 61400-2: 1996
This standard relates to wind turbine generator systems and deals with the safety of small wind turbines. It is applied as the Swift Rooftop Wind Energy System™ has a swept rotor area of less than $40m^2$ and generates at a voltage below 1,000 V, a.c. or 1,500 V, d.c. and therefore falls within the scope of this standard. Mechanical components are design and specified to meet this standard. Apart from EMC, described below, the specific electrical standard applied to satisfy EN 61400-2 is EN 60950.

EN 61400-24: 1996
Lightning protection of wind turbines.

EN 60950: 2000
The Swift Rooftop Wind Energy System™ operates at safety extra low voltage (SELV), below the threshold voltage at which the low-voltage directive is normally applicable. However, EN 60950 is applied as a standard for safety aspects other than the risk of electric shock. These include flamibility of component parts, temperature rise of user-accessible components, labelling and accompanying documents.

BS 5760-0:1986
Although BS 7671 deals with electrical installations, component parts of the Swift Rooftop Wind Energy System™ are designed to facilitate its installation in accordance with this standard.

BS EN 61000-3-2 and BS EN 61000-3-3
Electro-magnetic compatibility limits for harmonic distortion & voltage fluctuation.

EN 50081-1
Electro-magnetic compatibility - domestic, commercial and light industrial premises

EN 50081-2
Electro-magnetic compatibility - industrial premises.

EN 61000
Mains frequency (power quality) effects including flicker and harmonic distortion

VDE 126
For the safety of Grid Monitoring (Including Anti-Islanding Protection)

IEE 16th Edition Wiring Regulations BS7671
For the safety of domestic electrical installations

Electricity Association, Engineering Recommendation G59
Electricity Association (since 1 October 2003 superseded by Energy Networks Association). Grid connection of embedded generators at $<$5MW and $<$20kV.

Electricity Association, Engineering Recommendation G83/1
Electricity Association (since 1 October 2003 superseded by Energy Networks Association). Grid connection of embedded generators up to 16A per phase (supersedes G77)

BS 5080-1: 1993
The structural fixings used to attach the Swift turbine to a concrete substrate are tested in compliance with BS 5080-1: 1993.

7. Technical Specification

Rated power output: 1.5 kW *
Annual Power Supplied: 4500 kWh *
1.6 Tonnes of CO2 reduction/annum **

Planning Compliant Design
Acoustic emission < 35 dB(a)
Moulded carbon-fibre rotor (fail safe)
EMI suppression technology

Embedded electrical connection
Direct Water Heating
Battery Charging

5-blade HAWT wind turbine
Rotor diameter 2.0m (6.5 feet)
Product Life: 20 years

Mounting mast (BS1387, ISO65)
EMC directive compliant
LVD directive complaint
CE marked

Low maintenance
Single or multiple installation
Compact design

Safety systems comply with International Standard IEC 1400-1 & BS EN 61400-2
Electricity Association Requirement G59, G77and G83 compliant.
BS 7671 :16th Edition of the IEE Wiring Regulations
BS 5760-7: Reliability of Systems, Equipment and Components

The Swift turbine is mounted on a bespoke mast with a minimum blade-roof clearance of approximately 0.5 metres. It has a novel over-power regulation mechanism, which is totally passive and maintains its tip speed ratio across its entire operating envelope. The turbine has a novel twin-vane progressive furling mechanism which maintains the systems integrity and safety in high winds. It will operate automatically around the clock.

* Rated wind speed: 12.0 m/s
** Substituting end-user electricity with a single 1.5kW rooftop turbine at 35% utilization by CEDRL RETScreen® International).