Education & Training Program

Servicing Rotor Blades
Of
Wind Turbine Generators

On the following pages we present
a training concept with focus on
rotor blade inspection & repairs

Schedule and prices for training in London

Module 1

2-day-training for Rotor Blade Inspections £ 399,50 incl. VAT

Introductory price 2011 **£ 345,45 incl. VAT**

Sat & Sun	22./23.01.2011	9am to 5pm	London
Sat & Sun	05./06.03.2011	9am to 5pm	London
Sat & Sun	18./19.06.2011	9am to 5pm	London
Sat & Sun	15./16.10.2011	9am to 5pm	London
Sat & Sun	26./27.11.2011	9am to 5pm	London

Module 2

10-day-training for Glass Fiber Composite Repair Work
on Rotor Blades (Basic Module) £ 1997,50 incl. VAT
Introductory price 2011 **£ 1496,95 incl. VAT**

Mon - Fri	24.01.-04.02.2011	9am to 5pm	London
Mon - Fri	07.03.-18.03.2011	9am to 5pm	London
Mon - Fri	20.06.-01.07.2011	9am to 5pm	London
Mon - Fri	17.10.-28.10.2011	9am to 5pm	London
Mon - Fri	28.11.-09.12.2011	9am to 5pm	London

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Module 1

Training Topic

”Inspection of rotor blades“

- **Training goal**

Enabling the trainee to

- inspect rotor blades with a trained eye.
- evaluate damage to determine the relevance and implications for the structural integrity of the rotor blade (with module 1 limited to a certain extent of damage)
- prepare qualified reports (text & photos)

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Module 1 – Rotor Blade Inspection

Wind Turbine Generator - Design & Function - THEORY

Design	Basics Power output Pitch-controlled Stall-controlled Constant rotor speed Variable rotor speed WTG with gearbox & without gear box	physical basics electrical basics WTG designs function power generation & grid feeding & pros & cons of various designs
Components	Rotor blades Generator Gear box Controls Nacelle Tower Foundation	Design & function - basics
Electronic controls	Set-up for working on rotor blades Shutdown & turn-on-procedures	Instruction through wtg maker Instruction through wtg operator Safety rules General safety features Automatic safety devices Manual safety devices Manual controls (pitching the blades for fitting functional requirements, turning the rotor)
Periodic inspections	Rotor blades Machine Controls Safety installations. Tower Foundation	Priority on rotor blades and lightning protection system Rotor blade assessment (inside & outside) Other components noted at the margin
Responsibility Safety	Contact persons - client - contractor - site manager	Communication before/during/after the assignment Contacts in case of emergency Rescue department in care

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Module 1 – Rotor Blade Inspection

Rotor Blade - Basics & Design - THEORY

Function	Generatiing power	Aerodynamic basics Forces on rotor blade (basics) Function of pitch control (blade adjustment) Function of stall control (tip-brake)
Blade design Blade components	Reliant upon: - manufacturer - wtg power - year of construction	design production methods pros & cons
Materials	core, hull components	Field experiences
Air flow controlling components-	Vortex Stall-Stripes Guerney-Flaps Turbo-Rills Zig-Zag ribbon Special designs	Design & function Physical performance Application
Tip-Mechanic	components	Damages through wear & tear Damages because of design flaws Wear & tear of the cones and effects
Pitch control	Control Safety Wear & tear on mechanism	Possible failure of the automatic safety features
Lightning protection-system	Receptor Potential equalization Ground connection	Function & significance Standards (according to manufacturer, civil service, insurance companies, etc) Periodic assessments, testing lightning protection systems & testing of ground resistance (equipment, standards, methods) , Receptor (assembling, components, common failures) Documentation, formulas
Force on the rotor blade With the view on damage causes	Aerodynamic-force Impact force	Force fields – damage fields Areas of most likely damage Force carrying & most relevant areas Oscillations
Damage	Catalogue of all types of damage	Damage evaluation Judging potential repair Determining the repair method Creating repair concept Determining the optimum access method Determining and handling of insurance relevant damage

Module 2

Training Topic

„Glass Fiber Composite Work“

Theory & Practice

- **Training goal**

Training the trainee in

- basic skills of glass fiber repair work
- material & supplies
- tools
- handling resin & webbing

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Module 2 – Glass Fibre Composite Repair Work

THEORY

Basics & Application – Working Safety

Synthetic Resin Design elements	Resin & Bonding Material	Chemical constitution/ physical function Chemical / physical performance Resin systems (resin, hardener, accelerator – method of adjustments) cohesion/ adhesion fields of application handling (basics) impact of climate conditions
Composite materials – Basics	Webbing Clutch Glass fibre Filling material Auxilliary materials	Constitution Webbing types Webbing - qualities & characteristics Physical characteristics Appropriate choice for specific application
Safety rules - at processing	On-location	Rules & regulations (according to manufacturer, civil service, insurance companies, etc) Voluntary safety Precaution against fire
Safety - at handling & storing	At - storage room - vehicle	Rules & regualtions New container Container in use Fire prevention
Health protection	Fumes Skin & eye care	Precaution (ventilation, protection clothing, gloves, goggles, etc.) Cleaning & treating skin Emergency cases

PRACTICE

Laminating Course

Laminating Work flow	Synthetic resin Tools	Working with epoxy resin and various webbings

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Module 3

Training Topic

„Rotor Blade Repair Work“

Theory & Practice

Training goal

Enabling the trainee to

- carry out repair work on small & medium rotor blade damages –
- safe handle of material & supplies
- know the importance of safety gear
- prepare proper repair reports

Training is carried out on the ground, some lectures could be held in combination with the planed repair work in January – February 2010.

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Module 3 – Rotor Blade Repair Work

Repair Work On Blade Surface & Structure -

Damages	Standards Blade type specific Manufacturer specific	Damage evaluation Repair feasibility Determining repair method Determining access method
Basics Knowlege base	Surface damage. Structural damage.	Determining repair material (manufacturer, supplier, etc.) Tools & equipment
Composite designs- On rotor blades	Fibre & resin Pre-Packs Sandwich & filling material	Layouts for rotor blades (standards & specials) Physical characteristics application
laminating	Depending on access method: - Seiltechnik - Bühnentechn. - Stationär	Material composition (Webbing, resin system, adjustment of mixture) Pre-Packs, task preparation Working technique according to access method
chamfering	Design	Basics (chamfer ratio, webbing type, etc.) Application & Performance
Bonding	Field of application	Choosing bonding material Application & Equipment
Surface treatment	Putty Gelcoat Topcoat	Chemical constitution/ physical function Chemical / physical performance handling (basics) handling rules (according to manufaturer, experience, etc)
Proofing & sealing On rotor blades	Field of application	Sealant (characteristics & handling) Sealant (types & assembling)
Surface treatment Coating	Gelcoat Varnish	Preparing surfaces Protection foil methods & working devices (brushing, rolling, spraying, according to access method) Auxilliary devices (especially using rope access)
Leading ege protection- - liquid	Liquid products	manufacturer preparing surface adjusting mixture
Leading ege protection- - - foil	3M / TESA Foil Edge sealing	Preparation of the surface Cutting, stencil for cutting curves Edge sealing

Module 3 – Rotor Blade Repair Work

Repair Work On Blade Components - Theory

Reparatur an Komponenten der Blattsteuerung		
Pitch mechanic	Control Sealings Maintenance	Adjusting blade according to access method (rope or platform) Automatic safety controls Handling the hydraulic Changing rummber seals
Tip-area **Tip-mechanic**	Fiber component repair work Service of the tip-mechanism	Repair work at hem Repair work on service hatch Service on tip-mechanic Changing tip cones Adjustments on tip mechanism
Repair and Fitting Aerodynamic Flow Elements		
Vortex-Generator	Spare parts Retrofitting Replacement Bonding material	Demounting broken elements Preparing surface Mounting new elements Sealing edges Requirements & preparations when blade is going to be fitted for the first time. (initial installation, retrofitting)
Stall-stripes	Retrofitting Replacement	Demounting Prepairing surface Mounting new elements Calibration & work flow (retrofitting instructions/ measurements)
Zig-zag ribbon	like previous	like previous
Guerney-Flaps	like previous	like previous
Turbo-Rills	like previous	like previous

PRACTICE

Repair Work On Blade & Components

Damages on rotor blade		
Repairing damages on rotor blade samples	Repair of gelcoat spallings, cracks, holes	Choosing and handling the appropriate material Preparation & workflow working methods & tools
Surface treatment	Topcoat, Varnish	Choosing and handling the appropriate material Preparation & workflow working methods & tools