Important Update:

Due to new developments shortly to be released, we are now requiring that all installs have an additional 1mm 4core SWA cable laid alongside the turbine power cable. This cable should be left unterminated at both ends with the exposed ends protected from contact.

This is to enable us to implement monitoring and logging solutions which will be of benefit to both the customer and the reseller. Failure to lay this cable will mean that you and your customer miss out on these future developments which in some instances may be provided free of charge.

Osiris Energy Osiris 10 Foundation Installation Guide V8A

FOUNDATIONS ARE TO BE INSTALLED BY TRAINED PERSONNEL ONLY.
THE FOUNDATIONS IN THIS MANUAL ARE A GUIDE ONLY AND AN ASSESMENT OF THE GROUND SHOULD BE MADE PRIOR TO INSTALLATION TO ASSESS WHETHER THESE FOUNDATIONS ARE ADEQUATE FOR THE SPECIFIC SITE CONDITIONS

Revision History

Revision	Date	Description of Change	Initials
0	11/01/2010	First Release	BH
1	16/02/2010	Minor Grammatical Amendments	BH
2	04/05/2010	Full foundation spec revision	BH
3	06/05/2010	Additional drawings for clarity. Revised reinforcing schedule.	BH
4	13/05/2010	Improved annotations in appendix 2 and 3	BH
5	25/05/2010	Amended spec for ease of construction. V4 is still a valid foundation design however this version should be cheaper and quicker to produce. Changes in Photos, Section 3.3, Appendix 1, 2 and 3.	BH
6	17/09/2010	Photos updated throughout. Bar code 03 quantity increased from 12 to 16	BH
7	11/10/2010	Additional 100kN Details	BH
8	10/11/2011	Revised foundation to suit new 15m tower design. Please ensure you check which tower design you will be receiving to decide on whether you will need to use V7 or V8 of these instructions. The new design will be phased in gradually	BH
8A	15/11/2011	Added requirement for additional cable to the turbine for future logging and monitoring system	BH
8B	25/10/2012	Added requirement for additional cable to the turbine for logging and monitoring system based on revision of 15/11/2011	BH

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1. Introduction

This manual contains important information concerning the installation of the Osiris 10 wind turbine foundations. It is strongly recommended that you read and familiarise yourself with its contents before beginning work.

ONLY OSIRIS ENERGY TRAINED AND CERTIFIED INSTALLERS SHOULD INSTALL OSIRIS ENERGY WIND TURBINES. POOR OR INCORRECT INSTALLATION CAN LEAD TO FAILURES WHICH MIGHT ENDANGER LIFE.

OSIRIS ENERGY WILL NOT ACCEPT ANY LIABILITY FOR ANY PROBLEMS OR FAILURES DUE TO TURBINES WHICH HAVE BEEN INSTALLED BY UNCERTIFIED INSTALLERS.

IF YOU ARE NOT CERTIFIED, DO NOT INSTALL THE TURBINE. IF YOU ARE CERTIFIED, AND ARE IN ANY DOUBT ABOUT ANY INSTRUCTION CONTAINED IN THIS DOCUMENT, CONTACT OSIRIS ENERGY BEFORE INSTALLATION

This manual gives a minimum standard that Osiris Energy expects all installations to comply to. Installers are required to be MCS accredited and members of the REAL Assurance scheme and should ensure that installations comply with all requirements as part of these accreditations.

Installers are also required to keep abreast of current legislation and should ensure all installations comply with the most up to date legal requirements. Particular attention should be given to any changes in British Standards (e.g. BS7671 Wiring regulations), Energy Savings Trust recommendations or DNO connection requirements. Where changes in this legislation improve on the standards in this document the new guidance should be taken to overrule the information given in this manual.

The Osiris 10 turbine is a reliable, well engineered machine backed up with a 5 year warranty. At Osiris Energy we are confident that with proper installation and maintenance the turbine will run successfully and reliably for many years to come.

2. Health and Safety

The long term safety of the wind turbine depends on a number of issues that both system designer and installer must address. Potential hazards need to be identified and eliminated or minimised. This does not just include those which may be present during installation but also any that may develop over time.

Poor installation can compromise the long term safety of the system. Equally, unsafe site and working conditions can put installation engineers at risk. Correct design of the system as well as thorough planning of the installation phase will help to ensure the quality of the installation as well as the safety of the work team.

Installers need to take note of their statutory duties under health and safety law and are responsible for ensuring compliance with the law.

The Construction (Design and Management) Regulations may also apply if more than four people will be involved in the construction work at any one time. The project is notifiable to the Health & Safety Executive if it will exceed 30 days or involve more than 500 person-days of work. However, there are exceptions to this.

As part of standard Health & Safety practice, a Risk Assessment should be completed. This is a legal requirement under the Management of Health & Safety at Work Regulations 1999.

Especial attention should be given to the following points:

- Due regard should be given to any public rights of way close to the installation site
- The local situation should be taken into account, e.g. the likely presence of children
- Existing site services (e.g. overhead or underground electric cables) should be identified and exclusion zones defined
- Temporary signs, notices and barriers should be erected
- The local weather conditions should be considered. Osiris Energy does not recommend the installation of turbines in wind speeds greater than 12 m/s.
- Structural and mechanical installation must be actively managed and supervised by a suitably experienced and competent person
- All workers involved in the works must be fully briefed on the sequence of operations before they commence. This is to include the identification of danger areas that must not occupied during the erection process
- All personnel must wear appropriate personal protective equipment, including high visibility jackets, hard hat and safety boots
- During installation and maintenance works, an exclusion zone shall be established to prevent persons not engaged with erection of the turbine from gaining admittance
- Standard precautions for working with rotating machinery should be taken: long hair should be tied back; loose clothing avoided; rings, necklaces and other jewelry removed.

3. Foundation installation

3.1 Ground Assessment

The foundation details given in this document are given as a guide only. We always recommend a ground assessment is carried out before installation to determine whether the standard foundation design given in this document is appropriate. If there is any doubt about the ground conditions it is recommended that a qualified civil engineer is consulted and a custom foundation designed to suit the particular requirements

This standard foundation design in this document can be constructed in various sizes depending on ground bearing pressures.

3.3m x 3.3m x 1.5m Foundation: 175kN/m^2

3.5m x 3.5m x 1.5m Foundation: 125kN/m^2

3.75m x 3.75m x 1.5m Foundation: 100kN/m^2

The following table gives an indication of the allowable bearing pressure which may be expected from various types of soils. However the design of suitable foundations depends on many factors in addition to the applied loading and allowable ground bearing pressure.

Type of Subsoil	Condition of Subsoil	Field Test Applicable	Approximate bearing pressure kN/m^2
Rock	Not inferior to sandstone, limestone or firm chalk	Requires at least a pneumatic or other mechanically operated pick for excavation	1000
Gravel / Sand	Compact	Requires pick for excavation. Wooden peg 50mm square cross section hard to drive beyond 150mm	Dense to very dense 150-400 Loose to medium dense 50-250
Clay, Sandy Clay	Firm	Can be moulded by substantial pressure with the fingers and can be excavated with a spade	50-100
Sand, Silty Sand Clayey Sand	Loose	Can be excavated with a spade. Wooden peg 50mm square in cross section can be easily driven	<75
Silt, Clay, Sandy Clay	Soft	Fairly easily moulded in the fingers and readily excavated	<75
Silt, Clay, Sandy Clay	Very Soft	Natural sample in winter conditions exudes between fingers when squeezed in fist	<75

These values are provided for guidance only. If any doubt exists a qualified civil engineer should be consulted.

3.1 Preparation

It must be ensured that prior to the start of any work that the exact location of the foundations matches the location specified in the planning consent.

Before setting the base plate and foundations into the concrete foundation consider which way your Wind Turbine will be lowered/raised and position the hinge-pin and foundation plate appropriately.

The foundation consists of a large block of high-strength concrete. Twenty four (15m) or fourteen (12m) high tensile steel foundation rods are set into the concrete and these are attached to the foundation base plate and hydraulic cylinder base plate. The foundation also includes a removable template which sits above the bolts and ensures that alignment is correct.

It is recommended that the foundation be prepared with one single load of concrete. Where this is not possible it is very important that the second load is added before the initial load has set.

Usually, when building houses, builders use a method known as 'Shutter and Backfill'. When using this method a mould is produced (shuttering) which is then filled with concrete. The area around the mould is then backfilled with earth after the foundation has cured.

Whilst this method is suitable for building construction, we do not recommend it for wind turbine foundations. For wind turbine foundations it is much better to have an irregular shaped foundation surrounded by solid ground than a perfect cube surrounded by loose earth.

3.2 Concrete Specification

If ground conditions are judged to be standard, a 35N or better concrete will be adequate for most conditions. When ordering use the code RC28/35.

You should allow plenty of time for the foundation to set and fully cure before erecting the turbine. We recommend a curing period of at least 2 weeks however any recommendations from your concrete supplier should be followed. This is especially important if temperatures fall below 5 degrees Celsius or the weather is particularly damp.

If a quicker curing time is required then a quick-setting concrete additive can be used. If an installer feels this is required we recommend consulting with a Structural Engineer to decide on the exact additives to be used.

The quantity of concrete should be calculated to suit the exact hole dimensions. This is likely to be between 16 and 24 cubic meters. This equates to around 3 truck loads.

When pouring concrete it is essential that it is thoroughly compacted with a vibrator and worked around all parts and into all corners and voids.

3.3 Foundation Kits

There are two foundation kits depending on the tower size specified. It is essential that the correct foundation is installed for the correct tower. It is not possible to retrofit a 15m tower on a 12m base. Steel reinforcement is also required but not supplied. For ordering purposes we provide a reinforcing schedule in Appendix 1.

Please check that all parts of the received foundation kit are correct. It is also essential to ensure that the base plates are orientated and spaced correctly as shown in appendix 2 or 3.

12M Tower Foundation Kit

The 12m foundation fit comprises the following:

Part No	Name	Details	Qnty
1	Tower Foundation J Bolt	M36x1500	10
2	Cylinder Foundation J Bolt	M36x1330	4
3	Tower Base Plate	860 dia	1
4	Cylinder Base Plate	330 dia	1
5	M36 Nut	M36	28

15m Tower Foundation Kit

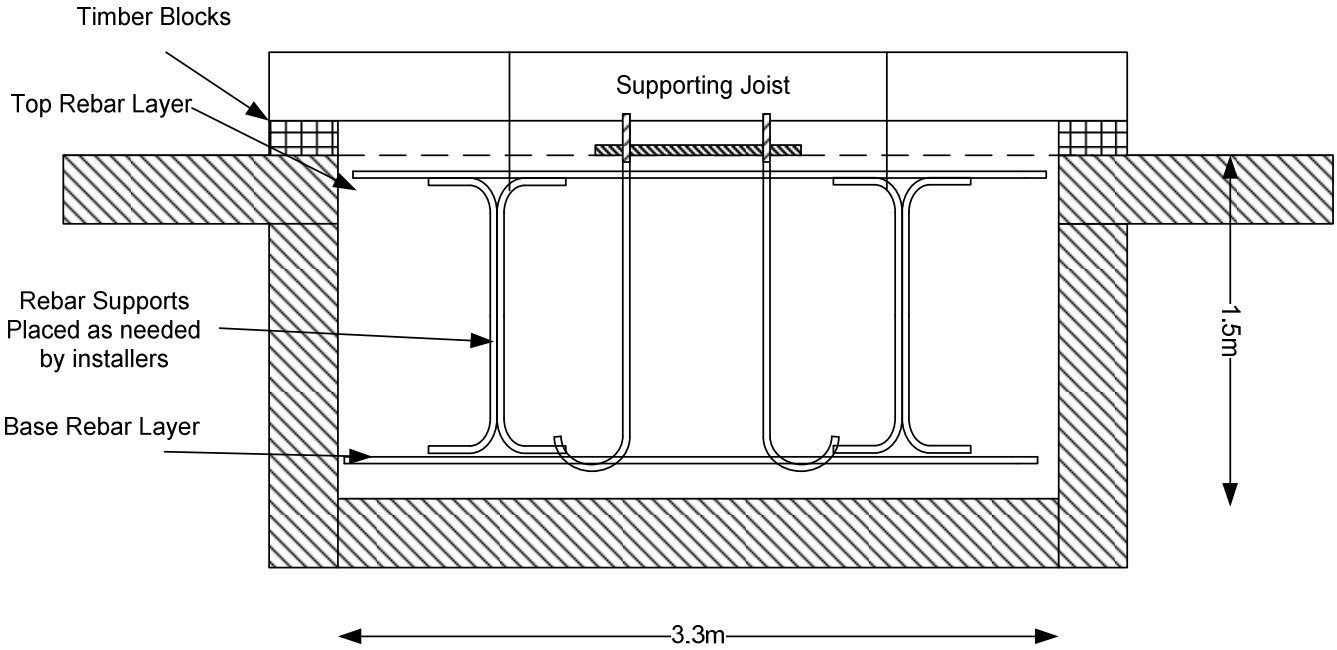
Part No	Name	Details	Qnty
1	Tower Foundation J Bolt	M30x1500	20
2	Cylinder Foundation J Bolt	M36x1500	4
3	Tower Base Plate	1170 dia	1
4	Cylinder Base Plate	350 dia	1
5	M30 Nuts	M30	40
6	M36 Nuts	M36	8

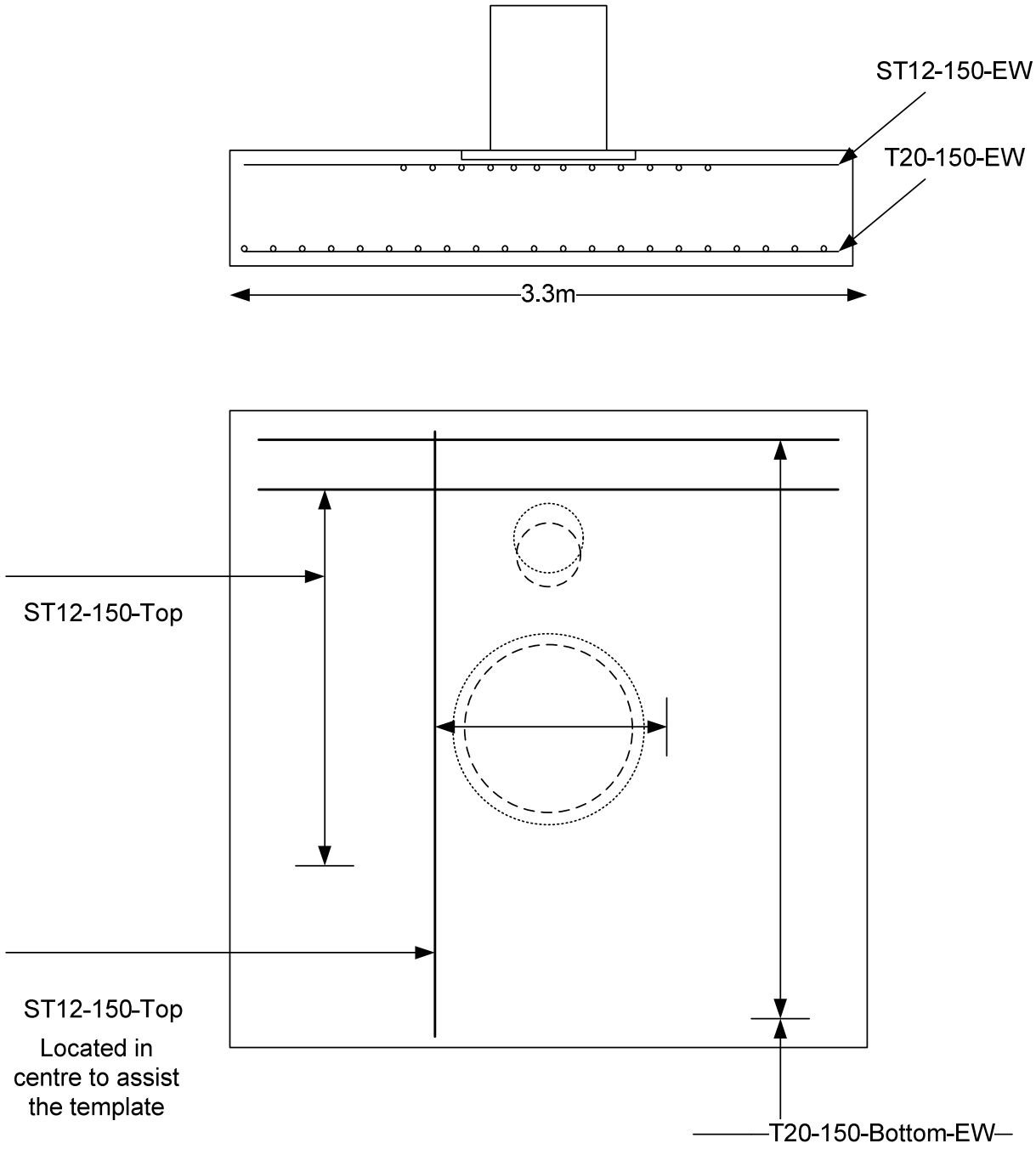
3.4 Foundation Kit Construction

- First build up the foundation bolts and anchor plates. The system is built up as shown in the photos below.
- First thread a nut onto each of the large foundation ‘J’ anchor bolts. This should be tightened down to the base of the thread.
- The top threaded section of the anchor bolts should then be threaded through the circular foundation plates and then into the top 10mm template. Finally a nut and washer should be tightened up to hold the anchor bolts in place.
- There are two templates on for the 12m tower and one for the 15m tower. Once all anchor bolts have been installed the structure can be lifted into a vertical, stood up position on a firm level surface.
- Next, the reinforcing bar needs to be added around the foundation structure.

3.4 Foundation Construction Methodology

Both size tower use the same size foundation. The methodology below applies to both towers.





- Excavate the hole to the correct width and length. For ground loadings of 175kN/m^2 the foundation will be 3.3m x 3.3m x 1.550m deep. For ground loadings of 125kN/m^2 the foundation will be 3.5m x 3.5m x 1.550m deep. For ground loadings of 100kN/m^2 the foundation will be 3.75m x 3.75m x 1.550m deep.
- Blind bottom of hole with 50mm of GEN 1 concrete and allow to cure.
- Insert 50mm concrete spacers to support the foundation steelwork and ensure correct cover
- Install bottom reinforcement around anchor assembly as per the drawings above. Where possible the reinforcement should go through the J bolt. The assembly should be fastened together with wire.

- Install top reinforcement around anchor assembly and fasten together with wire. Use supporting rebar (bar mark 03) as needed to support the top layer of rebar and prevent sagging.

- At this stage the cable conduit should be inserted through the foundation steel work up to the hole in the turbine base plate.
- The top reinforcement and base plate could be suspended with wire from wooden or steel joists spanning the excavation. This should prevent sagging and also help in positioning and leveling the base plate. It is also possible to bolt supports onto the top template

- The base plate should be leveled to the level of the foundation. (Please note that the concrete should come up to the top of the base plates. The top template will be removed at the end of installation.

  It is essential that this plate is as level as possible.

- Pour concrete using RC28/35 concrete. A vibrating poker should be used to ensure all voids are filled and that the concrete is spread evenly.

- Make sure that the base plate is fully supported underneath by concrete and that the top of the concrete is flush with the top of the base plate and is screed to smooth level. Also ensure the base plates are cleaned.

- Allow to cure fully before installing the turbine. This will be around 3-4 weeks however your concrete supply company should be consulted as cure time will depend on temperature and conditions.

- Once the concrete has set the supports and top template can be removed and used at the next installation

3.5 Cable trench

Specifications of required cables:
1) 3 PCS of 3 phase cable of generator(10 square mm or greater)
2) 1 PC of Grand cable(6 square mm or greater)
3) 2 PCS of signal cable of anemometer(1 square mm) and 2 PCS of drive cable of motor driven push rod(1 square mm)

Cable trenches should be installed at the same time as the foundations. The cable trench should be at least 750mm deep and go in an as direct-route as possible to the control panels. Cable runs should be as short as possible and avoid any sharp corners or bends.

There are two methods for cable installation

Ducting with draw rope.

In this case PVC ducting should be installed in the trench with an integral draw rope. This rope should be of sufficient strength to pull the heavy cable through the duct and around any corners.

The ducting and draw rope should be installed at the base of the trench and backfilled to around 200mm from the surface. The ducting should be designed to prevent water ingress and prevent pooling. Yellow Cable Warning tape should then be placed along the cable run route and then finally backfilled to the surface level.

Direct cable install

SWA cable can be directly installed in the trench at the time of digging. In this case a 25mm layer of sand should be first sifted into the trench to prevent sharp stones damaging the cable. The cable can be the installed on top of this layer and then covered with a further 25mm layer of sand to protect the top of the cable. The trench should then be backfilled to within 200mm of the surface where yellow cable warning tape should then be placed along the cable run before back filling to the surface level.

Appendix 1 – Reinforcing Steel schedule

3.3m x 3.3m

Member	Bar Mark	Type and Size	Total No	Length of Each Bar	Shape Code	A* (mm)	B (mm)	C (mm)
Base reinforcement	01	H20	44	3150	00	3150	-	-
Top reinforcement #	02	H12	24	3150	00	3150	-	-
Supporting reinforcement	03	H20	16	1650	21	250	1150	250

3.5m x 3.5m

Member	Bar Mark	Type and Size	Total No	Length of Each Bar	Shape Code	A* (mm)	B (mm)	C (mm)
Base reinforcement	01	H20	44	3350	00	3350	-	-
Top reinforcement #	02	H12	24	3350	00	3350	-	-
Supporting reinforcement	03	H20	16	1650	21	250	1150	250

3.75m x 3.75m

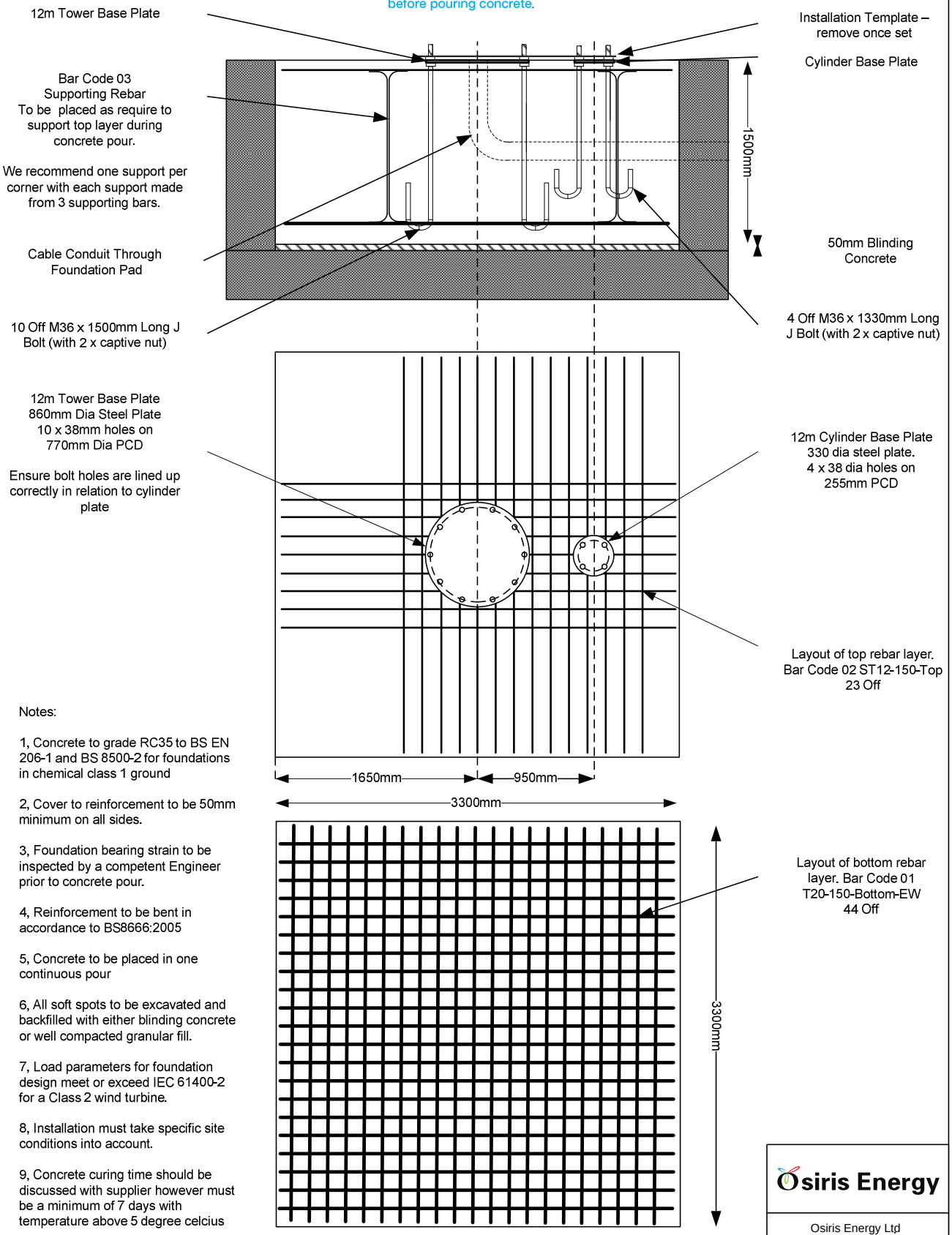
Member	Bar Mark	Type and Size	Total No	Length of Each Bar	Shape Code	A* (mm)	B (mm)	C (mm)
Base reinforcement	01	H20	50	3600	00	3600	-	-
Top reinforcement #	02	H12	24	3600	00	3600	-	-
Supporting reinforcement	03	H20	16	1650	21	250	1150	250

if preferred for installation the top reinforcement can be replaced with a mesh of equivalent size.

Supporting reinforcement to be placed as required by installer to support top rebar layer. We recommend one support per corner with 4 bars per support.

Appendix 2 – 12m Foundation Overview Drawing

Please check that all base plates are the correct dimensions before beginning work. Please also ensure they are orientated and spaced correctly before pouring concrete.



Notes:

1, Concrete to grade RC35 to BS EN 206-1 and BS 8500-2 for foundations in chemical class 1 ground

2, Cover to reinforcement to be 50mm minimum on all sides.

3, Foundation bearing strain to be inspected by a competent Engineer prior to concrete pour.

4, Reinforcement to be bent in accordance to BS8666:2005

5, Concrete to be placed in one continuous pour

6, All soft spots to be excavated and backfilled with either blinding concrete or well compacted granular fill.

7, Load parameters for foundation design meet or exceed IEC 61400-2 for a Class 2 wind turbine.

8, Installation must take specific site conditions into account.

9, Concrete curing time should be discussed with supplier however must be a minimum of 7 days with temperature above 5 degree celcius

10, If in doubt seek professional advice

Osiris Energy

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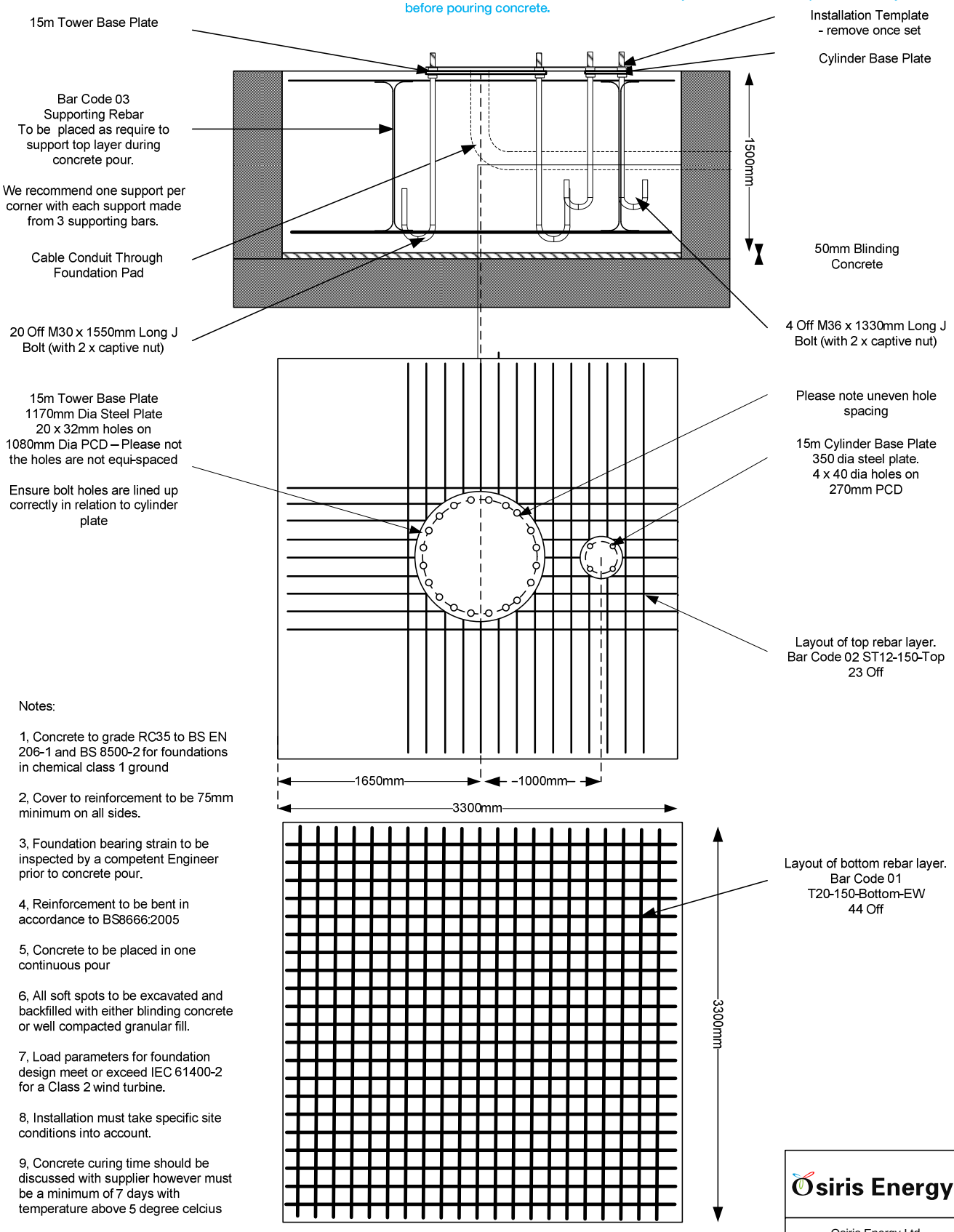
info@ginlong.com

Appendix 3 – 15m Foundation Overview Drawing

Please check that all base plates are the correct dimensions before beginning work. Please also ensure they are orientated and spaced correctly before pouring concrete.



Notes:

1, Concrete to grade RC35 to BS EN 206-1 and BS 8500-2 for foundations in chemical class 1 ground

2, Cover to reinforcement to be 75mm minimum on all sides.

3, Foundation bearing strain to be inspected by a competent Engineer prior to concrete pour.

4, Reinforcement to be bent in accordance to BS8666:2005

5, Concrete to be placed in one continuous pour

6, All soft spots to be excavated and backfilled with either blinding concrete or well compacted granular fill.

7, Load parameters for foundation design meet or exceed IEC 61400-2 for a Class 2 wind turbine.

8, Installation must take specific site conditions into account.

9, Concrete curing time should be discussed with supplier however must be a minimum of 7 days with temperature above 5 degree celcius

10, If in doubt seek professional advice

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Appendix 4 – Foundation Sign Off Certificate

OSIRIS ENERGY FOUNDATION CERTIFICATE

I CERTIFY THAT THE FOUNDATIONS FOR THE WIND TURBINE AND TOWER ARE INSTALLED AT LEAST THE STANDARDS OUTLINED IN THE OSIRIS ENERGY INSTALLATION INSTRUCTIONS. WE HAVE ASSESSED THE SPECIFIC GROUND CONDITIONS ON SITE AND THE INSTALLED FOUNDATION HAS BEEN DEEMED SUITABLE

WHERE CHANGES TO THE SPECIFICATION HAVE BEEN MADE THESE HAVE BEEN MADE WITH THE APPROVAL OF A REGISTERED CIVIL ENGINEER AND THESE CHANGES DO NOT REDUCE THE FOUNDATIONS RATINGS IN ANY WAY. WE ALSO HOLD AN APPROPRIATE DESIGN FILE SHOWING ALL CALCULATIONS MADE AND THIS IS AVAILABLE ON REQUEST.

I UNDERSTAND THAT ANY DEVIATIONS FROM THE OSIRIS SPECIFICATION WHICH ARE JUDGED TO REDUCE THE EFFECTIVNESS OF THE FOUNDATION DESIGN MAY INVALIDATE OUR WARRANTY

NAME:	
SITE ADDRESS:	
DATE:	
TURBINE TYPE AND TOWER SIZE	
STANDARD / NONSTANDARD FOUNDATION DESIGN?	
MCS INSTALLER DETAILS	
SIGNED	

This information should also be filled in online by the Osiris Reseller as part of the warranty registration at:
WWW.OSIRISWIND.COM/WARRANTY

FAILURE TO DO THIS MAY RENDER THE CUSTOMERS WARRANTY INVALID