Waukee School District Wind Turbine Site Assessment

H.) The rotor for this particular machine is only designed to turn 167 rpm at any given wind speed. This is because the Endurance S-343 machine is an induction based A/C generating unit. To be this it must match the cycles (wave length) of the grid feeding the property. The over speed controls are a redundant fail safe pneumatic disk brake design. There are 2 pneumatic brakes that apply separate from each other. One break is enough to stop the machine completely but again it is a fail safe design. The cut out speed for this machine is 54 mph. It will not start back up until it is in normal operation conditions.

I.) The S-343 machine is an upgrade from the S-350 machine. It has 2' longer blades and a larger gearbox. This allows more production. The S-250 had been in production for over 5 years and has been tested by NREL (National Renewable Energy Laboratory). The S-343 has been in production for 2 years now and has also been tested by NREL.

J.) Mid American Utilities has been notified of intentions for a 5KW Endurance wind turbine on their grid. Mid American Utilities has a net metering policy of 500 KW and under so we are well in the parameters of this policy.

K.) This is what is being decided in the P and Z meetings and the City Council meetings upcoming

L.) This site is conducive for a wind turbine. Please see the wind assessment attached to this page. The wind speeds are from AWS Truewind a site respected by the industry for accurate data. This also supplies a wind rose and wind speeds broken down by month.

M.) This site and turbine height will comply with all FAA regulations. There is no lighting required for the turbine as it is under the 200' height.

N.) The Waukee School District has more than adequate insurance that the turbine can be attached to with a rider. The insurance required by the utility company can also be attached to their existing insurance. This is what other customers of VanWall Energy have done in the past.

O.) The City of Waukee noise ordinance will suffice for this machine.

P.) Shadow flicker will not be an issue in this location.

Q.) Please let me know anything else necessary for this assessment.

Thanks,

Jesse Fenske

VanWall ENERGY

Endurance wind power

S-Series Interconnection Supplement | S-Series

endurancewindpower.com

Green energy that works™

Version 1.9
June 14, 2010

www.endurancewindpower.com

Contents

Introduction

This document is intended to assist dealers in establishing an interconnection agreement with the local utility for the Endurance 5kW wind turbine system.

Interconnection Characteristics

Grid connection:	Direct
Inverter:	None

Generator Characteristics

Generator Technical Data

Generator type:	Induction
Generator speed:	1800-1850 rpm
Voltage:	240 VAC single phase above 1.5 kW, 120VAC single phase below 1.5 kW
Manufacturer:	Marathon Electric
Model:	ME040292
Frame Size:	184-TC
Certification:	UL 1004 CSA C22.2 No. 100

Additional Induction Generator Data

Rotor Resistance, Rr:	0.550 Ω
Rotor Reactance, Xr:	1.106 Ω
Magnetizing Reactance, Xm:	35.69 Ω
Exciting Current:	2.8Amps @ 240V, 60 Hz
Stator Resistance, Rs:	Main = .417 Ω Aux = .836 Ω
Stator Reactance, Xs:	X1M = 1.309, X1A = 1.560 Ω
Short Circuit Reactance, Xd:	3.236 (100MVA base the pu would be 12944000)
Rotor inertia:	0.018 kg-m^2

Table 1. Generating Characteristics

Characteristic	S-250	S-343
Rated Power (kW)	4.3	5.2
Rated VA (kVA)	4.6	5.9
Rated Current (A)	19.2	24.4
Peak Power (kW)	5.8	5.9
Peak VA (kVA)	6.3	6.7
Peak Current (A)	26.4	27.9

Motoring characteristics

The generator is used as a motor to start the rotor from the stopped rotor position. This will occur no more than once every 10 minutes and typically no more than a few times per day.

Motoring Voltage:	120 VAC single phase
Motoring Current:	~41 A
Motoring VA:	~5,000 VA
Motoring Time:	<8 seconds typical (dependent on wind speed at the time)

Protection Equipment

Disconnect Switch:

The wind turbine installation requires a lockable disconnect switch which is clearly labeled "WIND GENERATOR DISCONNECT SWITCH". This disconnect switch can be located at either the base of the tower or at the utility connection.

Interconnection Protective Relay:

The Endurance S-Series turbines come equipped with distributed generation interconnection relay protection. The relay will monitor and disconnect the wind turbine generator during conditions of over/under voltage and/or over/under frequency resulting from either a system wide voltage/frequency disturbance or due to local system islanding. Phase loss will also be detected since both legs of the single-phase 240 VAC connection will be monitored separately at all times. These monitoring parameters have been determined by IEEE1547.

Any out-of-bound condition will result in the turbine disconnecting from the local utility grid. After the grid has been restored, a minimum "off-line" wait

Table 2. SEL interconnection relay settings

Monitored Parameter	ANSI Device #	Setting	Voltage or Frequency (based on 120VAC/60Hz Nom.)	Cycles to Disconnect	Time to Disconnect (sec.)
under-voltage (level 1)	27	50% Nom.	60 VAC	6	0.1
under-voltage (level 2)	27	88% Nom.	106 VAC	108	1.8
over-voltage (level 1)	59	110% Nom.	132 VAC	48	0.8
over-voltage (level 2)	59	120% Nom.	144 VAC	6	0.1
under-frequency (level 1)	81	95% Nom.	57 Hz	6	0.1
under-frequency (level 2)	81	98.8% Nom.	59.3 Hz	6	0.1
over-frequency (level 1)	81	100.8% Nom.	60.5 Hz	6	0.1

period of 5 minutes will be imposed before the turbine resumes normal operation.

SEL-547 Interconnection Relay
Table 2 documents parameter settings for the Schweitzer Engineering Laboratories SEL-547 utility interconnection relay; other custom settings can be accommodated.

Over Current:
The wind turbine will be protected by a main circuit breaker. This breaker will be a 40 A - 240 VAC 2 pole.

Control Panel

The control panel is housed in a NEMA Type 4 & Type 12 enclosure and is typically mounted at the base of the tower [CSA C22.2 No. 14-05, UL 508A].

Metering

We recommend the wind turbine system be metered allowing for an evaluation of energy production. A standard 240 V utility meter is adequate.

Power Quality

Power Factor
The power factor (PF) has been measured using a Phaser watt transducer (accuracy 0.3%). Data was collected at 5 Hz and averaged for 1 minute then binned into 500 watt bins, shown in Figure 3 on page 1-4.

Total Harmonic Distortion
Total harmonic distortion (THD) has been measured using a Phaser watt transducer (accuracy 0.5%). The Phaser can be configured to calculate either THD-F, a ratio of the harmonics to the fundamental or THD-R, a ratio of the harmonics to the RMS of the input. Both THD-F and THD-R were collected. Data was collected at 5 Hz and averaged for 1 minute then binned into 500 watt bins, as shown in Figure 2 on page 1-4.

Both values are shown to be as high as 1.5% dropping to less than 1.0% at the higher power levels.

Voltage Fluctuations
The Endurance has been designed to minimize voltage fluctuations (voltage sag or flicker) that can occur when an induction generator is connected with the utility grid. There are three key elements used to reduce these voltage sags.

1. The generator is connected at 120 VAC. By using a lower voltage the power draw is cut by 75%.
2. A power resistor is switched in at the moment of contact resulting in a voltage drop across the resistor and therefore a further reduction in current draw, which reduces flicker during start-up.
3. The control program has been designed to use hysteresis which limits the number of on- and off-line cycles in a given time.

Measurements were taken at our test facility to evaluate the percent drop in voltage during an on-line connection. Although it is understood that the voltage sag will be somewhat site-dependent on the local system impedance we suspect that our test facility, which is located on the end of the utility line, will represent a higher system impedance.

Our analysis of 10 on-line events showed an average voltage sag of 1.9% with a standard deviation of 0.55%. This process evaluated the RMS value of the single voltage cycle with the highest voltage drop after contact. Nominal voltage is typically recovered within a single voltage cycle; hence this approach determined the largest percent voltage sag due to the event.

Using the plot shown in Figure 1 from IEEE we see that a voltage sag of this magnitude is allowed if its frequency is less than ~1 event/minute. The current control limits on- and off-line cycling via a hysteresis algorithm. Data collected on a turbine operating in the field indicates the effectiveness of this approach. During winds that are fluctuating around cut-in, the highest frequency experienced by the machine for 7 on/off-line connections was 0.85 events/minute with the highest frequency between any two consecutive events at 1.17 events/minute.

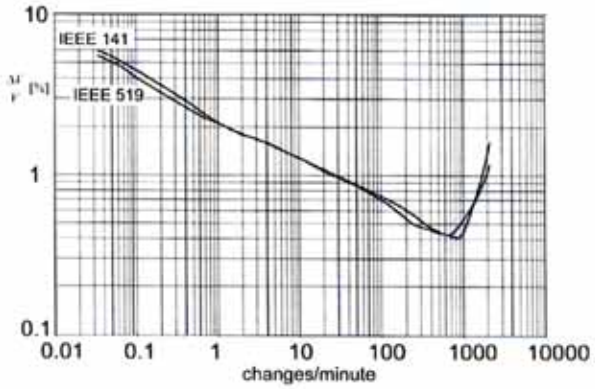


Figure 1. IEEE Stds 141 & 519 flicker curves

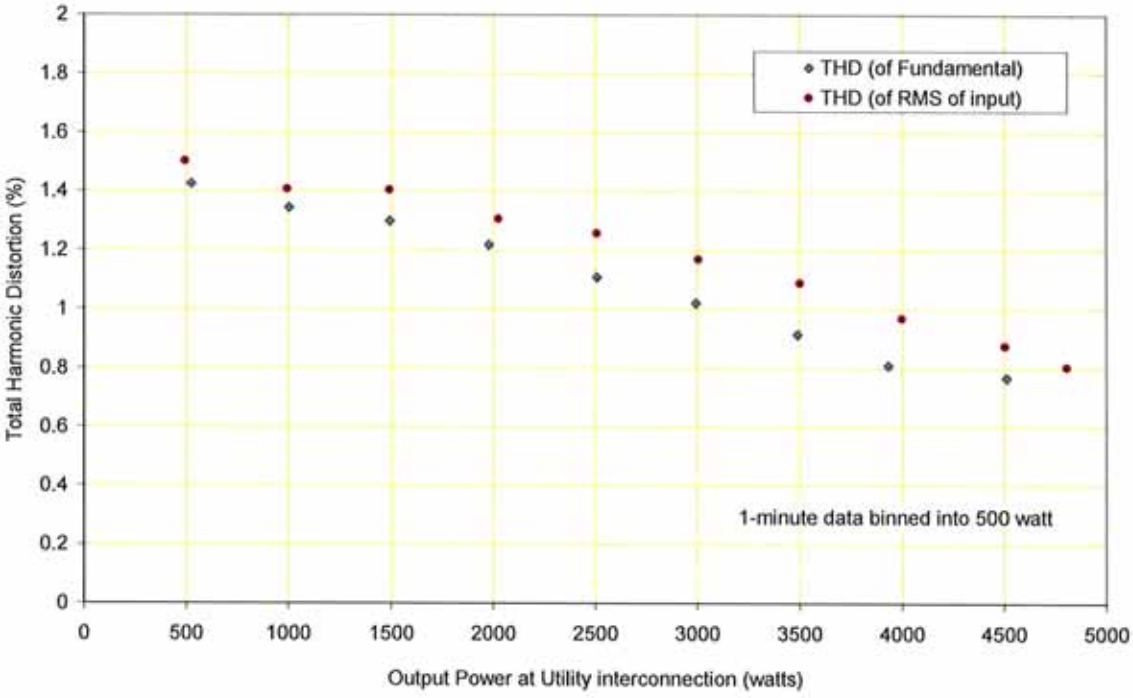


Figure 2. Total harmonic distortion

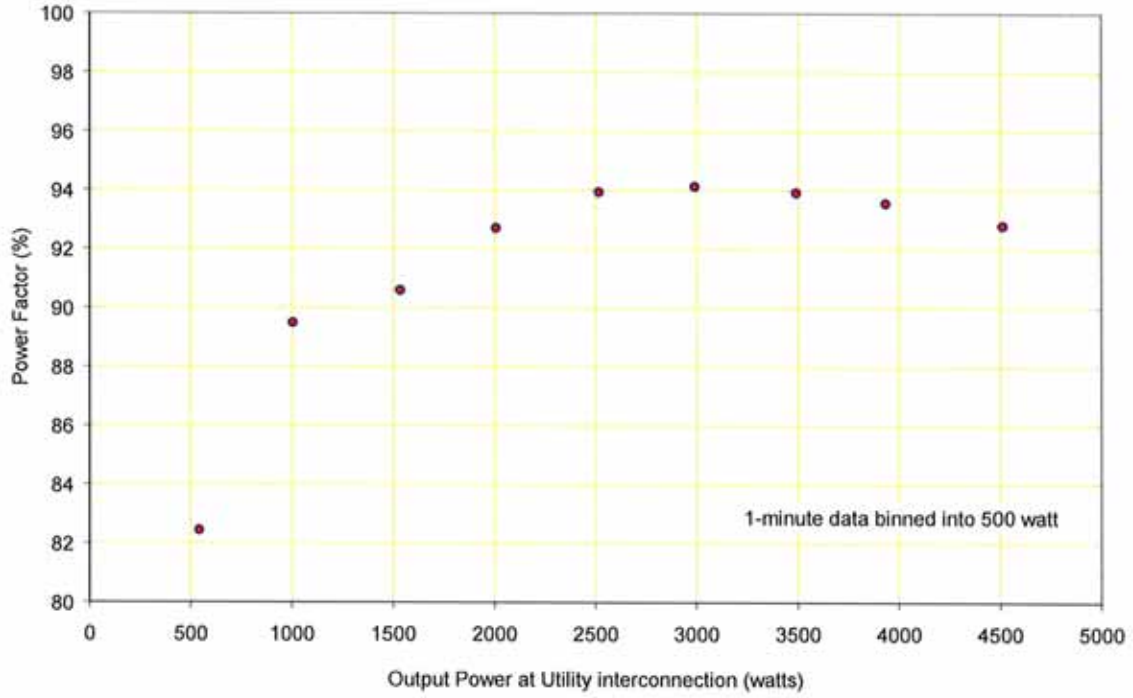


Figure 3. Measured power factor

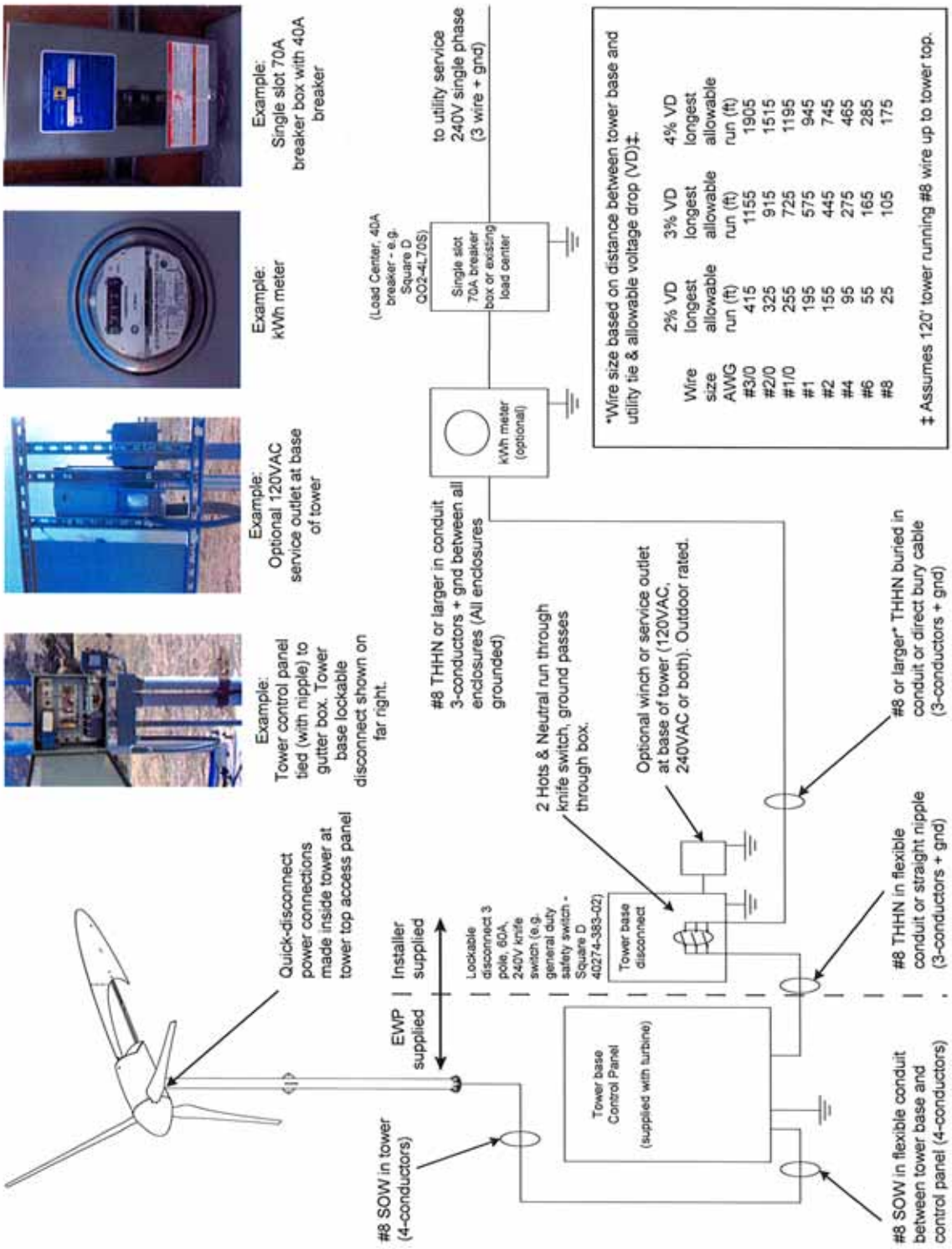
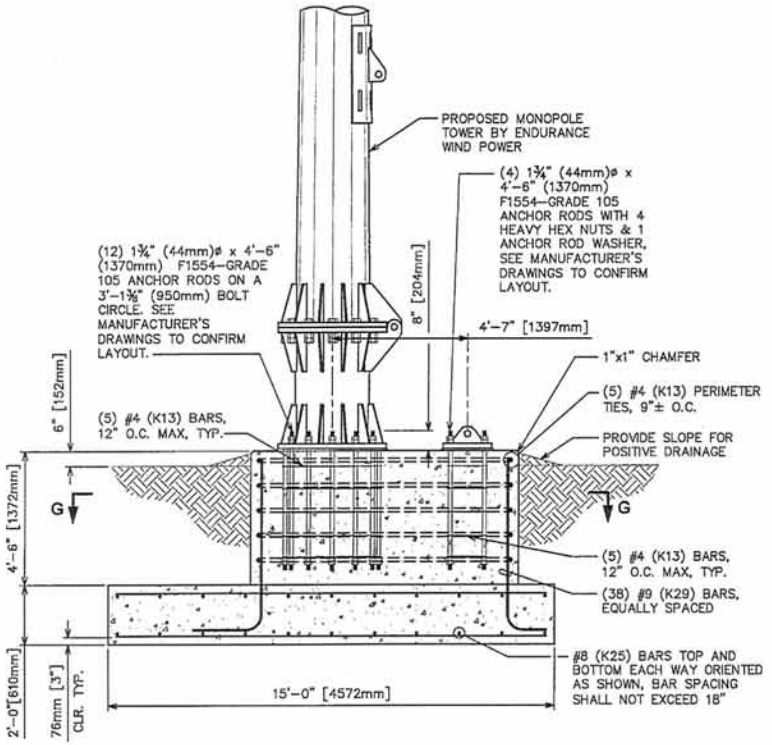


Figure 4. System synopsis

NOTES:

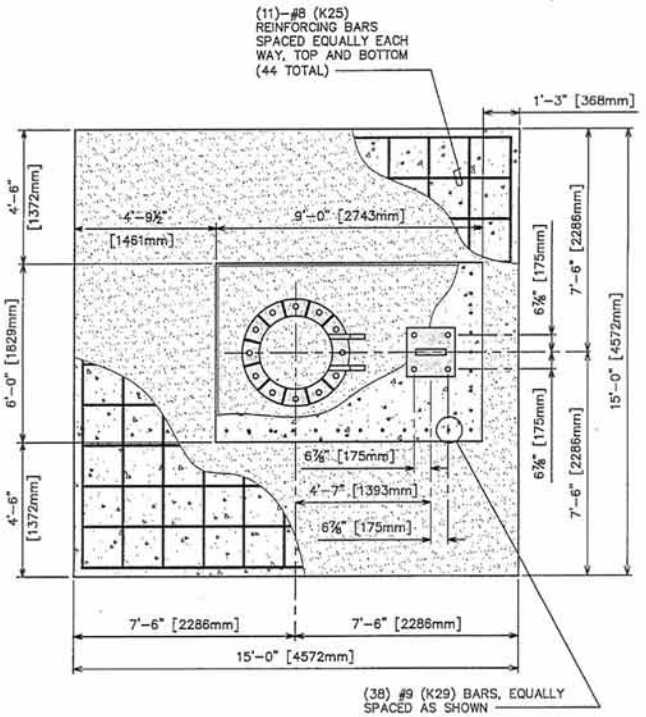
1. THE FOUNDATION DESIGN IS BASED ON SOIL CLASS 5, AS SHOWN IN TABLE 1804.2 (IBC 2006). IT IS THE RESPONSIBILITY OF THE OWNER TO VERIFY BY GEOTECHNICAL INVESTIGATION THAT ACTUAL SITE SOIL PARAMETERS EQUAL OR EXCEED THOSE SHOWN IN THE REFERENCED TABLE ON SHEET S-10. IF CONDITIONS ARE DIFFERENT THAN THIS VALUE, A FOUNDATION ANALYSIS SHOULD BE PERFORMED TO DETERMINE THE STRUCTURAL ADEQUACY OF THE SUBSTRUCTURE.
2. IF THE FROST LINE IS KNOWN TO BE GREATER THAN THE FOUNDATION DEPTH OR THE WATER TABLE IS LESS THAN THE FOUNDATION DEPTH, THE DESIGN ENGINEER (TOWER ENGINEERING PROFESSIONALS, INC.) SHALL BE NOTIFIED PRIOR TO CONSTRUCTION AND A FOUNDATION ANALYSIS OR RE-DESIGN SHALL BE PERFORMED.



FOUNDATION - SOIL CLASS 5

SCALE: ¼" = 1'-0" [6.35mm = 304.8mm]

0 4 8
SCALE IN FEET



SECTION G-G

SCALE: ¼" = 1'-0" [6.35mm = 304.8mm]

0 4 8
SCALE IN FEET

PLANS PREPARED FOR:

Endurance wind power
#107-109052 26th Ave.
Surrey, BC Canada V3S 3V7
Office: (604)-628-5432

PROJECT INFORMATION:

104-FT± [31.7M±] MONOPOLE FOUNDATIONS

PLANS PREPARED BY:

TOWER ENGINEERING PROFESSIONALS
3703 JUNCTION BOULEVARD
RALEIGH, NC 27603-5263
OFFICE: (919) 661-6351
FAX: (919) 661-6350

SEAL:

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
G. M. ANDRES
30869
June 22, 2009

REV	DATE	ISSUED FOR:
4	06-22-09	REVISED CONSTRUCTION
3	06-12-09	REVISED CONSTRUCTION
2	05-19-09	REVISED CONSTRUCTION
1	05-12-09	REVISED CONSTRUCTION

DRAWN BY: JAB | CHECKED BY: REG

SHEET TITLE:

FOUNDATION - SOIL CLASS 5 (OPTIONAL)

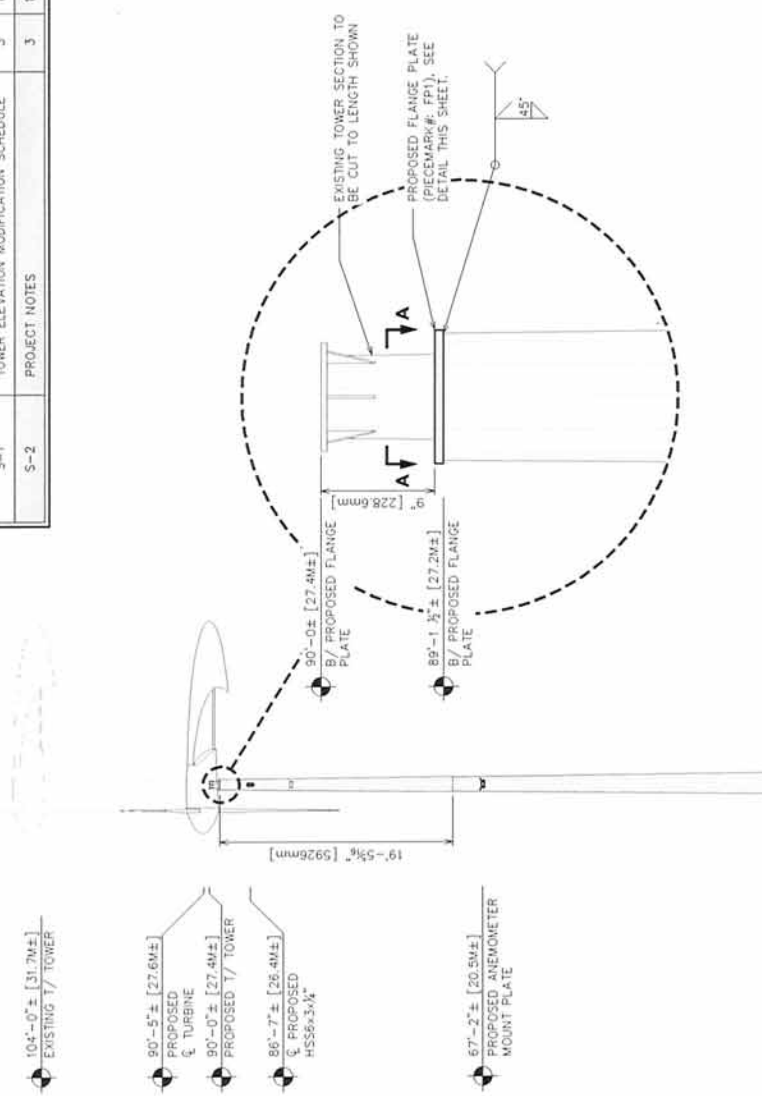
SHEET NUMBER: **S-8C**

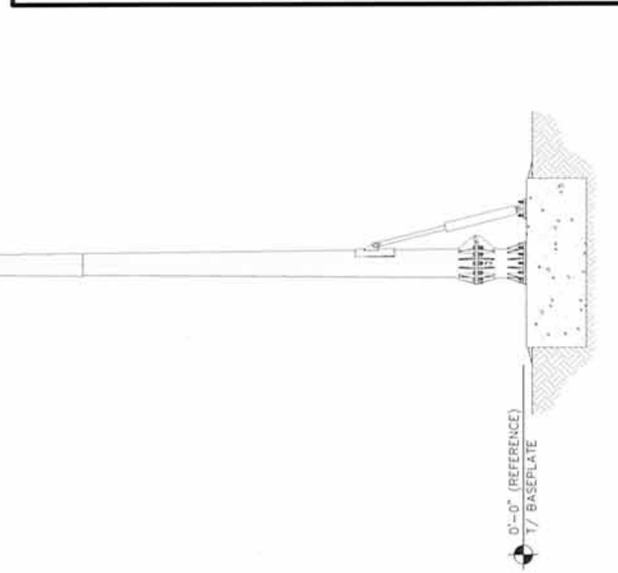
REVISION: 4

TEP #: 090421

INDEX OF SHEETS

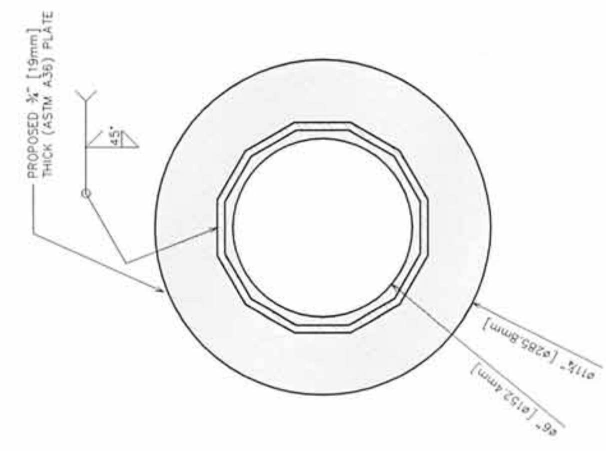
NO.	SHEET TITLE	REV	DATE
S-1	TOWER ELEVATION MODIFICATION SCHEDULE	3	10-26-09
S-2	PROJECT NOTES	3	10-26-09





TOWER ELEVATION

SCALE: 1" = 10' [25.4mm = 3048mm]



SECTION A-A

SCALE: 3" = 1'-0" [76.2mm = 304.8mm]

PLANS PREPARED FOR:

Endurance wind power
#107-109052 26th Ave.
Surrey, BC Canada V3S 3V7
Office: (604)-628-5432

PROJECT INFORMATION:

104-FT± [31.7M±] MONOPOLE MODIFICATION (90-FT± MODIFIED HUB HEIGHT)

PLANS PREPARED BY:

TOWER ENGINEERING PROFESSIONALS
3703 JUNCTION BOULEVARD
RALEIGH, NC 27603-5263
OFFICE: (919) 661-6351
FAX: (919) 661-6350

SEAL:

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
G. M. ANDRES
30869
October 26, 2009

REV	DATE	ISSUED FOR:
3	10-26-09	REVISED PER CLIENT
2	10-15-09	REVISED PER CLIENT
1	09-14-09	REVISED PER CLIENT
0	09-08-09	MODIFICATION DRAWINGS

DRAWN BY: JAB | CHECKED BY: KMM

SHEET TITLE:

TOWER ELEVATION & MODIFICATION DETAILS

SHEET NUMBER: **S-1**

REVISION: **3**

TEP #: 090421