



Date Videbæk, Friday, 23<sup>rd</sup> of January 2015

Description: Fullabrook "2761\_P04\_2014-11-17\_EXT1\_Fullabrook\_Further\_ Updated \_Mitigation\_Strategy"

Account: ESBI Engineering Ltd. Contact Person: Alan Canty Request process: Direct Reply

Project No: 19488

Service Team: C-Support NorthEMEA WTG Engineering & Support

Employee Responsible: Mr. Lars Peter Hansen Employee SCADA: Mr. Carsten Holm Jensen Employee Requestor: Mr. Frederick Greene

I can hereby confirm that Vestas has finished the implementation of the noise mitigation strategy in all the turbines and also on the SCADA system at Fullabrook wind farm.

The turbines and the SCADA system are now operating with settings according to the document 2761\_P04\_2014-11-17\_EXT1\_Fullabrook\_Further\_Updated\_Mitigation\_Strategy.....xlsx.

The Vestas SCADA specialist has developed and introduced the Sector Wind Direction Pause system controlled by the Power Plant Controller.

This new feature was successfully tested and reviewed in the time period from Thursday, January 15<sup>th</sup> 2015 to Tuesday, January 20<sup>th</sup> 2015.

The Sector Wind Direction Pause system was fully integrated and activated on the Fullabrook SCADA system on Wednesday, January 21<sup>st</sup> 2015.

On the following pages you will find a table showing an overview of the current turbine noise settings and the time when they were entered and verified in the turbines. Also a table with SCADA settings has been added to this document.

On the last page in the document you will find a screenshot showing the SCADA settings for the Sector Wind Direction Pause system, which is part of the noise mitigation strategy.

Updated Friday, 06 March 2015: short description of VTM Turbine Parameter Monitoring on page 8

Yours sincerely
Lars Peter Hansen
Engineering Northern Hub
Global Service, EMEA





# **Turbine mitigation strategy:**

Turbine ID	Generator strategy	Mitigation Sector	Parameters	for NRMS	Date and time for the implementation of Mitigation Strategy dd-mm-yyyy hh:mm:ss	Initials
41307/WTG01	Delta mode only	Turbine 1 Operational Mode Required Min Wind Speed	Sector 1 6 5,3	Sector 2 3 11,2		LPH
		Max Wind Speed Min Wind Direction Max Wind Direction Overall Time Period	11,2 0 270 0700 -	14,0 0 270 2300	14-01-2015 10:30:18	TAL
41308/WTG02	Delta mode	Turbine 2	Sector 1	Sector 2		
11300, W1002	only	Operational Mode Required Min Wind Speed	1 5,3	6 5,3		LPH
		Max Wind Speed Min Wind Direction Max Wind Direction	14,0 0 90	14,0 90 180	19-01-2015 07:00:25	TAL
		Overall Time Period	24	77		
41309/WTG03	Delta mode	Turbine 3 Operational Mode Required	Sector 1 4	Sector 2		
	only	Min Wind Speed	7,3	9,9		LPH
	-	Max Wind Speed	16,8	16,8	13-01-2015 11:51:11	
		Min Wind Direction	180	180		TAL
		Max Wind Direction Overall Time Period	180 0700-			
41310/WTG04	Delta mode	Turbine 4	Sector 1	Sector 2		
41310/ 1004		Operational Mode Required	6	4		LPH
	only	Min Wind Speed Max Wind Speed	3,9 10,3	10,3 17,3	13-01-2015 12:45:00	L: ::
		Min Wind Direction	all directions	all directions		
		Max Wind Direction Overall Time Period	all directions 24	all directions		LA
41311/WTG05	Delta mode	Turbine 5	Sector 1	Sector 2		
	only	Operational Mode Required Min Wind Speed	N/A N/A	N/A N/A		LPH
	- /	Max Wind Speed	N/A	N/A	13-01-2015 08:07:48	
		Min Wind Direction	N/A	N/A		TAL
		Max Wind Direction Overall Time Period	N/A N/	N/A		N. C.
41312/WTG06	Delta mode	Turbine 6	Sector 1	Sector 2		
41312/ W 1000		Operational Mode Required	6	4		LPH
	only	Min Wind Speed Max Wind Speed	3,9 10,3	10,3 17,3	12 04 2045 12 52 50	LIII
		Min Wind Direction	all directions	all directions	13-01-2015 12:52:50	
		Max Wind Direction	all directions	all directions		LTH
		Overall Time Period	24			
41313/WTG07	Delta mode	Turbine 7 Operational Mode Required	Sector 1 6	Sector 2 2		
	only	Min Wind Speed	5,3	5,3		LPH
	•	Max Wind Speed	15,5	14,0	13-01-2015 08:57:28	
		Min Wind Direction  Max Wind Direction	270 90	90 270		TAL
		Overall Time Period	30 24			5. (
41314/WTG08	Delta mode	Turbine 8	Sector 1	Sector 2		
100 1, 11 1000	only	Operational Mode Required	N/A	N/A		LPH
	Offig	Min Wind Speed Max Wind Speed	N/A N/A	N/A N/A	13-01-2015 09:05:21	
		Min Wind Direction	N/A	N/A	13-01-2013 09.03.21	Z31
		Max Wind Direction Overall Time Period	N/A N/	N/A A		LTH
41315/WTG09	Delta mode	Turbine 9	Sector 1	Sector 2		
, 005	only	Operational Mode Required	6	4		LPH
	Offig	Min Wind Speed Max Wind Speed	3,9 9,9	9,9 17,3	13-01-2015 09:21:27	
		Min Wind Direction	180	180	13-01-2013 03.21.27	
		Max Wind Direction	90	90		LTH
		Overall Time Period	24	п		



Miligation Sector Parameters for NRMS   Implementation of Miligation Stategy   Miligation S						Date and time for the	Initials
Manage	Turbine ID	Generator	Mitigation Sector Parameters for NRMS			implementation of	
Manage		strategy				Mitigation Strategy	
August   Sector   S		G,					
Comparison   Com	/1316/WTG10	Delta mode		Sector 1	Sector 2	,,,,,	
Max Virial Direction	41310/ W TO 10						1.011
Miles Vising Direction		only				1	LPH
A1317/WTG11   Delta mode only   Delta mode onl						13-01-2015 13:53:17	
August   Delta mode only							THE
Part			Overall Time Period	24	17		
Only	41317/WTG11	Delta mode			Sector 2		
Max Vind Speed   S.2   17.3   13-01-2015 13:06:57   Max Vind Direction		only			9,2		LPH
Max Vind Direction		,				13-01-2015 13:06:57	
A1318/WTG12   Delta mode only   Tubbs 12   Tubbs 23   Tubbs 24							JAL
Turbinc 12							216
Only	41210 /WTC12	Dolta mada				1	
Manual Register   Manual Reg	41316/WIG12						ID⊔
Min Wind Direction   190   30   180   30   180   30   180   30   180   30   180   30   180   30   30   30   30   30   30   30		only					LPIT
Max Wind Direction   90   18					<del></del>	13-01-2015 10:25:19	
Aliano							ITH
Only							
Only	41319/WTG13	Delta mode	Turbine 13	Sector 1	Sector 2		
Mill Wind Speed   Signature   Mill Wind Speed   Mill directions	.1515, 111515		Operational Mode Required	6	4		I PH
Min Wind Direction   all directions		Offig				12 01 2015 12:20:10	2
Mark Wind Direction   Su directions   Su dir						13-01-2015 13:20:19	
A			Max Wind Direction	all directions	all directions	1	HIL
Only			Overall Time Period	24	17		
Min Wind Speed   3,3   7,3   12,4   Min Wind Speed   17,3   12,4   Min Wind Direction   180   90   Max Wind Direction   30   180   00   00   Max Wind Direction   30   180   00   00   Max Wind Direction   30   180   00   00   00   00   00   00	41320/WTG14	Delta mode					
Max Wind Speed   17.3   12.4   Min Wind Direction   180   50   180   1		only					IDH
Mills Wind Direction   180   30   180		····,				13-01-2015 10:56:33	
Add   Comparison						13 01 2013 10.30.33	TA
A							
Only						1	
Min Wind Speed   5,3   8,6   17,3   13-01-2015 13:38:40	41321/WTG15	Delta mode				-	
Min Wind Direction   Question   Max Wind Directions   Delta mode   Only   Min Wind Direction   Question   Qu		only					LPH
Max Wind Direction   270   sill directions   24/7						13-01-2015 13:38:40	
Altitude						1	TA
A1322/WTG16   Delta mode only						1	
Only	/1222/MTG16	Dalta mode					
Max Wind Direction   30   31 directions   13-01-2015 12:08:23   Max Wind Direction   0   31 directions   0   0   0   0   0   0   0   0   0	41322/ WIG10		Operational Mode Required			1	IDH
Min Wind Direction   90   all directions   Max Wind Direction   0   all directions   0   0   all directions   0   0   0   all directions   0   0   0   all directions   0   0   0   0   0   0   0   0   0		only				12 04 2045 42 00 22	LFII
Max Wind Direction   0   all directions						13-01-2015 12:08:23	
A1323/WTG17   Delta mode							THE
Only			Overall Time Period	24	17	]	
Min Wind Speed   5,3   8,6   17,3   13-01-2015 12:23:19	41323/WTG17	Delta mode		Sector 1	Sector 2		
Willin Wind Speed   5,3   0,6   17,3   13-01-2015 12:23:19   Willin Wind Direction   30   all directions   Max Wind Direction   0   all directions   0   24/7	,	only			_	4	LPH
Min Wind Direction   30   all directions   Max Wind Direction   0   all directions   Deverall Time Period   24/7		J ,				13-01-2015 12-22-19	
A1324/WTG18   Delta mode only						15 01 2015 12.25.15	TAI
A1324/WTG18   Delta mode only						1	1 H
Only   Operational Mode Required   6   4   Min Wind Speed   5,3   3,2   17,3   Max Wind Speed   3,2   17,3   Min Wind Direction   all directions   all directio					-	1	
Min Wind Speed   5,3   3,2   17,3   13-01-2015 12:39:04   Max Wind Speed   3,2   17,3   Min Wind Direction   all directions   all directions   all directions   overall Time Period   24/7	41324/WTG18	Delta mode					,
Max Wind Speed   3,2   17,3   Min Wind Direction   all directions   all		only					LPH
Max Wind Direction   all directions   all directions						13-01-2015 12:39:04	
Overall Time Period   24/7							TAL
Delta mode only							- 10
Only   Operational Mode Required   6   4	/1325/M/TG10	Delta mode				i	
Min Wind Speed   5,3   8,6	71323/ 00 1019			6			IDH
Min Wind Direction		only				44.04.2045.05.00.45	LT 11
Max Wind Direction 90 90						14-01-2015 07:09:46	
							AA
						1	



					Date and time for the	Initials
Turbine ID	Generator	Mitigation Sector	<b>Parameters</b>	for NRMS	implementation of	
	strategy				Mitigation Strategy	
	0,				dd-mm-yyyy hh:mm:ss	
41326/WTG20	Delta mode	Turbine 20	Sector 1	Sector 2		
11320, 111020	_	Operational Mode Required	6	4		LPH
	only	Min Wind Speed	5,3	8,6		LFII
		Max Wind Speed	8,6	17,3	14-01-2015 07:33:27	
		Min Wind Direction	270	all directions	14 01 2013 07.33.27	TAI
		Max Wind Direction	180	all directions		THE
		Overall Time Period	24	17		
41327/WTG21	Delta mode	Turbine 21	Sector 1	Sector 2		
,	_	Operational Mode Required	6	4		LPH
	only	Min Wind Speed	5,3	8,6		LPII
		Max Wind Speed	8,6	17,3	14-01-2015 08:18:06	
		Min Wind Direction	270	all directions		TAI
		Max Wind Direction	180	all directions		THE
		Overall Time Period	24	17		
41328/WTG22	Delta mode	Turbine 22	Sector 1	Sector 2		
,	_	Operational Mode Required	4	N/A		LPH
	only	Min Wind Speed	7,3	N/A		LPП
		Max Wind Speed	17,3	N/A	14-01-2015 08:38:22	
		Min Wind Direction	180	N/A		TAI
		Max Wind Direction	90	N/A		THE
		Overall Time Period	24	17		

# SCADA mitigation strategy:

SCADA system	VOB	Initials
Park title	Fullabrook	
Country	United Kingdom	
WSMS developed	Week 2 and 3	CHJ // //
WSMS tested finished	21-01-2015	CHJ //
WSMS Start-up date	21-01-2015	СНЈ

Turbine ID		l Direction F From SCAD	Pause system	Date and time for the implementation of Mitigation Strategy dd-mm-yyyy hh:mm	Initials
41317/WTG11	Min Wind Speed Max Wind Speed Min Wind Direction Max Wind Direction Time Period	Shut Down 1 12,2 17,3 270 0 2300-0700	Shut Down 2	21-01-2015 15:00	C HJ
41319/WTG13	Min Wind Speed Max Wind Speed Min Wind Direction Max Wind Direction Time Period	Shut Down 1 12,2 17,3 270 0 2300-0700	Shut Down 2	21-01-2015 15:00	C HJ
41322/WTG16	Min Wind Speed Max Wind Speed Min Wind Direction Max Wind Direction Time Period		Shut Down 2	21-01-2015 15:00	C HJ
41324/WTG18	Min Wind Speed Max Wind Speed Min Wind Direction Max Wind Direction Time Period	Shut Down 1 8,2 12,4 0 90 0700-2300	Shut Down 2	21-01-2015 15:00	C HJ

Operation State

Winddirection

Enabled

Hour Start

Hour Stop

WS Stop

WD Start

WD Stop

Windspeed Avg

WSMS Active

WS Start 12.2

Run

Sector 1

23

16.8

180 [

270

1.89 m/s

116 degrees

Sector 2

180



Turbine ID		d Direction Pa From SCADA	•	Date and time for the implementation of Mitigation Strategy dd-mm-yyyy hh:mm	Initials
41326/WTG20		Shut Down 1	Shut Down 2		0.111
1	Min Wind Speed	8,2	-	24 04 2045 45 00	C HJ
	Max Wind Speed	12,4	-	21-01-2015 15:00	Λ
	Min Wind Direction		-		//14
	Max Wind Direction	90	-		(7)
	Time Period	0700-2300	-		
41327/WTG21		Shut Down 1	Shut Down 2		
11327, 111321	Min Wind Speed	5,3	10,9		C HJ
		2,0	10,0		C 1 13
	Max Wind Speed	12,4	16,8	21 01 2015 15:00	0113
	Max Wind Speed Min Wind Direction	12,4 0	16,8 180	21-01-2015 15:00	PLA
	Max Wind Speed	12,4 0	16,8	21-01-2015 15:00	CH
	Max Wind Speed Min Wind Direction	12,4 0	16,8 180	21-01-2015 15:00	CH)
41328/WTG22	Max Wind Speed Min Wind Direction Max Wind Direction	12,4 0 90	16,8 180 270	21-01-2015 15:00	CHS
41328/WTG22	Max Wind Speed Min Wind Direction Max Wind Direction	12,4 0 30 0700-2300	16,8 180 270 0700-2300	21-01-2015 15:00	СН
41328/WTG22	Max Wind Speed Min Wind Direction Max Wind Direction Time Period  Min Wind Speed Max Wind Speed	12,4 0 30 0700-2300 Shut Down 1 12,2 16,8	16,8 180 270 0700-2300 Shut Down 2 12,2 17,3		CHS
41328/WTG22	Max Wind Speed Min Wind Direction Max Wind Direction Time Period  Min Wind Speed Max Wind Speed Min Wind Direction	12,4 0 90 0700-2300 Shut Down 1 12,2 16,8 180	16,8 180 270 0700-2300 Shut Down 2 12,2 17,3 180	21-01-2015 15:00	CHS
41328/WTG22	Max Wind Speed Min Wind Direction Max Wind Direction Time Period  Min Wind Speed Max Wind Speed	12,4 0 90 0700-2300 Shut Down 1 12,2 16,8 180	16,8 180 270 0700-2300 Shut Down 2 12,2 17,3		CHS

### Explanation to the SCADA WSMS picture:

When the defined criteria in a sector are met, the turbine operation state is changed to Pause. The entry in the alarm log will read "Paused by source 6" (Environmental). All three different criteria will have to be met in order to pause the turbine. If one of the criteria is no longer met the turbine will be put back into production.

- Operation State: Tells what state the turbine is in. (Run = in Production)
- Windspeed Avg: Is the filtered and averaged wind speed signal used by the WSMS
- Winddirection: Is the filtered nacelle position signal used by the WSMS
- WSMS active: Green means that the sector wind direction system is activated
- Enabled: Green tells how many sectors that are used
- Criteria 1: <u>Hour start and Hour stop</u>: If the time is in between the start and stop hour, the frame is green and one of three criteria is met.
- Criteria 2: <u>WS Start and WS stop</u>: If the Wind speed Avg. is in between the start and stop speed, the frame is green and the second out of three criteria is met.
- Criteria 3: <u>WD Start and WD stop</u>: If the Wind direction is in between the start and stop position, the frame is green and the third out of three criteria is met.

• The clock used by the WSMS: The time used is the local time zone





#### How to check the status of WSMS:

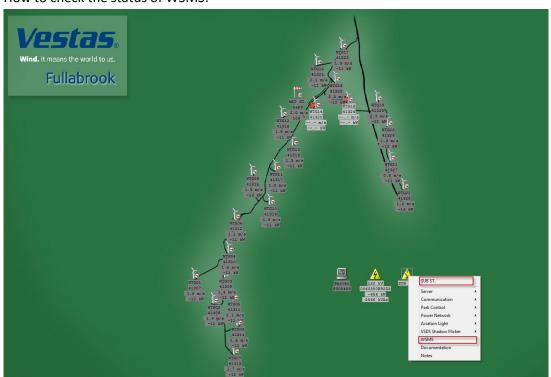


Figure 1 It is visible on the SCADA system by right clicking on the SUB ST icon and choosing WSMS.

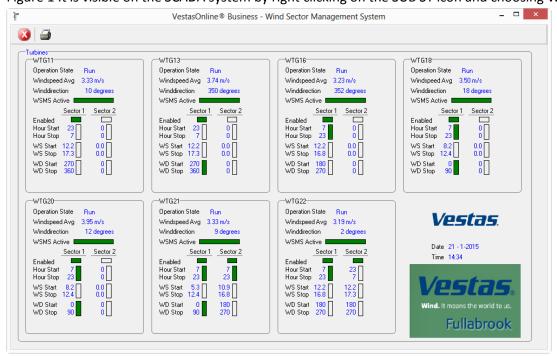


Figure 2 Status WSMS picture



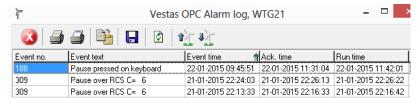


Figure 3 Example from a turbine log where the turbine is paused from the SCADA/WSMS system



### **VTM Turbine Parameter Monitoring**

Turbine Parameter Monitoring is an internal Vestas' tool which allows Vestas to monitor self-selected parameter on individual turbines.

The monitor checks turbine parameter up against a reference database.

The reference database is maintained by Technical Field Support in the regions.

The reference database for Fullabrook wind farm contains noise setting and generator operation mode for all turbines.

The turbine parameter values are supplied from two different sources to the Vestas Database

- 1. If any Vestas computer makes change to a turbine configuration, it is sending the new configuration to Vestas Database afterwards.
- 2. The customers SCADA system collects turbine parameter and transfer the data to Vestas Database on a daily basis.

If selected turbine parameter is different from parameters in reference database, the monitor generates an alert, which is visible to all VTM users at Vestas.

Responsibility for handling alerts from the parameter monitor is the Regions / Technical Field Support department.

Extraordinarily our VTM Specialist will develop an automated status message that will be sent by email to the Vestas customer service manager for Fullabrook with an interval of every quarter or half-year.

From: VWSVDCSupport@vestas.com [mailto:VWSVDCSupport@vestas.com]

Sent: 5. marts 2015 12:32 To: Lars Peter Hansen

Subject: Fullabrook Parameter Alerts.rdl was executed at 3/5/2015 12:32:05 PM

## VTM Parameter status

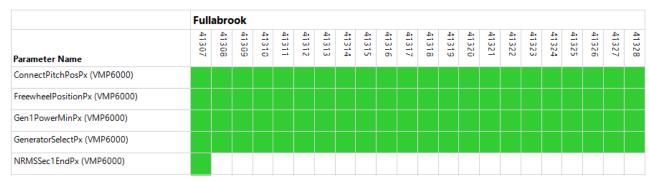


Figure 4 example of a status messages from Turbine Parameter Monitor

Green frame means that the reference database parameter and the actual turbine parameter have an identical value.

White frame means that this parameter the specific turbine is not monitored.

Red frame means that there is a difference in the parameter value between reference database and actual turbine parameter value